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THYMECTOMY IS NOT ASSOCIATED WITH CLINICAL IMPROVEMENT IN A MULTI-CENTER COHORT OF PATIENTS WITH ANTI-MUSK MYASTHENIA GRAVIS

Katherine Clifford (Burlington, VT), Lisa Hobson-Webb (Durham, NC), Michael Benatar (Miami, FL), Ted Burns (Charlottesville, VA), Carolina Barnett (Toronto, Canada), Nicholas Silvestri (Buffalo, NY), James Howard (Chapel Hill, NC), Amy Visser (Portland, OR), Brian Crum (Rochester, MN), Richard Nowak (New Haven, CT), Rachel Beekman (New Haven, CT), Aditya Kumar (New Haven, CT), Katherine Ruzhansky (Charleston, SC), I-Hwei Amy Chen (Charleston, SC), Michael Pulley (Jacksonville, FL), Shannon LaBoy (Jacksonville, FL), Melissa Fellman (Miami, FL), Noah Kolb (Burlington, VT), Shane Greene (Providence, RI), Mamatha Pasnoor (Kansas City, KS), Mazen Dimachkie (Kansas City, KS), Richard Barohn (Kansas City, KS), Michael Hehir (Burlington, VT)

INTRODUCTION: A randomized trial demonstrated benefit from thymectomy in non-thymomatous anti-acetylcholine receptor (AChR) antibody positive generalized myasthenia gravis (MG). Uncontrolled observational studies suggest that thymectomy may not be efficacious in anti-muscle-specific kinase (MuSK) MG. Histological studies demonstrate less hyperplastic thymic tissue in anti-MuSK MG patients compared to anti-AChR MG patients.

OBJECTIVE: To evaluate the therapeutic impact of thymectomy in anti-MuSK MG.

METHODS: Data from a multicenter, retrospective blinded review of rituximab in anti-MuSK MG were analyzed. The primary outcome was the Myasthenia Gravis Foundation of America (MGFA) Post-Intervention Status (PIS). An MGFA PIS score of Minimal Manifestations or better was defined a priori as a favorable outcome. Secondary outcomes included: prednisone dose, other immunosuppressant medications, intravenous immunoglobulin (IVIG) or plasma exchange (PLEX) treatment, and the Myasthenia Gravis Status and Treatment Intensity (MGSTI).

RESULTS: Baseline characteristics were similar between thymectomy (n=26) and non-thymectomy (n=29) groups, including treatment with rituximab (42% versus 45%). Median followup was >3 years. At last visit: (1) 35% (9/26) of thymectomy subjects reached the primary outcome compared to 55% (16/29) of non-thymectomy subjects (p=0.17); and (2) 69% of thymectomy subjects were taking prednisone compared to 41% of non-thymectomy subjects (p=0.058) (median dose 10 mg/day versus 0 mg/day, p=0.04). After controlling for rituximab, baseline prednisone, and final IVIG/PLEX treatment, thymectomy was not associated with greater likelihood of favorable clinical outcome, but broad confidence intervals cannot exclude therapeutic effect (OR: 0.43, 95% CI: 0.13-1.48, p=0.18).

SUMMARY/CONCLUSION: Thymectomy was not associated with additional clinical improvement in this multicenter cohort of anti-MuSK MG patients.

Katherine Clifford, BA
Golseth Young Investigator Award Recipient
ERYTHROMELALGIA AND SENSORY NEUROPATHY IN AUTOIMMUNE HEPATITIS: A CASE STUDY
Long Davalos (Cincinnati, OH), Hani Kushlaf (Cincinnati, OH)

INTRODUCTION: Autoimmune hepatitis (AIH) can be associated with extrahepatic autoimmune disorders. The association between pure sensory neuropathy, erythromelalgia, and AIH has not been described.

OBJECTIVE: To report the clinical presentation and results of diagnostic testing as well as the clinical course of a patient with erythromelalgia, sensory neuropathy, and AIH.

CASE REPORT: A 51-year-old female was diagnosed with AIH, confirmed by liver biopsy and positive anti-smooth antibody (ASMA). During her hospital stay, she developed tingling and burning sensation in her feet up to mid shins, associated with muscle cramps in her calves and feet. Two days later, she noted paresthesia in her hands, and intermittent left facial and scalp paresthesia. Her lower extremity pain progressed to her knees, and she had mild balance difficulties without falls. She was treated with prednisone and azathioprine for the AIH. Eight months later, she developed erythromelalgia in her feet. She had 5 flares/day, exacerbated by physical activity and hot temperature. Examination (not during a flare) revealed stocking decrease of pinprick sensation up to just above the knees and decreased vibration in the big toes. Muscle strength and reflexes were normal. Electrodagnosis showed sensory length-dependent axonal neuropathy. Blink reflexes were normal. Autonomic reflex screen was normal except for postganglionic sudomotor impairment in the distal leg. Extensive laboratory testing for inflammatory, infectious, autoimmune, and metabolic disorders was negative except for a positive ASMA (1:80). Minor salivary gland biopsy was negative for Sjögren's syndrome.

SUMMARY/CONCLUSION: Sensory neuropathy and erythromelalgia can occur in the setting of AIH. Neurologists should be aware of this association.

Long Davalos, MD
Golseth Young Investigator Award Recipient-Runner Up Resident and Fellow Member Award Recipient

QUANTITATIVE CLINICAL AND AUTOIMMUNE ASSESSMENTS IN STIFF PERSON SYNDROME: EVIDENCE FOR A PROGRESSIVE DISORDER
Goran Rakocevic (Philadelphia, PA), Harry Alexopoulos (Athens, Greece), Marinos Dalakas (Philadelphia, PA)

INTRODUCTION: Stiff-person Syndrome (SPs) is a disorder characterized by muscle rigidity and episodic spasms in axial and limb musculature, along with heightened sensitivity to external stimuli.

OBJECTIVE: To describe the natural history of SPS, the extent of accumulated disability, and the associated clinical features in patients prospectively followed for up to 8 years in a single center.

METHODS: Our collective cohort included 57 patients with mean age at disease onset 42 years (range: 22-60). Of these, 32 patients were examined every 6 months over 2 years without receiving immune therapies to assess the disease progression using quantitative scales of stiffness index and heightened sensitivity.

RESULTS: The most frequent initial symptom was leg stiffness, followed by paraspinal muscle rigidity and painful spasms in 95% of patients. Although none required assistance for ambulation during the first 2 years of disease, 46 patients (80%) lost the ability to walk independently during the followup period, despite symptomatic medications. In the longitudinal cohort, the number of stiff areas increased (p<0.0001), consistent with worsening functional status and quality of life. A strong association with the HLA-DR or DQ haplotypes was confirmed.

SUMMARY/CONCLUSION: This is the largest prospective study of SPS patients, followed for up to 8 years at a single center, and the first to provide longitudinal data on SPS natural course in a large patient subgroup using objective clinical measures. The study shows that SPS is a progressive autoimmune disease that leads to disability if therapy is not initiated early or immunotherapy is not applied.

Goran Rakocevic, MD
Best Abstract Award Recipient
VALIDATION OF THE TRIPLE TIMED UP-AND-GO TEST FOR CLINICAL ASSESSMENT IN LAMBERT-EATON MYASTHENIA PATIENTS

Shruti Raja (Durham, NC), Donald Sanders (Durham, NC), Vern Juel (Durham, NC), Yadollah Harati (Houston, TX), A. Gordon Smith (Salt Lake City, UT), Amanda Peltier (Nashville, TN), Jau-Shin Lou (Fargo, ND), David Richman (Sacramento, CA), Angie Wu (Durham, NC), Kathy Ales (Princeton, NJ), Laura Jacobus (Princeton, NJ), David Jacobus (Princeton, NJ), Jeffrey Guptill (Durham, NC)

INTRODUCTION: There are no validated, practical, and quantitative measures of disease severity in Lambert–Eaton myasthenic syndrome (LEMS).

OBJECTIVE: To validate the Triple Timed Up-and-Go Test (3TUG) as a measure of disease severity in LEMS patients.

METHODS: Data from the DAPPER trial were analyzed to assess 3TUG reproducibility and relationships between 3TUG times and other measures of LEMS severity.

RESULTS: For an acceptable difference ≤20%, the coverage probability was 0.93 (95% CI: 0.82-0.99) between repeated time-matched 3TUGs recorded from the same subject by the same observer, and 1.00 (95% CI: 0.92-1.00) between 3TUGs recorded by 2 independent observers. Correlation between 3TUG times and total Lower Extremity Function Scale scores was significant in subjects who continued 3,4-diaminopyridine (3,4-DAP) free base (−0.64, p=0.02) and in those who discontinued 3,4-DAP (−0.64, p=0.01). Worsening of ≥3 points on the Weakness Self-Assessment Scale corresponded with a ≥74% prolongation of 3TUG time (i.e., worsening). An investigator assessment of “much worse” corresponded with a 94% increased 3TUG time. Linear regression of compound muscle action potentials (CMAPs) and 3TUGs showed a trend of lower CMAPs with increasing 3TUG time in subjects who discontinued 3,4-DAP. Correlation between 3TUG time and LEMS and activities of daily living score after withdrawal (0.17) was not significant (p=0.50); there was a significant negative correlation (−0.69, p=0.01) in subjects who continued 3,4-DAP.

SUMMARY/CONCLUSION: The 3TUG is reproducible, demonstrates construct validity, and correlates with changes in specific patient and physician assessments of disease severity. Together with the previously demonstrated reliability, these findings indicate the 3TUG is a valid measure of disease severity in LEMS patients.

Shruti Raja, MD
Best Abstract Award Recipient-Runner Up

ASSOCIATION BETWEEN PLANTER FASCIITIS AND FOOT ENTRAPMENT NEUROPATHY: MUSCULOSKELETAL ULTRASOUND AND ELECTRODIAGNOSTIC STUDY

Naglaa Gadallah (Cairo, Egypt), Nadia Arousi (Cairo, Egypt), Hebatallah Chammy (Cairo, Egypt), Sara Tantawi (Cairo, Egypt)

INTRODUCTION: Planter fasciitis (PF) is the most common cause of heel pain. It may be correlated with dysfunction of planter or calcaneal nerves.

OBJECTIVE: To assess the possible association between PF and foot entrapment neuropathy.

METHODS: This study included 40 patients (80 feet) with primary PF (unilateral/bilateral) and 20 matched control subjects (40 feet). Musculoskeletal foot ultrasound (US) examination was performed. PF was considered present if 2 of the following are found: local inflammatory changes, fibrous or calcified tissue around the medial calcaneal tuberosity, thickened plantar fascia >4 mm, and/or decreased echogenicity. Motor and sensory NCSs of the bilateral medial and lateral planter nerves (MPN-LPN) and sensory NCSs of the medial calcaneal nerve (MCN) were performed.

RESULTS: US examination showed that 56/58 diseased feet had abnormal thick planter fascia (>4 mm), compared to the unaffected contralateral feet (<3.7 mm) and control subjects (<3.5 mm). Hypoechogenicity was detected in 44 feet. NCSs showed abnormal values in 28 feet: 18 MPN, 14 LPN, 10 MCN, and 10 combined 2 or 3 nerves. Of the 22 contralateral asymptomatic feet, 8 showed abnormal delayed latencies: 6 with single nerve affection and 2 with simultaneous sensory affection of 3 nerves. A significant negative correlation was found between PF disease duration and the motor response amplitude of the MPN. Planter fascia thickness showed negative correlation with sensory amplitude, and positive correlation with sensory latency of the LPN.

SUMMARY/CONCLUSION: Our findings support the hypothesis that PF characterized by abnormal thickened fascia is the cause or at least is associated with planter nerve neuropathy.

Naglaa A. Gadallah, MD
President's Research Initiative Award Recipient

Naglaa A. Gadallah, MD
AANEM Foundation International Fellowship Award Recipient
HOW OFTEN IS MOLECULAR THERAPY AN OPTION FOR DUCHENNE MUSCULAR DYSTROPHY PATIENTS
Hui Yang (Gaithersburg, MD), Katelyn Beattie (Gaithersburg, MD), Patrick Reed (Gaithersburg, MD), Meg Bradbury (Gaithersburg, MD), Amanda Lindy (Gaithersburg, MD)

INTRODUCTION: Duchenne muscular dystrophy (DMD) is a severe, early-onset disorder that results from pathogenic variants in the DMD gene and affects 1/5000 males. Exon skipping (ES) and nonsense read through (NRT) therapies have recently gained FDA approval for specific DNA defects. ES therapies facilitate the excision of a specific exon to restore the reading frame when combined with a specific out-of-frame deletion. This results in a truncated, but somewhat functional, protein, thus ameliorating the phenotype. ES therapies for exons 45, 51, and 53 are currently available, and preclinical development is underway for exons 35, 44, 50, 52, 55, 43, and 8. NRT therapy promotes the replacement of premature termination codons with random amino acids, allowing for the production of full length protein.

OBJECTIVE: To determine what proportion of DMD patients are eligible for variant-specific therapy.

METHODS: We evaluated a cohort of 269 males with a clinical suspicion of DMD to identify therapy-amenable DNA defects.

RESULTS: A positive diagnosis was reported in 68% (183/269) of individuals. The mean age at molecular testing was 11 years. A total of 136 pathogenic copy number variations (CNVs) and 21 nonsense variants were identified. Forty CNVs were amenable to exon 45, 51, or 53 skipping, and another 22 were amenable to pending therapies. Overall, 45.4% (83/183) of pathogenic variants were treatable.

SUMMARY/CONCLUSION: Although the efficacy of ES and NRT therapies is still being investigated, our data demonstrate that a significant proportion of males (83/269; p<0.001) harbor a treatable variant and highlight the importance of molecular diagnosis in the era of precision medicine.

Hui Yang, PhD
President’s Research Initiative Award Recipient

SUPRASCAPULAR NEUROPATHY: A REVIEW OF 87 CASES
Anza Memon (Detroit, MI), Braydon Dymm (Detroit, MI), Bashiruddin Ahmad (Detroit, MI), Lonni Schultz (Detroit, MI), Arun Chandok (Detroit, MI)

INTRODUCTION: Suprascapular neuropathy (SSN) is rare, with an estimated prevalence of 4.3% in patients with shoulder pain. Symptoms and physical findings can mimic rotator cuff disease.

OBJECTIVE: To understand the etiology, clinical presentation, EDX findings, and recovery time in patients with SSN.

METHODS: A retrospective chart review of patients with an EDX code of SSN seen between January 2000-December 2016 was performed. Demographics and detailed clinical information were recorded and included the date of diagnosis, side of injury, potential etiology, muscle atrophy, pain, weakness, treatment, and recovery. Detailed EDX data were also recorded. Two sample t-tests, Wilcoxon 2-sample tests, and chi-square tests were used to compare the subgroups, as well as assess association of EDX measures with recovery.

RESULTS: Of the 87 patients included, 57 were male, 63 were Caucasian, 19 were African American. The mean age at diagnosis was 47.3 years. Idiopathic etiology was the most common with 41 (47%) patients, followed by falls in 13 (15%), motor vehicle accident in 12 (14%), sports related in 9 (10%), and lifting related in 3 (3%). Of the 9 patients with sports related etiology, 4 were related to football and 1 for each of the following: cheerleading, golf, softball, swimming/hockey, and boxing. Of the 87 patients, 58 had isolated SSN (I-SSN), 24 had SSN associated with axillary neuropathy (A-SSN), 2 had brachial plexopathy, 2 had long thoracic, and 1 had radial SSN.

SUMMARY/CONCLUSION: Axillary neuropathy is commonly associated with SSN. Idiopathic etiology is the most common followed by trauma. EDX findings aid in the initial diagnosis, but do not correlate with prognosis.

Anza Memon, MD
President’s Research Initiative Award Recipient
**9**

**CORRELATION BETWEEN ELECTRICAL IMPEDANCE MYOGRAPHY AND TWO QUANTITATIVE ULTRASOUND PARAMETERS IN DUCHENNE MUSCULAR DYSTROPHY**

**Bhaskar Roy** (New Haven, CT), **Basil Darras** (Boston, MA), **Craig Zaidman** (St Louis, MO), **Jim Wu** (Boston, MA), **Kush Kapur** (Boston, MA), **Seward Rutkove** (Boston, MA)

**INTRODUCTION:** Quantitative ultrasound (QUS) and electrical impedance myography (EIM) are potential noninvasive biomarkers of Duchenne muscular dystrophy (DMD).

**OBJECTIVE:** To correlate grayscale levels (GSLs) and quantitative backscatter analysis (QBA) with EIM parameters.

**METHODS:** QUS parameters along with EIM 50 kHz phase, 100/300 kHz phase ratio, and slope were recorded from 6 muscles at baseline, 6 months, and 12 months from an ongoing study with 36 DMD and 29 healthy boys.

**RESULTS:** Among the DMD boys, GSL and QBA values showed significant correlation with all EIM parameters in the biceps brachii and deltoid. Particularly strong correlation was noted at 12 months in biceps with EIM 100/300 ratio and EIM-slope; spearman rho was −0.67, 0.7, respectively, for GSLs (p<0.01) and −0.72, 0.73, respectively, for QBA (p< 0.001). Significant correlation was noted in forearm muscles with EIM-50 kHz. Quadriceps and gastrocnemius showed weak-to-moderate correlation inconsistently. When considered in groups, proximal muscles, upper extremity muscles, and all 6 muscles averaged showed significant correlation throughout with all EIM parameters for both GSL and QBA values. In majority of the occasions, spearman rho >0.5 and p<0.05. Changes in GSL and QBA values from baseline to 12 months were correlated with changes in different EIM parameters from baseline to 12 months. No consistent correlation was noted in individual muscles, however, consistent correlation pattern was noted when muscles were considered in groups. No similar significant correlation pattern was noted among healthy subjects.

**SUMMARY/CONCLUSION:** Moderate correlation of QUS with EIM parameters probably suggests the distinct nature of the muscle health information provided by these parameters.

Bhaskar Roy, MD, MMST  
President’s Research Initiative Award Recipient

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**10**

**NOVEL PHYSICAL THERAPY INTERVENTION FOR PATIENTS WITH CHARCOT MARIE TOOTH. A RETROSPECTIVE CASE SERIES**

**James Nussbaum** (New York, NY)

**INTRODUCTION:** There is no cure for patients with Charcot–Marie–Tooth (CMT) disease, and upon being diagnosed patients are often told there is nothing to be done to help them. The common phenotype in CMT includes imbalance, difficulty with mobility, gait deviations, pes cavus, and difficulties with activities of daily living due to distal sensory and motor impairments. Numerous specialties in healthcare typically address these and other issues commonly presented by CMT patients, including physical and occupational therapy, orthotic management, and orthopedic consults.

**OBJECTIVE:** To explore outcome measures in 5 consecutive patients with CMT who participated in a novel 3-step therapeutic intervention aimed at improving mobility, balance, and quality of life.

**METHODS:** Participants participated in twice or thrice weekly visits for 2 months. The intervention included gravity assisted ambulation with visual feedback, standing balance activities with gravity assistance, and lower extremity (LE) functional strength training using a Hi-Lo table to promote success and reinforce biomechanics for transfers. Pre and post testing demonstrated significant improvements in mobility, balance, and LE functional strength.

**RESULTS:** The mean change in outcome measures were as follows: 6 minute walk test: +243.4 ft; Berg Balance Scale: +3.6; 20 ft self-selected gait speed: −0.42 seconds; 20 ft fast gait speed: −0.65 seconds; 20 ft fast retro gait: −2.84 seconds; sit to stand in 30 seconds: +4.8 repetitions; 4 square test: −7.27 seconds.

**SUMMARY/CONCLUSION:** A focused therapeutic intervention in CMT patients may improve balance, mobility, and functional strength without any observed or reported adverse events.

James Nussbaum, PT, PhD, SCS, EMT  
President’s Research Initiative Award Recipient
A NOVEL COMPOUND HETEROZYGOUS MUTATION IN TITIN LEADS TO CORE MYOPATHY WITH HEART DISEASE
Ryan Castoro (Nashville, TN), Jean Pierre Betancourt (Nashville, TN), Stacy Stark (Nashville, TN)

INTRODUCTION: Titin is a large sarcomeric protein involved with muscle contraction and sarcomere structure. Mutations in Titin have been shown to cause several myopathic and cardiomyopathic diseases. Infantile hypotonia can result from several neuromuscular disorders such as spinal muscle atrophy, RASopathies, and core myopathy with heart disease, to name a few.

OBJECTIVE: To identify a genetic explanation for a patient's infantile hypotonia.

CASE REPORT: Here we present a 2-month-old female with a history of cardiac anomalies who presented to our hospital for respiratory failure and hypotonia. We first used targeted next generation sequencing for RASopathies, congenital fiber type disproportion disease, and spinal muscle atrophy. We next performed whole exome next generation sequencing. At 4 months of age she underwent needle EMG/NCSs and a muscle biopsy. She was followed for 3 years in clinic with serial examinations, radiographs, echocardiograms, and pulmonary function tests.

RESULTS: Whole exome next generation sequencing results identified a previously unreported compound heterozygous mutation in Titin: c.50683_50864dupGG p.K16956Vfs*8; c.977782, p.W32594Cfs*8. The heterozygous mutations each co-segregated in her parents. Muscle biopsy demonstrated type 1 fiber predominance with moderate variation in size. Needle EMG/NCSs were nondiagnostic. She was followed for 3 years in clinic with serial examinations, radiographs, echocardiograms, and pulmonary function tests.

SUMMARY/CONCLUSION: Here we describe a novel compound heterozygous mutation that leads to core myopathy with heart disease. Additionally, through this patient and a literature review we provide an in-depth phenotypic classification of infantile Titinopathies.

Ryan Castoro, DO, MS
President’s Research Initiative Award Recipient

CLINICAL, LABORATORY AND ELECTRODIAGNOSTIC FEATURES OF ZINC DEFICIENCY-INDUCED PERIPHERAL NEUROPATHY
Favio Bumanlag (Philadelphia, PA), Jin Luo (Philadelphia, PA)

INTRODUCTION: Zinc, an essential trace element, participates in more than 200 enzymatic reactions and plays critical roles in maintaining normal structural-functional conditions of multiple systems. Peripheral nerves are susceptible to damage from zinc deficiency. Unfortunately, zinc deficiency-induced peripheral neuropathy (PN) is often misdiagnosed or delayed in diagnosis. Literature on zinc deficiency-induced PN is sparse.

OBJECTIVE: To study the clinical and electrophysiologic features of zinc deficiency-induced PN.

METHODS: We retrospectively reviewed the charts of our neuromuscular clinic/EMG laboratory database from January 1, 2015 to December 31, 2017 to identify patients with PN and zinc deficiency. Subjects who had an abnormal copper level were excluded. Data and findings were obtained including clinical presentations, past medical histories, body mass index, neurological examinations, laboratory results, and records of needle EMGs/NCSs.

RESULTS: Twelve patients (mean age: 55.1±16.7 years; M/F: 6/6; zinc: 52.5±6.2 mcg/dL, range: 37-134 mcg/dL; copper: 107.6±26.4 mcg/dL, range: 84-173, [ref: 72-166 mcg/dL]) were included. Of those, 11 received an electrophysiologic evaluation. The notable findings in presentation included paresthesia (75%) and gait abnormalities (42%), but only one obesity (8%). Three had diarrhea (25%). Neurological examination showed sensory deficits (83%), reduced tendon reflexes (67%), and abnormal Romberg test (67%). Cerebrospinal fluid protein was increased in 4/5 subjects. Electrophysiologic evaluations showed demyelinating PN features (28%) and distally active denervation preferably in the lower extremities. Detailed results of clinical, laboratory, and EDX findings will be presented.

SUMMARY/CONCLUSION: Recognition of the features of zinc deficiency-induced PN will help effectively manage patients.

Favio Bumanlag, CNCT, R.NCS.T
Technologist Member Award Recipient
AGAROSE BASED ACETYLCHOLINE REDUCES QUANTITATIVE SUDOMOTOR AXON REFLEX TEST’S (QSART) FALSE POSITIVES

Ali Arvantaj (Cleveland Heights, OH), Karen Spencer (Cleveland, OH), Sally Tsirambidis (Westlake, OH), Kimberly Mantz (Northfield, OH), Jenice Robinson (Beachwood, OH), Bashar Katirji (Cleveland, OH)

INTRODUCTION: The quantitative sudomotor axon reflex test (QSART) is a useful measure of postganglionic sudomotor function. It is based on the iontophoresis of either acetylcholine (ACh) solution or agarose based ACh gels which induces a local sweat response.

OBJECTIVE: To investigate effectiveness of agarose based ACh in reducing QSART’s false positives.

METHODS: We compared QSARTs using ACh gel in 2017-2018 on 250 patients with 556 QSARTs performed with liquid ACh during 2015-2016. Patients with abnormal values were divided into 3 groups. Group 1—true small fiber neuropathy (SFN)—had reduced QSART values, not related to medication effects, and confirmed with presence of at least 1 of the following: symptoms consistent with SFN, underlying illness commonly associated with SFN (diabetes mellitus, amyloidosis, etc.), and abnormal skin biopsy, rechecked by QSART or abnormal thermoregulatory sweat testing. Group 2—technical—cases had low QSART values, stopped medication, but did not meet Group 1 confirmation requirements. Group 3—medication effect—had reduced QSARTs due to medications that often affect sudomotor functions (such as amitriptyline).

RESULTS: In the liquid ACh group, 139/556 (25%) had reduced QSART values: technical: 61 (10.9%), medication effect: 42 (7.5%), true SFN: 36 (6.5%). In the ACh gel group, 41/250 (16.4%) had reduced QSART values: technical: 10 (4%), medication effect: 15 (6%), true SFN: 16 (6.4%). Technical problems with QSART dropped from 10.9% (liquid) to 4% (gel), which is statistically significant (chi square statistics 8.4, p=0.0037).

SUMMARY/CONCLUSION: Agarose based ACh gel is technically significantly better than ACh liquid, and reduces false–positive diagnoses of SFN.

Ali Arvantaj, CNCT, CAP
Technologist Member Award Recipient Runner Up

UTILITY OF OUTPATIENT AUTONOMIC ROTATION AT VETERANS AFFAIRS TO BENEFIT RESIDENT/FELLOW EDUCATION

Jasvinder Chawla (Hines, IL), David Kvarnberg (Hines, IL), Matthew McCoyd (Maywood, IL)

INTRODUCTION: Autonomic disorders are common but not frequently recognized by residents given limited exposure. A dedicated rotation focusing on autonemics education is generally not part of residency programs. Residents frequently encounter diverse autonomic issues either in the inpatient, consultation, or their continuity of care clinic setting.

OBJECTIVE: To propose the development of a structured elective in autonomic disorders, specifically designed to meet the needs of residents and fellows.

METHODS: An intensive autonomic rotation will be incorporated into a 4-week neuromuscular block. The authors discuss the structure of the training program, including goals, objectives, and core competencies. The academic teaching rotation will feature many experiences, including (1) daily participation in group teaching activities, (2) opportunities for participation in admission interviews, (3) basic and invasive autonomic testing proficiency, (4) presentation of a clinical case at the monthly neuromuscular clinical conference, (5) completion of a pre- and post-rotation assessment with focus on autonomic disorders, and (6) independent scholarly activities such as the preparation of an article suitable for publication. Methods are presented of differentiating curricula to increase applicability across the spectrum of training programs that vary in available resources.

SUMMARY/CONCLUSION: Current exposure to autonomic disorders in residency programs is meager. An academic teaching-based autonomic rotation as part of a neuromuscular elective can provide residents with experiences beyond those typically offered in residency programs. We will monitor the impact of the autonomic rotation via feedback, testing assessments, and resident/fellows evaluations, which will ultimately improve patient care. We highly recommend similar models be incorporated in other residency programs.
AAVEM SURVEY OF EMG AND NERVE CONDUCTION STUDY TRAINING IN US RESIDENCY PROGRAMS
Peter Donofrio (Nashville, TN), Raghav Govindarajan (Columbia, MO)

INTRODUCTION: Little literature exists overviewing resident training in peripheral EDX.

OBJECTIVES: To survey United States residency programs in neurology and physical medicine and rehabilitation (PM&R) on EDX.

METHODS: AANEM surveyed 93 neurology and PM&R residency programs on 24 topics regarding training house officers in the technique and performance of peripheral EDX.

RESULTS: Sixty-five percent of the programs responding were neurology and 34% were PM&R. Four to eight weeks of training was most common (range: 2-48 weeks). The sequence of training was continuous in 50% of programs and fragmented in 50%. Training in needle EMG was required in 94% of programs. Training primarily occurred in the second and third years of residency. The majority of programs had more than 3 attending physicians educating the house staff. More than 80% of programs conducted organized needle EMG and neuromuscular teaching conferences as part of the rotation. Performance of the needle examination was observational only in 8% of programs and in 61% the trainee was supervised continuously by faculty. The number of NCSs performed independently varied greatly among the programs. Other results to be reported include average number of needle examinations performed, organization of NCS training, written/oral examinations, muscle/nerve biopsy reviews, and training materials.

SUMMARY/CONCLUSION: The AANEM survey demonstrated a large variability in the requirements for training residents in the performance of peripheral EDX. The results raise the need for developing uniform requirements for training house residents.

BILATERAL FOOT DROP CAUSED BY T12 INFECTIOUS SPONDYLITIS AFTER VERTEBROPLASTY
Je-Sang Lee (Busan, South Korea), Yong Beom Shin (Busan, South Korea)

INTRODUCTION: The most common cause of foot drop is lumbar degenerative disc herniation, particularly at L4/5. Foot drop resulting from thoracolumbar lesions is rare, and a T12 lesion is a quite rare cause associated with foot drop.

CASE REPORT: A 69-year-old man presented with sudden onset, severe bilateral leg pain and bilateral foot drop. Radiologic findings revealed T12 spondylitis compressing the conus medullaris. He underwent vertebroplasty for a T12 compression fracture after falling 6 months prior. On physical examination, bilateral foot drop with radiculopathy of the L5 dermatome was identified and an upper motor neuron sign was revealed. An acute bilateral L5 root lesion as well as a conus medullaris lesion were found on needle EMG. Surgery was performed for decompression and reconstruction. Afterwards, the muscle strength of the lower extremities recovered to good grade from trace grade, and he could walk without a cane. Microbiologic assessment revealed no causative pathogens. Empirical antibiotics with an antituberculotic drug were administrated.

CONCLUSION: This case, to the author’s knowledge, is a very rare report of bilateral foot drop associated T12 infectious spondylitis after vertebroplasty. It is essential to keep in mind that fracture can occur at the site of vertebroplasty and to understand T12-L1 lesion anatomy, in addition to performing needle EMG in a case of atypical neurological deficit such as this one, bilateral L5 root lesion due to T12 compression fracture.
17 SPINAL ACCESSORY AND SUPRASCAPULAR NERVE INJURY FOLLOWING HUMAN BITE: A CASE REPORT
Marine Dididze (North Bay Village, FL), William Ward (Miami, FL), Kathya Ramos Vargas (Miami, FL)

INTRODUCTION: The spinal accessory (SAN) and suprascapular (SN) nerves are susceptible to local trauma due to their location.

OBJECTIVE: To report the first case of SAN and SN damage related to human bite.

CASE REPORT: A 23-year-old right-handed man with no relevant past medical history presented complaining of right shoulder weakness, pain, and difficulty with overhead lifting and shoulder abduction/flexion following a human bite to the right neck that occurred 3 months ago. He initially had right arm numbness/tingling which resolved. The next day he experienced neck stiffness that evolved into shoulder pain. Focused physical examination revealed right scapular winging (medial and lateral component) between 60-90 degrees, worse at 60 degrees; wall pushup with right-sided lateral more than medial winging; weakness in external rotation in the right shoulder compared to the left; and trigger and tender point in right supraspinatus with palpable soft tissue prominence. MRI of the cervical spine showed small disc osteophyte at the level of C5-6 vertebrae without other changes. MRI of right brachial plexus was normal. NCSs revealed a right SAN injury as evidenced by an 88% decrease in amplitude compared to the left. Needle EMG revealed moderate active denervation potentials in the right trapezius muscle with evidence of reinnervation. A NCS in the right scapular nerve was normal, but needle EMG revealed mild denervation potentials in the right supraspinatus muscle with evidence of reinnervation, indicating a less prominent right SN injury.

SUMMARY/CONCLUSION: Although neck surgery is considered the most common cause of SAN and SN injury, local trauma should be included in a differential diagnosis.

Marine Dididze, MD, PhD
Resident and Fellow Member Award Recipient

18 AUDIO FEATURES AND MACHINE LEARNING FOR IDENTIFICATION OF NEEDLE EMG SIGNALS
Hiroyuki Nodera (Tokushima, Japan), Yusuke Osaki (Tokushima, Japan), Hiroki Yamazaki (Tokushima, Japan), Atsuko Mori (Tokushima, Japan), Yuishin Izumi (Tokushima, Japan), Ryuji Kaji (Tokushima, Japan)

INTRODUCTION: The diagnostic importance of audio signal characteristics in needle EMG is well recognized. For clinical analysis of waveform identification, EDX practitioners often depend heavily on the sounds that are produced by different kinds of spontaneous and voluntary activated muscle potentials during needle EMG.

OBJECTIVE: To study audio characteristics of representative needle EMG signal patterns and apply them for classification by machine learning algorithms.

METHODS: Audio files of 9 classes of needle EMG signals were trimmed into 2-second segments. Two sets of audio features (384 and 4367 features each) were used to classify using 4 machine learning algorithms.

RESULTS: With 841 audio files, the support vector machine with a larger feature set showed the best overall accuracy of 88.5%. A larger number of audio features yielded higher accuracies in 3 out of 4 classifiers than the smaller set. Attribute selection methods showed that mel-frequency cepstral coefficients (MFCC)-related features were useful in correct classification.

SUMMARY/CONCLUSION: Audio features extracted from needle EMG signals can be a valuable tool to classify various signal patterns in the clinical needle EMG testing.
19

TRICEPS: A STUDY OF KINETICS AND FIBER DISTRIBUTION OF THE THREE MUSCLE HEADS FOR A BETTER C7 MYOTOMAL EMG STUDY
Sankar Bandyopadhyay (Hershey, PA)

INTRODUCTION: During training, residents and fellows often learn a method of choosing 1 particular head out of the 3 heads of the triceps muscle. The triceps is a prime example of where application of anatomy and neurokinetic principles can lead to a more meaningful needle EMG study.

OBJECTIVE: To improve the triceps muscle needle EMG.

METHODS: Review of muscle anatomy and kinetic physiology from Gray's Anatomy and available EMG literature.

RESULTS: The activation sequence of the triceps muscle, with increasing efforts, is medial followed by lateral followed by the long heads of triceps. With lower efforts, type 1 fibers are preferentially recruited; and with higher effort, larger type 2 fibers. Conventional needle EMG, basically, is a study of type 1 fibers. Selective activation of the medial head of the triceps or anconeus involves largely type 1 fibers. Lateral head activation leads to a combination of type 1 and 2 fibers, and the long head, predominantly type 2 fibers. Most EDX practitioners check the more proximal and deeper lateral or long head with a higher proportion of C6 contribution, compared to the superficial medial head. The latter also has a lower chance of bleeding and ease with a 30-gauge needle and is used almost exclusively for checking C7, the most important reason for checking the triceps. Other heads need stronger activation often activating larger type 2 fibers, inadvertently showing "large units" leading to an erroneous diagnosis of chronic C7 radiculopathy.

SUMMARY/CONCLUSION: A better adherence to knowledge of anatomy, fiber distribution, and muscle kinetics, and a willingness to change tradition may be scientifically more rewarding in the EMG laboratory.

20

SENSORY GUILLAIN BARRE SYNDROME: REVIEW OF CASES
Fatima Pantiu (Buenos Aires, Argentina), Luciana León Cejas (Buenos Aires, Argentina), José Crespo (Buenos Aires, Argentina), Cintia Marchesoni (Avellaneda, Argentina), Ana Pardal (Buenos Aires, Argentina), Ricardo Reisin (Buenos Aires, Argentina)

INTRODUCTION: The classic Guillain–Barré syndrome (GBS) is characterized by motor weakness, hyporeflexia, but limited sensory deficits. Sensory variants involving either small or large fibers or both are unusual and represent a diagnostic challenge.

OBJECTIVE: To describe patients presenting with the sensory variant of GBS.

METHODS: We retrospectively analyzed the clinical and electrophysiological findings of patients fulfilling the criteria for sensory GBS according to the Oh criteria (Oh and colleagues 2001).

RESULTS: Six patients were identified (mean age: 38 years; range: 15-54). Four had a previous infection. They all consulted due to distal painful paresthesias and allodynia. On examination the 6 patients presented normal strength and normal cranial nerves through the course of the disease with reduced knee and ankle reflexes in 3 patients. Distal hyperesthesia to pinprick was identified in 3, and 1 of them additionally had hyperhidrosis and constipation. Two additional patients presented hypoesthesia to pinprick and temperature. One patient had distal proprioceptive sensory loss with sensory ataxia. Cerebrospinal fluid albumin cytological dissociation was present in 3 patients. NCSs identified a sensory motor demyelinating neuropathy in 2 patients. Among the 4 with normal NCSs, 2 had abnormal cold and warm threshold in their quantitative sensory testing evaluation. All patients received symptomatic treatment for the neuropathic pain and only 2 IV immunoglobulin therapy. Longstanding pain, fatigue or both were persistent findings in 5 patients after a mean followup of 6 months.

SUMMARY/CONCLUSION: The sensory variant of GBS is both an infrequent presentation and a diagnostic challenge. Longstanding pain and fatigue are common persisting findings.

Fatima Pantiu, MD
IFCN Award Recipient
BILATERAL PROXIMAL MEDIAN NEUROPATHY: AN UNCOMMON FINDING IN A PATIENT WITH COMMON COMPLAINTS
Collin Grant (Columbus, OH), Peter Grant (Medford, OR), William Pease (Columbus, OH)

INTRODUCTION: Median neuropathies are common in EDX practice, and by far the most common entrapment is in the carpal tunnel. However, entrapment sites arise from: compression between the 2 heads of the pronator teres or between the pronator teres and the fibrous arch of the flexor digitorum superficialis (pronator teres syndrome), entrapment or injury of the pure motor anterior interosseous branch of the median nerve (anterior interosseous syndrome), the thickened fascia that serves to attach the biceps to the ulna (bicipital aponeurosis or lacertus fibrosus), or a fibro-osseous ligament extending from a bony spur of the distal humerus (ligament of Struthers).

CASE REPORT: A middle aged male presented to the clinic after 3 months of paresthesias in both hands, left worse than right. This is a rare case of proximal median neuropathy, likely due to an anatomical variance causing bilateral compression by the ligament of Struthers or bilateral bicipital aponeurosis/lacertus fibrosus. Differentiation between these last 2 diagnostic entities would necessitate an anatomical study such as ultrasound or MRI. EDX testing showed bilateral median neuropathy with entrapment localized to the elbow area bilaterally. Needle EMG showed significant muscle membrane instability and neuropathic motor unit abnormalities in all median-innervated muscles up to and including the pronator teres.

SUMMARY/CONCLUSION: Although CTS is extremely common in the EDX laboratory, it is important for clinicians to keep in mind the less common causes of median neuropathy. This case emphasizes this and highlights an extreme case of anatomical variance causing very uncommon bilateral proximal median entrapments.

HIGH IMPACT TRAUMA, ROOT AVULSION, AND ELECTROPHYSIOLOGY
Paul Overdorf, Jr. (Hershey, PA), Aiesha Ahmed (Hershey, PA)

INTRODUCTION: Brachial plexus injuries occurring from high energy trauma often have a poor prognosis. Narakas described the incidence of brachial plexus injuries in 1068 patients over 18 years: 72% involved road traffic accidents, with 70% of those involving motorcycle or pedal cycles. Characterized further, avulsion injuries have a worse prognosis than acute ruptures.

OBJECTIVE: To describe some of the classic diagnostic findings seen in nerve root avulsions.

CASE REPORT: A 20-year-old male presented with a 2-month history of right upper limb weakness and numbness after a right distal third humerus fracture secondary to a high speed motorcycle accident. His examination revealed diffuse atrophy of the right arm, complete plegia, and anesthesia of the entire extremity with a preserved shoulder shrug. EDX testing revealed acute brachial plexopathy with loss of axonal continuity in all muscles tested except for the rhomboids and trapezius. Chronic denervation was noted in the rhomboids with normal motor units in the trapezius. MRI to evaluate the right upper extremity plexus revealed nerve root avulsion involving the right C6, C7, C8, and T1 nerves with pseudomeningocele formation.

SUMMARY/CONCLUSION: In this patient, the EDX studies pointed to a root greater than distal pan brachial plexus injury. MRI was able to confirm the nerve root avulsions. Unfortunately for this patient, Narakas described the Law of the Seven Seventies (approximation) for traumatic brachial plexus injuries, which in part notes that 70% will experience persisting pain. The patient is to undergo computed tomography myelogram to further characterize the injury for more definitive treatment plans.
ASSOCIATION OF GRIP STRENGTH WITH THE SEVERITY OF CARPAL TUNNEL SYNDROME
Stephen Kishner (New Orleans, LA), Paige Davis (New Orleans, LA), Donald Mercante (New Orleans, LA)

INTRODUCTION: CTS generally shows reduced grip strength compared to control subjects. Grip strength is temporarily reduced after CTS surgery, and it can take several months for this to normalize. Grip strength may improve quicker after endoscopic release compared to open release. Given time, there can be a further improvement of grip strength compared to preoperative values.

OBJECTIVE: To determine if there is any correlation between grip strength and EDX severity of CTS.

METHODS: An average of 3 grip strength measurements was completed at the time of EDX testing. Grip strength loss from predicted normal values was obtained. The correlation of grip strength loss and EDX parameters was analyzed.

RESULTS: Dominant hand CTS showed a weak but significant correlation of reduced grip strength with prolonged motor latency and with reduced sensory amplitude. However, the non-dominant hand did not show any correlation.

SUMMARY/CONCLUSION: There appears to be a weak but significant correlation between the loss of grip strength and the EDX severity of CTS, but only in the dominant hand.

ASSOCIATION OF ULNAR NEUROPATHY ACROSS THE ELBOW AND DIABETES
Stephen Kishner (New Orleans, LA), Paige Davis (New Orleans, LA), Donald Mercante (New Orleans, LA)

INTRODUCTION: Entrapment neuropathies such as CTS and ulnar neuropathy across the elbow (UNE) have been commonly associated with diabetes. Education and working level, as well as smoking, have been associated with UNE.

OBJECTIVE: To determine if there is any correlation between UNE and the duration or severity of diabetes.

METHODS: Eighty patients referred to the EDX laboratory were evaluated for the presence UNE, diabetes, duration of diabetes, and severity of diabetes. Severity of diabetes was graded by diet controlled, controlled by oral agents, or insulin requiring.

RESULTS: Both Fisher’s exact test and chi-square analysis suggest that diabetes is associated with UNE and male gender. However, there was no correlation between UNE with duration or severity of diabetes.

SUMMARY/CONCLUSION: UNE appears to be associated with diabetes and male gender. No association could be found with UNE and duration or severity of diabetes.
MYASTHENIA GRAVIS COEXISTING WITH INFLAMMATORY MYOPATHY: A CASE REPORT
Erica Seidel (Minneapolis, MN), George Manousakis (Minneapolis, MN)

INTRODUCTION: There are some case reports of myasthenia gravis (MG) associated with inflammatory myopathies, however this association most often occurs in the presence of a thymoma.

OBJECTIVE: To report a rare case of MG associated with an inflammatory myopathy without thymic pathology.

CASE REPORT: A 56-year-old male with a history of MG with positive acetylcholine receptor antibodies status post thymectomy in 1993 presented with a three-month history of progressive bilateral upper extremity weakness. Examination showed weakness predominantly affecting the deltoids, triceps, wrist, and finger extensors. Routine NCS were normal. Repetitive stimulation of the ulnar nerve showed a decrement of 18% which did not repair after 1 minute of isometric exercise. Needle exam showed early recruitment of small, short duration, polyphasic units at the biceps, triceps, deltoid, extensor carpi radialis (ECR), extensor digitorum communis (EDC), and extensor indicis proprius (EIP). Fibrillations were also noted in the deltoid, ECR, EDC, and EIP. Muscle biopsy showed an inflammatory myopathy with prominent perivascular and perimysial inflammation, consistent with brachicervical inflammatory myopathy.

SUMMARY/CONCLUSION: Proximal weakness in a patient with MG may be due to multiple causes, including inadequately treated MG, or a coexisting disorder. Inflammatory myopathy in association with myasthenia in the absence of thymoma is rare. It is important to consider coexisting disorders in patients with known MG in order to provide an accurate diagnosis and appropriate treatment to ensure optimal patient outcomes.

ASSOCIATION OF DIABETES SEVERITY AND CARPAL TUNNEL SYNDROME
Stephen Kishner (Metairie, LA), Paige Davis (New Orleans, LA), Donald Mercante (New Orleans, LA)

INTRODUCTION: Diabetes mellitus has been thought to be a risk factor associated with CTS. Other wrist factors thought to be associated with CTS can include age, gender, body mass index (BMI), and wrist thickness/width ratio (WTWR).

OBJECTIVE: To determine if there is any correlation between CTS and the severity of diabetes.

METHODS: Patients referred to the EDX laboratory were evaluated for the presence of CTS, BMI, age, gender, WTWR, and the presence and severity of diabetes. Severity of diabetes was graded by diet controlled, controlled by oral agents, or insulin requiring.

RESULTS: Diabetes and BMI had the strongest associations with CTS. Severity of CTS nerve conduction parameters was more likely with diabetes controlled by oral agents or insulin, as compared to no diabetes or if diabetes was diet controlled.

SUMMARY/CONCLUSION: Severity of CTS appears to be associated with severity of diabetes. CTS was found to be more severe if more diabetic treatment is required.
ANTHROPOMORPHIC DATA AND SEVERITY OF CARPAL TUNNEL SYNDROME NERVE CONDUCTION PARAMETERS
Stephen Kishner (Metairie, LA), Paige Davis (New Orleans, LA), Donald Mercante (New Orleans, LA)

INTRODUCTION: Many anthropomorphic parameters have been thought to be risk factors associated with CTS. These include body mass index (BMI), wrist thickness/width ratio (WTWR), and abdominal circumference (AC). Other important risk factors thought to be associated with CTS include age and gender.

OBJECTIVE: To determine if there is any correlation between anthropomorphic parameters and severity of nerve conduction parameters in CTS. This includes median nerve sensory latency (SL), sensory amplitude (SA), motor latency (ML), and motor amplitude (MA).

METHODS: Patients referred to the EDX laboratory were evaluated for the presence of CTS, BMI, age, gender, WTWR, AC, and waist/hip ratio. Analysis was performed to see if these factors were associated with severity of SL, SA, ML, and MA.

RESULTS: SL severity did not show any correlation with any of these factors. SA severity showed correlation in order of descending significance: age, WTWR, and AC. MA severity showed a correlation only with AC. ML severity showed correlation in order of descending significance: WTWR, BMI, and AC.

SUMMARY/CONCLUSION: Risk factors associated with CTS including WTWR, BMI, AC, and age show some correlation with severity of CTS nerve conduction parameters.

MUSCLE BIOPSY AND ELECTROMYOGRAPHY CORRELATION
Elie Naddaf (Rochester, MN), Margherita Milone (Rochester, MN), Michelle Mauermann (Rochester, MN), Jay Mandrekar (Rochester, MN), William Litchy (Rochester, MN)

INTRODUCTION: In myopathies, the correlation of individual needle EMG and histopathologic findings remains poorly explored, as most previous studies have focused on the ability of muscle biopsy and needle EMG to distinguish the neuropathic versus myopathic nature of the underlying neuromuscular disease.

OBJECTIVE: To correlate individual needle EMG abnormalities with specific muscle histopathologic findings.

METHODS: We identified 100 patients who had a muscle biopsy and needle EMG performed on the same muscle. We used a detailed grading system ranging from 0 or absent to 4 for severe; and graded 16 histopathologic findings in each biopsy. The needle EMG findings were also graded from 0 to 4 according to the standard protocol of our EMG laboratory. We used Kendall’s tau for non-parametric ordinal correlation analysis.

RESULTS: Fibrillation potentials correlated with atrophic, necrotic, and regenerating fibers, fiber splitting, fibers harboring vacuoles, fibers reacting for nonspecific esterase, fibers with congophilic inclusions, inflammation (endomysial and perimysial), and increased endomysial connective tissue. Short duration motor action unit potentials (MUAPs) correlated with atrophic, necrotic, and regenerating fibers, increased endomysial connective tissue, and perimysial inflammation. Long duration MUAPs correlated with fiber type grouping. Increased phases of MUAPs correlated with atrophic fibers, increased endomysial connective tissue, and fibers reacting for nonspecific esterase; and increased turns correlated with atrophic and regenerating fibers, increased endomysial connective tissue, and target formations.

CONCLUSION: By demonstrating a clear correlation of various needle EMG and histopathologic findings, this study helps to better interpret EDX testing in myopathies, and serves as a platform to further assess the correlation between clinical, needle EMG, and histopathologic findings.
UPPER TRUNK BRACHIAL PLEXOPATHY VS. C5-C6 RADICULOPATHY
Adnan Solaiman (Hershey, PA), Frank Baird (Hershey, PA), Aiesha Ahmed (Hershey, PA)

INTRODUCTION: Brachial plexus injuries and cervical radiculopathies can occur with motor vehicle accidents (MVAs). EDX studies are helpful in localization, prognosis, and management.

CASE REPORT: A healthy 37-year-old male developed left shoulder and arm weakness after an MVA. Brachial plexus MRI showed edema in the axilla. Needle EMG/NCSs performed 6 months later showed absent lateral antebrachial cutaneous (LAC) sensory nerve action potential (SNAP), low medial antebrachial cutaneous (MAC) and radial SNAP amplitudes, and denervation in the biceps, pronator teres, deltoid, supraspinatus, infraspinatus, and rhomboid muscles.

DISCUSSION: In a retrospective analysis of EDX studies in patients after an MVA, Braddom and colleagues (2009) reported an 8% frequency of cervical radiculopathy and 3% frequency of plexopathy, which was slightly increased compared to non-MVA patients. In our case, the EDX findings were mixed; the absent LAC pointed towards upper trunk brachial plexopathy, whereas the needle EMG findings showed neurogenic changes in the rhomboids, which pointed towards radiculopathy. It is pertinent to evaluate for both plexus and root injuries in cases of trauma to allow for appropriate management of patients.

SUMMARY/CONCLUSION: This case highlights the importance of checking the LAC and MAC NCSs in patients with history of trauma, as in such cases it is possible to have both radiculopathy and plexopathy instead of just one or the other. Needle examination without performing these uncommon sensory NCSs can lead to an inaccurate and incomplete diagnosis.

Adnan Solaiman, MD
Resident and Fellow Member Award Recipient

SUBCLINICAL NEUROPATHY ASSOCIATING HYPOTHYROIDISM
Mai Rabii (Cairo, Egypt), Abeer El-Zohiery (Cairo, Egypt), Mona El Hossiny (Cairo, Egypt), Mohamed Ragaii (Cairo, Egypt)

INTRODUCTION: Neuropathic affection, noted incidentally among hypothyroid patients, shows variable frequencies, types, and patterns. Although its mechanism is not yet fully understood, it might be the metabolic alteration occurring due to hormonal imbalance which affects the Schwann cells and induces a segmental demyelination. Early diagnosis is, hence, advised to minimize structural damage and disability.

OBJECTIVE: To detect subclinical neuropathy among hypothyroidism patients and to record its type.

METHODS: The study included 60 recently diagnosed hypothyroid patients without any neurological symptoms and signs. Twenty matched healthy subjects were included as a control group. All participants were subjected to clinical assessment, laboratory tests, and nerve conduction studies (NCSs). Motor NCSs were performed for bilateral median, ulnar, posterior tibial, and common peroneal nerves; sensory NCSs for median, ulnar, and sural nerves bilaterally; and F-wave studies for bilateral median, ulnar, peroneal, and posterior tibial nerves. Patients with any other cause of possible neuropathy were excluded from the study.

RESULTS: In this study, 86.6% of our patients showed polyneuropathy and none showed mere mononeuropathy. The neuropathy recorded was either sensorimotor (57.7%) or pure sensory (42.3%) polyneuropathy, mainly mixed axonal-demyelinating type. Median and peroneal nerves were the predominantly affected nerves (49% and 25%, respectively). A high incidence of entrapment neuropathy, especially carpal tunnel syndrome (66.67%), was encountered among the patients.

SUMMARY/CONCLUSION: Sensorimotor, axonal-demyelinating polyneuropathy is commonly associating hypothyroidism. It is advised to perform NCSs early and routinely on all recently diagnosed hypothyroid patients even if neurologically asymptomatic.

Abeer A. El-Zohiery, MD
IFCN Award Recipient
31
CARDIOVASCULAR AUTONOMIC REFLEXES IN INDIVIDUALS WITH PREDIABETES
Joel Gutierrez (Havana, Cuba), Rachel Pérez (Havana, Cuba), Ana Conesa (Havana, Cuba), Yaima Fábregas-Deulofeo (Havana, Cuba), Manuel Licea Puig (Havana, Cuba)

INTRODUCTION: In patients with diabetes mellitus, impaired cardiovascular autonomic reflexes (CARs) are associated with increased mortality. It is controversial whether individuals with prediabetes (preDM) have abnormal CARs.

OBJECTIVE: To evaluate heart rate (HR) and blood pressure (BP) regulation during active standing in individuals with preDM.

METHODS: CARs were evaluated in 27 individuals with preDM (age: 47.5±9.8 years) and 31 healthy control subjects (age: 46.3±9.0 years). PreDM was defined as a fasting glucose of 5.6-6.9 mmol/L or a 2-hour glucose of 7.8-11 mmol/L. Oscillometric diastolic (DBP) and systolic (SBP) BP and HR were recorded during 5 minutes in the supine position and at the first, third, and fifth minutes after active standing.

RESULTS: Supine SBP (72±8 versus 64±10 mmHg, p=0.01) and DBP (124±13 versus 115±12 mmHg, p=0.01) were significantly higher in individuals with preDM than in normal control subjects. No differences between groups were observed for BP during standing. No subjects presented signs of orthostatic hypotension. No differences between groups were observed for absolute HR during the supine or standing states. The percentage of subjects with increased HR upon standing was similar for both groups. The magnitude of HR increment upon standing was lower in subjects with preDM at the first (8±12 versus 16±10 bpm, p=0.01), third (8±8 versus 18±12 bpm, p=0.00), and fifth (11±9 versus 18±12 bpm, p=0.04) minutes after standing.

SUMMARY/CONCLUSION: These results demonstrate that individuals with preDM regulate BP normally during standing. The lower increment of HR upon standing could indicate mild cardiac parasympathetic damage but could also be secondary to the underlying hypertension.

Joel V. Gutierrez, MD, PhD
IFCN Award Recipient

32
NERVE CONDUCTION NORMAL VALUES FOR ELECTRODIAGNOSIS IN PEDIATRIC PATIENTS
Conor Ryan (Rochester, MN), Erin Conlee (Rochester, MN), Rishi Sharma (Rochester, MN), Eric Sorenson (Rochester, MN), Andrea Boon (Rochester, MN), Ruple Laughlin (Rochester, MN)

INTRODUCTION: Existing normal value references for pediatric NCSs are based on very limited sample sizes with questionable reliability. As electrodiagnosis is central to many pediatric diagnoses, there is a need for establishing better normative data references.

OBJECTIVE: To derive normal values of NCSs in pediatric patients.

METHODS: We used the electronic records system at Mayo Clinic Rochester to identify pediatric patients (0-17 years) with normal findings on needle EMG and NCSs from January 1, 1997, through September 20, 2017. Descriptive statistics established normal values by age group.

RESULTS: Over 20 years we performed 2011 NCSs on 1918 pediatric patients where the results were interpreted as normal. Age, gender, height, and weight were recorded for each patient. Patients were analyzed according to age: under 1 year (72), 1-2 years (83), 2-5 years (167), 5-10 years (267), 10-15 years (536), 15-17 years (886). Normal references ranges for amplitude, conduction velocity, and distal latency were subsequently established for each age group for each nerve studied that had sufficient sample size (4 motor and 4 sensory nerves). F waves were obtained when performed. Distance and temperature were collected when available.

SUMMARY/CONCLUSION: Needle EMG and NCSs are frequently employed in the evaluation of neuromuscular disorders afflicting children and adolescents. This study presents data obtained from over 2000 pediatric NCSs, making it the most robust study of its kind and offering the most reliable reference values available for interpreting pediatric NCSs.

Conor Ryan, MD
Resident and Fellow Member Award Recipient
PERONEAL SPARING WITH TIBIAL INVOLVING PATTERN DIFFERENTIATES IMMUNE-MEDIATED MOTOR AXONAL NEUROPATHY FROM MOTOR NEURON DISEASE
Dong Zhang (Jinan, China), Chuanzhu Yan (Jinan, China)

INTRODUCTION: The identification of immune-mediated motor axonal neuropathy of patients within the spectrum of lower motor neuron syndromes is crucial as they are treatable.

OBJECTIVE: To determine the electrophysiological biomarker in immune-mediated motor axonal neuropathy.

METHODS: We describe 2 patients with chronic motor axonal neuropathy, both of whom had positive anti-GM1 immunoglobulin G antibodies and good outcome. During the electrophysiological examination of the both patients, we found normal compound muscle action potentials (CMAPs) of peroneal nerves recorded by the extensor digitorum brevis (EDB) muscle, although the CMAPs of tibial nerves recorded by the abductor hallucis brevis (AHB) muscle were decreased significantly. We retrospectively analyzed electrophysiological data of 66 acute motor axonal neuropathy (AMAN) patients and compared them with 68 ALS and 46 Kennedy’s disease (KD) patients.

RESULTS: Of the AMAN patients, 37 with had normal CMAPs of the EDB while 16 had normal CMAPs of the AHB. The CMAP amplitudes divided by each cutoff value were significantly larger in the EDB (1.06±0.76) than in the AHB (0.61±0.56). The ratio of CMAP-AHB to CMAP-EDB is significantly decreased in AMAN patients (1.40±1.57) compared with ALS (8.28±15.29) and KD (2.72±1.91) patients.

SUMMARY/CONCLUSION: Peroneal nerve relative sparing with the tibial nerve involved in a more severe pattern could be a biomarker for immune-mediated motor axonal neuropathy.

Dong Zhang, MD
IFCN Award Recipient

INTERACTION OF CATHODAL AND ANODAL STIMULATIONS IN NERVE CONDUCTION STUDIES, REVISITED
Takamichi Kanbayashi (Itabashi-ku, Japan), Yosuke Miyaji (Itabashi-ku, Japan), Takaharu Yamauchi (Nagoya, Japan), Masahiro Sonoo (Itabashi-ku, Japan)

INTRODUCTION: At the 2016 AANEM Annual Meeting, we reported that in NCSs the anodal stimulation became more likely to occur when the cathode was shifted away from the nerve. In this study, we investigated the reverse effect, that of anodal stimulation on cathodal stimulation.

OBJECTIVE: To investigate the interaction of cathodal and anodal stimulations in NCSs.

METHODS: In 10 healthy volunteers, the ulnar nerve was stimulated at the wrist using 2 bipolar surface electrodes. The cathode of 1 electrode was placed distally on the nerve trunk, whereas the anode of the other was placed proximally, simulating the ordinary motor NCS. We changed the stimulus intensity at the cathode and anode independently, and evaluated the threshold of the anodal stimulation using the antidromic mixed nerve action potential (MNAP) at the elbow, and that of the cathodal stimulation using the compound muscle action potential (CMAP) from the abductor digiti minimi muscle.

RESULTS: When the stimulus intensity at the distal cathode was set at 0, 10, and 20 mA, the threshold of the MNAP by anodal stimulation was 8.6 ± 1.7, 11.2 ± 2.1, and 13.3 ± 2.9 mA, respectively. When the stimulus intensity at the proximal anode was set at 0, 4, and 8 mA, the threshold of the CMAP by cathodal stimulation was 3.0 ± 0.4, 2.7 ± 0.3, and 2.4 ± 0.3 mA, respectively.

SUMMARY/CONCLUSION: During bipolar stimulation, the cathodal stimulation interferes with the anodal stimulation, whereas the anodal stimulation assists the cathodal stimulation.
THE ATYPICAL CASE OF FOOT DROP IN 7TH DECADE ATTRIBUTED TO FIG4 MUTATION.

Khatuna Gurgenashvili (Hershey, PA), Aiesha Ahmed (Hershey, PA)

INTRODUCTION: Hereditary neuropathies are underrecognized in patients with late-onset axonal neuropathy. Charcot–Marie–Tooth (CMT) disease type 4J is a rare form of autosomal recessive CMT linked to FIG4 mutation. The previously reported phenotype of CMT4J is distinct from other CMT types due to its proximal and distal weakness that can be asymmetric.

OBJECTIVE: To report a heterozygous carrier status of FIG4 gene mutation that can be associated with late-onset (7th decade), axonal, symmetric polyneuropathy phenotype.

CASE REPORT: We report a case of 79-year-old man, with no significant past medical history, who presented to the neuromuscular clinic with a 5-year history of bilateral foot drop. Needle EMG/NCSs revealed a sensorimotor, length-dependent, symmetric axonal polyneuropathy. Extensive testing for acquired causes for the axonal neuropathy was negative. A CMT gene panel revealed 1 pathogenic copy of a FIG4 mutation-c.122T>C. We propose that our patient's CMT phenotype with progressive foot drop was associated with FIG4 carrier status either as a compound heterozygous or manifested carrier.

SUMMARY/CONCLUSION: Axonal CMT types are underrecognized, especially in elderly patients. Previously reported FIG4 mutations had been linked to early-onset CMT4J that may cause proximal and distal weakness and severe disease phenotype. To the best of our knowledge, this patient is the oldest (73 years) than previously reported cases with FIG4 associated CMT.

IMPROVING DOCUMENTATION OF ANTICOAGULATION AND ANTITHROMBOTICS IN THE EMG LABORATORY – A QUALITY IMPROVEMENT INITIATIVE

Mitchell O'Neill (Detroit, MI), James Selwa (Detroit, MI)

INTRODUCTION: There is a theoretical risk of significant bleeding or hematoma formation whenever the skin is punctured with a needle. Due to these risks and a lack of available guidelines, many EDX practitioners do not perform the needle examination on anticoagulated patients.

OBJECTIVE: To increase the number of patients for which we document anticoagulation or antiplatelet use in needle EMG/NCS reports.

METHODS: We developed a questionnaire which screened for current or past anticoagulation and antiplatelet use. Also, we changed the current history documentation templates in order to prompt documentation of anticoagulation/antiplatelet use.

RESULTS: Prior to intervention, for 98/100 patients, there was no documentation of current or previous anticoagulation or antiplatelet use. After intervention, 81% of patients had documentation affirming or denying current anticoagulation use. Also, 97% of patients had documentation affirming or denying current antiplatelet use. In addition, the screening form helped identify 6 patients currently on anticoagulation medication.

CONCLUSION: Overall, there was significant improvement in the documentation of anticoagulation use from 1 to 81% of charts. This represents an increase of 80% (95% CI: 70.2-86.5, p<0.0001). Documentation of antiplatelet use improved from 1 to 97% of charts representing a 96% improvement (95% CI: 89.0-98.1, p<0.0001). Our intervention was effective in increasing documentation of anticoagulation and identifying 6 at-risk patients currently on anticoagulation before needle examination. For these patients, the needle examination was deferred.
**SPECTRUM OF NEUROMUSCULAR DISORDERS IN NEONATAL-INFANTILE PERIOD IDENTIFIED BY EMG FROM A PEDIATRIC CENTER**  
Obehioya Irumudomon (Burlington, MA), Partha Ghosh (Boston, MA), Basil Darras (Boston, MA)

INTRODUCTION: Needle EMG in the neonatal–infantile period plays a pivotal role in diagnosing neuromuscular disorders. However, it is technically challenging and hence frequently underutilized.

OBJECTIVE: To determine common referral patterns and how needle EMG assisted in determining the final diagnosis in the neonatal–infantile period.

METHODS: We retrospectively identified infants (≤12 months old) who underwent needle EMG over 15 years from a single pediatric center. Almost all the studies were performed without sedation.

RESULTS: We included 184 patients between the ages of 2 days and 12 months; 117 (63%) had abnormal findings on needle EMG. Of those with abnormal results (117/184): hypotonia (42%), brachial plexopathy (22%), and arthrogryposis (8.5%) were the most common referral questions. Whereas, in patients with normal results (67/184): hypotonia (56.7%), neuropathy/myopathy (6%), and arthrogryposis (6%) were the most common referrals. Among the patients with hypotonia and abnormal needle EMG, spinal muscular atrophy (SMA) (30.6%), congenital myopathy (10%), and congenital muscular dystrophy (8.2%) were the most common final diagnoses, followed by myotonic dystrophy, Prader–Willi syndrome, mitochondrial disorders, and peripheral neuropathies. There were 7 patients with neuromuscular junction disorders: congenital myasthenic syndrome (2), infant botulism (3), and 2 lost to followup. Of the patients with brachial plexopathy (26) on needle EMG, traumatic brachial plexopathy was identified in 84.6% and tumors in 11.5%.

SUMMARY/CONCLUSION: Needle EMGs performed in the neonatal–infantile period were beneficial in establishing the diagnosis or facilitating the diagnostic workup of children with neuromuscular disorders. Motor neuronopathies (SMA) and brachial plexopathies were the most common EDX findings in our series.

Obehioya Irumudomon, MD  
Resident and Fellow Member Award Recipient

**ELECTROPHYSIOLOGICAL CHARACTERIZATION OF IMPAIRED SWALLOWING IN NEUROLOGICAL DISORDERS**  
Joel Gutierrez (Havana, Cuba), Pranith Kumar (New York, NY), Jose-Alberto Palma (New York, NY), Lucy Norcliffe-Kaufmann (New York, NY), Rachel Pérez (Havana, Cuba), Horacio Kaufmann (New York, NY)

INTRODUCTION: The electrophysiological characterization of the pattern of swallowing abnormalities associated to different neurological disorders can help to understand, classify, and manage swallowing disorders (SDs).

OBJECTIVE: To characterize the pattern of SDs of patients with Parkinson’s disease (PD), multiple system atrophy (MSA), and hereditary sensory and autonomic neuropathy type III (HSAN-III).

METHODS: SDs were evaluated in 17 patients (5 MSA, 8 PD, and 4 HSAN-III) and 21 age-matched normal control subjects (CO). Surface EMG of the suprahyoid muscles and laryngeal–pharyngeal mechanogram were recorded during voluntary swallowing of 2 ml of water. Each swallowing was started in response to an auditory stimulus. Swallowing reaction time (SRT), defined as time from the auditory stimulus to the start of EMG, and total duration of EMG (EMG-D) were measured and averaged across 16 swallowing trials.

RESULTS: SRT was significantly increased in the patients with HSAN-III as compared with CO (508±180 versus 199±37 ms, p=0.01). Patients with PD and MSA showed SRT (176±25 and 200±57 ms, p>0.05) similar to CO. All groups of patients showed significantly increased EMG-D as compared to CO (HSAN-III: 1928±593, MSA: 2097±980, PD: 2606±998 versus CO: 1300±281 ms, p=0.01). Patients with PD were the most severely affected.

SUMMARY/CONCLUSION: The severe increment of EMG-D observed in patients with PD could be caused by their underlying bradykinesia. The severe increment of SRT recorded in HSAN-III could be due to slow conduction through the cranial nerves and brainstem areas involved in this reflex response. The characterization of SDs could help to personalize their treatment.

Joel V. Gutierrez, MD, PhD  
IFCN Award Recipient
Evaluation of Neurophysiological Criteria for Guillain-Barré Syndrome in a Large Brazilian Institution
Wagner Cavalcante (São Paulo, Brazil), Ronnyson Grativvol (São Paulo, Brazil), Renam Gushi (São Paulo, Brazil), Igor Brockhausen (São Paulo, Brazil), Vitor Caldas (São Paulo, Brazil), Alberto Mello (São Paulo, Brazil), Carlos Heise (São Paulo, Brazil)

Introduction: Although several neurophysiological criteria for the diagnosis of Guillain–Barré syndrome (GBS) are available, there is no consensus regarding the ideal method in clinical practice. Additionally, only a few studies have evaluated neurophysiological characteristics of GBS patients in developing countries.

Objective: To evaluate the sensitivity and specificity of distinct neurophysiological criteria for GBS in a Brazilian population.

Methods: A retrospective study was conducted of patients with diagnosed or suspected GBS that underwent NCSs in a large Brazilian academic hospital between 2014 and 2017. In order to perform statistical analysis, control groups of patients with ALS and chronic diabetic polyneuropathy were included. Neurophysiological criteria of Albers, Cornblath, and Hadden were applied to every participant involved in the study.

Results: We found 99 suspected and 69 confirmed cases of GBS. The average age of confirmed GBS patients was lower than the control groups (p<0.01). Albers’ criteria showed elevated sensitivity (89.8%) but low specificity (40-63.3%). Cornblath’s criteria, on the other hand, revealed poor sensitivity (28.9%) and high specificity (100%). Hadden’s criteria presented sensitivity of 82.6% and specificity between 75 and 86.6%.

Summary/Conclusion: The criteria that approached a gold standard in our study was the one published by Cornblath, but its associated low sensitivity reduces its clinical applicability. Hadden’s criteria presented the best balance between sensitivity and specificity in our population, making this method an attractive tool to aid the diagnosis of GBS in Brazilian patients.

Wagner Cavalcante, MD
IFCN Award Recipient

Clinical Use of Transcranial Magnetic Stimulation in 5 Upper and Lower Motor Neuron Disorders
Nikolai Khromouchkine (Washington, DC), Mary Kay Floeter (Bethesda, MD)

Introduction: Transcranial magnetic stimulation (TMS) is an EDX technique which can assess for demyelination and neuronal loss in the corticospinal tract. Its use may have clinical implications in evaluating patients with progressive neurodegenerative disease.

Objective: To compare the prevalence of central conduction abnormalities in patients with 5 specific upper and lower motor neuron disorders and assess for an association between TMS and physical findings.

Methods: This study consisted of a chart review of 155 patients—with ALS, primary lateral sclerosis (PLS), primary progressive multiple sclerosis (PPMS), secondary progressive multiple sclerosis (SPMS), or post-polio myelitis—and 70 healthy control subjects. The frequency of abnormal central motor conduction time (CMCT) and threshold values to the abductor pollicis brevis (APB) and tibialis anterior muscles was compared between each disease cohort. Physical findings including spasticity and hyperreflexia obtained in 134 patients were compared to abnormal TMS values in each extremity.

Results: Patients with PPMS and SPMS had a clinically and statistically (p<0.0083) increased likelihood of having prolonged rather than absent motor evoked potentials compared to PLS and ALS in specific muscle groups. The frequency of TMS abnormalities did not differ between PPMS and SPMS patients. Post-polio patients had normal CMCT and thresholds. TMS abnormalities were significantly (p<0.00625) associated with upper motor neuron signs except for the CMCT to the left APB.

Summary/Conclusion: TMS abnormalities occurred with varying frequencies in the above disorders in a manner consistent with proposed axonal or demyelinating pathology. TMS may contribute to the diagnostic evaluation of patients with unexplained spasticity, particularly when PLS versus progressive MS are suspected.

Nikolai Khromouchkine, MD
Resident and Fellow Member Award Recipient

Evaluation of Neurophysiological Criteria for Guillain-Barré Syndrome in a Large Brazilian Institution
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Wagner Cavalcante, MD
IFCN Award Recipient
A CASE OF TRUE NEUROGENIC THORACIC OULET SYNDROME ACCOMPANIED BY AN ELONGATED C7 TRANSVERSE PROCESS
Hongbum Park (Ansan-si, Republic of Korea), Dong Hwee Kim (Ansan-si, Republic of Korea), Ki Hoon Kim (Ansan-si, Republic of Korea)

INTRODUCTION: An enlarged C7 transverse process (TP) is one of the leading causes of true neurogenic thoracic outlet syndrome (TOS).

OBJECTIVE: To describe the true neurogenic TOS correlated with enlarged C7 TP diagnosed by radiologic studies.

CASE REPORT: A 61-year-old man complained of progressive tingling sensation on the right medial forearm and ring and little fingers with shoulder pain for 4 years. Physical examination revealed hypesthesia of the right medial forearm and ring and little fingers as well as weakness of the abductor pollicis brevis, abductor digiti minimi, and first dorsal interosseous muscles. Compound muscle action potentials of the right median nerve were decreased. Sensory nerve action potentials (SNAPs) of the right medial antebrachial cutaneous nerve were not evoked, and SNAPs of the right ulnar and dorsal ulnar cutaneous nerves and median sensory nerve with the middle finger were decreased. But the right median sensory response with the thumb recording was normal. On needle EMG, abnormal spontaneous activities and/or large amplitude and long duration motor unit action potentials with reduced recruitment patterns were demonstrated, the median- and ulnar-innervated muscles originated from the medial cord of the right brachial plexus. MRI of the right brachial plexus showed that the distal portion of lower trunk was compressed between the subclavian artery and tip of the TP. CT and plain X-ray demonstrated that an enlarged and downward C7 TP and subclavian artery narrows the outlet of the lower trunk compared to the contralateral side.

CONCLUSION: The enlarged, downward TP should be considered in the differential diagnosis in a patient with suspected TOS.
DEMYELINATION IN HEREDITARY TRANSTHYRETIN POLYNEUROPATHY: IS IT FREQUENT?

Fabio Barroso (Buenos Aires, Argentina), Andrea Lautre (Buenos Aires, Argentina), Lucas Orellana (Buenos Aires, Argentina), Fernando Lorefice (Rosario, Argentina)

INTRODUCTION: Hereditary transthyretin amyloid polyneuropathy (hATTR-FAP) is an autosomal dominant disorder which ultimately leads to a bedridden state. hATTR-FAP is an axonopathy, however, previous reports have drawn attention to the fact that it may be misdiagnosed as chronic inflammatory demyelinating polyneuropathy (CIDP). Since misdiagnosis cause diagnostic delay and this, in turn, may limit the efficacy of treatments, these assertions warrant further examination.

OBJECTIVE: To determine the prevalence of demyelinating features in the peripheral nerves of subjects with hATTR-FAP.

METHODS: NCSs from subjects with hATTR-FAP examined at a single center were reviewed. The following parameters were analyzed on the peroneal, tibial, ulnar, and median nerves, when available: (1) distal motor latency (excluding median), (2) distal compound muscle action potential (CMAP) duration, (3) proximal/distal CMAP amplitude ratio, and (4) motor conduction velocity. Demyelination in any segment was defined according to European Federation of Neurological Societies/Peripheral Nerve Society criteria. The number of subjects, the number of nerves and nerve segments available for assessment, and proportion of subjects, nerves, and nerve segments with demyelinating features were determined.

RESULTS: Twenty-eight hATTR-FAP subjects had evaluable NCSs. Ten had inexcitable nerves. In 18 subjects, 94 segments were evaluable, of which 13 (14%) showed demyelinating features. These were close to the cutoff value for demyelination and were present in 2 subjects only (7%). No partial motor conduction blocks were found.

SUMMARY/CONCLUSION: Although hATTR-FAP is an axonopathy, less than 10% of subjects show mild demyelinating features. Since technical issues and additional genetic modifiers might explain these findings, the risk of misclassifying hATTR-FAP as CIDP appears to be low.

Fabio Barroso, MD
AANEM Foundation International Fellowship Award Recipient
THE CHANGES OF MEDIAN NERVE CONDUCTION AND ULTRASONOGRAPHIC FINDINGS IN HEMIPLEGIC STROKE PATIENTS  
MinKyun Sohn (Daejeon, South Korea), Young Wook Kim (Daejeon, South Korea)

INTRODUCTION: Overuse of the non-paretic hand and wrist may result in CTS in hemiplegic stroke patients, especially when the paretic hand is not functional.

OBJECTIVE: To evaluate the median nerve according to severity of weakness and duration of disease by NCS and ultrasonography.

METHODS: NCSs and ultrasonography of bilateral median nerve was performed on 28 hemiplegic stroke patients. Conventional median motor and sensory NCSs and cross-sectional area of median nerve was measured at the pisiform and radioulnar joint level.

RESULTS: The median motor latency was significantly prolonged and the conduction velocity was slowed in both hands at followup, and sensory latency was only prolonged in the non-paretic hand (p<0.05). These electrophysiological indices were more abnormal in patients who use their functional arm and chronicity of onset duration. There was no significant difference in cross-sectional area of median nerve between unaffected and affected arm, however it was significantly enlarged in the mild-to-moderate weakness group (p<0.05).

SUMMARY/CONCLUSION: Median NCS of hemiplegic stroke patients showed degeneration at followup with more significant changes in the motor nerve. These changes are more prominent in unaffected hands, milder weakness, and longer stroke duration subgroup. A hands protection technique is needed to educate hemiplegic stroke patients who use their hands functionally.

MinKyun Sohn, MD  
IFCN Award Recipient

UTILIZING A SCREENING QUESTIONNAIRE TO DIRECT APPROPRIATE ELECTROMYOGRAPHY REFERRAL IN THE DIAGNOSIS AND MANAGEMENT OF CARPAL TUNNEL SYNDROME: A QUALITY IMPROVEMENT PROJECT  
Mathieu Cuchanski (Danville, PA), Scott Friedenberg (Danville, PA)

INTRODUCTION: Not all patients with CTS need a needle EMG for diagnosis. Identifying clinical characteristics that predict CTS would help determine which patients do not need needle EMG, thus avoiding the discomfort, time, and cost of the procedure.

OBJECTIVE: To identify patients who do not need a needle EMG to diagnose CTS by using a modified screening tool.

METHODS: Patients referred to the EMG laboratory for hand numbness were screened with a modified CTS 8 questionnaire as part of a quality improvement initiative. Final clinical diagnosis and needle EMG data were reviewed to determine correlation with the CTS 8 results. Patients were considered to have a positive screen if they had (1) hand sensory symptoms or pain; (2) symptoms provoked by sleep, repetitive activity, or response to wrist splints/injections; and (3) no neck pain or foot symptoms. Patients with prior CTS surgery were excluded.

RESULTS: Over 6 months, 100 patients were screened (66 retrospective, 34 prospective); 97 underwent needle EMG. Thirty patients had a positive CTS screen of which 24 had median neuropathies at the wrists on needle EMG; 61 patients had a positive screen but were excluded due to other symptoms; 6 patients had a negative screen. On followup, 20/30 patients with a positive screen were felt clinically to have CTS. Seven were lost to followup, and 3 were thought to have other diagnoses.

SUMMARY/CONCLUSION: Approximately 30% of patients referred for hand numbness did not need needle EMG to reach the clinical diagnosis of CTS. The implementation of a screening tool would save time, money, and discomfort.

Mathieu Cuchanski, DO  
Resident and Fellow Member Award Recipient
**CASE OF MONONEURITIS MULTIPLEX: MULTIPLE PERIPHERAL NEUROPATHIES IN THE SETTING OF DELAYED DIAGNOSIS OF NEUROBORRELIOSIS**

Harmanpreet Tiwana (Hershey, PA), Mary Kovacik Eicher (Hershey, PA), Aiesha Ahmed (Hershey, PA)

OBJECTIVE: To describe a case of infectious etiology of mononeuritis multiplex.

METHODS: Lyme disease associated mononeuritis multiplex confirmed by clinical presentation of weakness involving the right arm proximally as well as the left arm distally over 18 months, needle EMG/NCS, and serum Lyme antibodies.

CASE REPORT: A 57-year-old male presented with subacute right arm proximal muscle weakness. Over the course of 2 years, he has had multiple Lyme disease infections including rash and fever, treated with oral doxycycline. Within these 2 years, he developed left wrist drop and underwent surgical exploration surgeries without improvement. He underwent needle EMG which was consistent with focal neuropathies involving left radial, right axillary, and suprascapular nerves. Serum Lyme antibody titers on confirmation with Western blot were positive. He was diagnosed with Lyme related mononeuritis multiplex.

SUMMARY/CONCLUSION: Mononeuritis multiplex is a nervous system disorder that involves damage to at least 2 separate nerve areas. Even though Lyme disease after hepatitis and HIV infection has been documented as one of the causes of mononeuritis multiplex, it is commonly misdiagnosed due to scarcity of standardization of serological markers, in addition to false-positive results. Diagnosis of neuroborreliosis can be made if there are positive antibodies in the serum and symptoms suggestive of central nervous system involvement. Current guidelines state patients should be treated with IV ceftriaxone but some recent data state oral doxycycline is as effective. Our patient continued to worsen despite having many courses of oral doxycycline. There have been reports suggesting a role of immunosuppressive therapy in treatment of refractory cases also.

**THE UTILITY OF TIBIAL NERVE SEPS IN DIAGNOSING LUMBAR SPINAL STENOSIS, COMPARISON WITH NCS AND F-WAVES**

Chizuko Oishi (Mitaka Shi, Japan), Yoshikazu Mizoi (Irumagun, Japan), Atsuro Chiba (Mitaka-shi, Japan), Masahiro Sonoo (Itabashi Ku, Japan)

INTRODUCTION: Lumbar spinal stenosis (LSS) is a common cause of lower limb motor and sensory impairments. Somatosensory evoked potentials (SEPs) can be a tool to evaluate LSS, although few studies have investigated its utility in diagnosing this disorder.

OBJECTIVE: To compare the diagnostic yield of tibial nerve SEPs with NCSs, including F waves.

METHODS: We retrospectively extracted LSS patients in whom tibial nerve SEPs were examined and reviewed their clinical and needle EMG records. The entry criteria were as follows: (1) presence of sensory, motor, or gait complaints, (2) unequivocal LSS in lumbar MRI judged to be the cause of symptoms, (3) tibial nerve SEPs, motor NCSs, and F wave studies of the tibial nerve and sensory NCSs of the sural nerve, and (4) no prior lumbar surgery.

RESULTS: Enrolled were 8 patients. Tibial nerve SEPs localized the lesion at the lumbar segment (P15-N21) in 6 patients. Notably, SEPs were abnormal in 3/4 patients without sensory symptoms. Compound muscle action potential of the tibial nerve was reduced in 2 patients, and minimal F wave latency was prolonged in the same 2 patients. In no cases were F waves abnormal despite normal SEPs. Sural sensory NCSs were normal for all cases.

CONCLUSION: Tibial nerve SEPs are useful in diagnosing LSS, especially the fact that their documenting lumbar lesions in patients lacking sensory symptoms will contribute to differentiating LSS from ALS. The sensitivity of F waves was much lower than that in tibial nerve SEPs.
**49**

**UTILITY OF HEART RATE RESPONSE TO DEEP BREATHING VERSUS VALSALVA RATIO IN INDIVIDUALS WITH ERECTILE DYSFUNCTION: DIABETICS, PRE-DIABETICS AND NON-DIABETIC PATIENTS - A VETERANS AFFAIRS STUDY.**

Jasvinder Chawla (Hines, IL), Kalea Colletta (Hines, IL), Paz Martinez (Hines, IL), Benn Smith (Scottsdale, AZ)

INTRODUCTION: Erectile dysfunction (ED) impacts 10-20 million American men and is associated with vascular, endocrinologic, and neurologic causes, among others. Valsalva ratio (VR) and heart rate response to deep breathing (HRDB) are reliable measures of parasympathetic function, and therefore are expected to be abnormal in a subset of ED patients. In a previous study, it was suggested that HRDB (42.1%) abnormalities were more commonly seen in ED patients than VR (26.3%), although no directly comparative studies have been performed to our knowledge.

OBJECTIVE: To examine rates and patterns of autonomic function (ANF) abnormality in ED patients.

METHODS: We examined ANF studies over the past 2 years for a variety of medical issues in 174 patients. Twenty-four of those patients were found to have ED.

RESULTS: In the ED population (n=24), HRDB was abnormal in 2 patients (8.3%) and VR was abnormal in 4 (16.7%). Both HRDB and VR were abnormal in 7 (29.2%) patients, while 13 (45.8%) patients had normal studies. The majority (91.7%) of the ED patients had concurrent diabetes mellitus. Interestingly, in the 8.3% of patients without diabetes, they all only demonstrated abnormal HRDB, with VR being normal.

SUMMARY/CONCLUSION: In diabetic ED patients, there were more VR abnormalities (16.7%) than HRDB (8.3%) abnormalities. In those without diabetes (albeit a small sample size), however, 100% of the population had abnormal HRDB only, suggesting that HRDB may be the most common ANF abnormality seen in ED patients. These findings are similar to results of the aforementioned study. More investigations are warranted.

**50**

**MOTOR AXON EXCITABILITY PROPERTIES IN CERVICAL SPONDYLOTIC AMYOTROPHY**

Cesar Colasante (Syracuse, NY)

Chaojun Zheng (Shanghai, China), Yu Zhu (Syracuse, NY), Cong Nie (Shanghai, China), Feizhou Lu (Shanghai, China), Dongqing Zhu (Shanghai, China), Robert Weber (Syracuse, NY), Jianyuan Jiang (Shanghai, China)

INTRODUCTION: Cervical spondylotic amyotrophy (CSA) has unique features; it presents with exclusively motor deficiency of the upper limbs without clinical sensory involvement. Theories proposed to explain this phenomenon include selective damage to ventral roots or anterior horns by bony spurs or herniated discs as well as vascular insufficiency to these structures. Although, these theories may play a role, they fall short in explaining why exclusively the motor structures are affected. It is possible that patients with CSA cervical motor nerve’s axons present a lower tolerance to insult compared to those without CSA. Studies have shown different excitability properties of axons that respond differently to injury, potentially accounting for variable axonal insult tolerance. Using threshold tracking technique we evaluate the excitability properties of cervical motor nerve’s axons in patients with CSA.

OBJECTIVE: To compare axonal excitability properties in patients with CSA to patients with cervical spondylotic radiculopathy (CSR) and healthy subjects.

METHODS: Threshold tracking was used to measure median motor axons in 21 patients with CSA, 10 patients with CSR, and 16 control subjects.

RESULTS: Compared with control subjects and CSR patients, CSA patients had decreased accommodation during depolarizing and hyperpolarizing currents. Also, compared to control subjects, a subset of patients with CSA (distal CSA) showed prolonged strength duration time constant, increased threshold electrotonus hyperpolarization, and increased superexcitability.

SUMMARY/CONCLUSION: Differences in motor axonal excitability in patients with CSA were found when compared with both healthy subjects and patients with CSR. This potentially suggest a lower tolerance to insult and, therefore, would explain the exclusively motor presentation of CSA.

Cesar Colasante, MD

Resident and Fellow Member Award Recipient
DETECTING MOTOR UNIT ALTERATIONS IN MYOPATHY AND NEUROPATHY FROM THE SURFACE EMG SIGNAL
Paola Contessa (Natick, MA), John Letizi (Natick, MA), Gianluca De Luca (Natick, MA), Serge Roy (Natick, MA), Anant Shenoy (Springfield, MA)

INTRODUCTION: Motor unit action potential (MUAP) shape and firing properties are routinely assessed in clinical practice using needle EMG for myopathic and neuropathic diseases. To date, no noninvasive alternative is available for patients that cannot tolerate needle examination.

OBJECTIVE: To investigate, in this pilot study, the feasibility of a new noninvasive surface EMG (sEMG) procedure to identify alterations in MUAP shape and firing behavior in selected myopathic and neuropathic diseases.

METHODS: Three male subjects with myopathy (myotonic dystrophy, 29-67 years old), 2 male subjects with neuropathy (Hirayama disease, 18 years old; and ALS, 60 years old), and 3 male control subjects (30-68 years old) volunteered. sEMG signals were recorded from the first dorsal interosseous during low (10% maximum) and high (up to 80% maximum) force contractions. MUAP trains were extracted (dEMG System, Delsys Inc., MA) and amplitude and firing rates compared across groups.

RESULTS: On average, 21±5, 20±7, and 9±6 MUAP trains per contraction were extracted from control, myopathic, and neuropathic individuals, respectively. Myopathic subjects showed significantly smaller MUAP amplitudes than control subjects, particularly during high force contractions (p<0.001), and 2/3 showed significantly greater firing rates, particularly during low force contractions (p≤0.002). Both neuropathic subjects showed significantly larger MUAP amplitudes (p<0.01) and significantly lower firing rates (p<0.003) than control subjects during low force contractions.

SUMMARY/CONCLUSION: Significant alterations in MUAP shape and firing behavior, consistent with the confirmed diagnoses, were identifiable using a novel sEMG procedure. The ability to extract MUAPs at both low and high force levels was beneficial in differentiating MUAP properties in patients from control subjects.

CUANTIFICATION AND SCORING OF ELECTROMYOGRAPHIC ABNORMALITIES IN PATIENTS WITH AMYOTROPHIC LATERAL ESCLEROSIS
Thomas Torres Cuenca (Bogotá, Colombia), Fernando Ortiz-Corredor (Bogotá, Colombia)

INTRODUCTION:
EMG abnormalities contribute to ALS diagnosis, the Awaji and El Escorial criteria establish levels of diagnosis certainty according to the findings. Sometimes it’s not possible to complete the abnormalities requirements; which does not change the diagnosis certainty; quantification and scoring of EMG abnormalities, which could be useful as complementary measurement.

OBJECTIVE: To develop a quantification score for EMG abnormalities in ALS patients correlating with clinical and functional variables.

METHODS
We included 281 patients with ALS diagnosis (possible 26%, probable 28.5%, and definitive 45.6% according to Awaji criteria) with an EMG evaluation of 1st dorsal interosseous, biceps brachialis, vastus medialis and tibialis anterior, scoring them according to active denervation and chronic reinnervation findings (range: denervation-reinnervation in 2 muscles, maximum hemibody score= 8), if two findings are not met, we study a replacement muscle (extensor indicis propius, deltoid, adductor longus and gastrocnemius respectively); we correlate the score obtained with the Awaji diagnosis certainty, manual muscle testing (MRC) and revised ALS Functional rating scale ALSFRS-R (total, gross and fine motor domains)

RESULTS
We found a statistical significant relation into the proposed EMG and ALSFRS-R scoring (r= 0.18; p=0.002), proposed EMG scoring of cervical segment and ALSFRS-R fine motor domain (r=0.30 ; p= 0.000), proposed EMG scoring of lumbar segment and ALSFRS-R gross motor domain (r=0.27 ; p= 0.000) and proposed EMG scoring and lower limb MRC (r=0.17; p=0.003).

SUMMARY/CONCLUSION: Quantification and scoring of EMG abnormalities in ALS resulted useful as a complementary measure in the description and classification of lower motor neuron abnormalities, correlating with clinical and functional variables.

Thomas Torres Cuenca, MD
Resident and Fellow Member Award Recipient

Thomas Torres Cuenca, MD
IFCN Award Recipient
GLIOMATOSIS CEREBRI PRESENTING WITH FINDINGS OF EARLY AXONAL VARIANT GUILLEMIN-BARRÉ SYNDROME: A CASE REPORT
Fabiola Reyes (Houston, TX), Suzanne Woodbury (Houston, TX), Talia Collier (Houston, TX)

INTRODUCTION: Guillain–Barré syndrome (GBS) is a common cause of acute flaccid paralysis in childhood. Approximately 5% of GBS in North America and Europe is predominantly axonal. Gliomatosis cerebri is a rare brain cancer described as a diffuse glioma that grows in a widespread and invasive pattern. Incidence rates for people under 39 years of age is between 0.04 and 0.03 per million.

OBJECTIVE: To describe a patient presenting with clinical signs and EDX evidence of early axonal variant GBS who was later diagnosed with gliomatosis cerebri, with paraneoplastic phenomena.

CASE REPORT: A previously healthy 17-year-old female was admitted with sudden onset weakness and falls. Examination findings included leg weakness and hyporeflexia, prompting an EDX study demonstrating normal sensory and motor NCSs with spontaneous activity diffusely throughout the legs on needle EMG. Brain and spine MRI showed no definitive findings that could explain the symptoms. The patient underwent multiple treatments for presumed axonal variant GBS with minimal improvement. Repeat EDX testing 11 weeks later showed findings similar to the first study. New neurological symptoms prompted repeat brain imaging which showed multiple central nervous system lesions. A brain lesion biopsy was subsequently performed with tissue findings that confirmed the diagnosis of gliomatosis cerebri.

SUMMARY/CONCLUSION: Childhood cancers can cause a clinical picture similar to GBS due to paraneoplastic syndrome and, though rare, should be considered in the differential diagnosis of acute flaccid paralysis in children.

Bei Cao, MD
Resident and Fellow Member Award Recipient

NEUROPHYSIOLOGICAL INDEX WAS ASSOCIATED WITH SURVIVAL OF AMYOTROPHIC LATERAL SCLEROSIS.
Bei Cao (Chengdu, China), Qianqian Wei (Chengdu, China), Ruwei Ou (Chengdu, China), Lingyu Zhang (Chengdu, China), Hui-fang Shang (Chengdu, China)

INTRODUCTION: The neurophysiological index (NI) is a potential electrophysiological biomarker in ALS. The etiology of ALS remains unknown, and its prognostic factors have not been satisfactorily investigated.

OBJECTIVE: To investigate the association between NI and survival of ALS.

METHODS: We included 191 ALS patients from our department between April 2015 and January 2017, then followed up every 3 months until December 2017. The revised ALS Functional Rating Scale (ALSFRS-R) was applied to assess the severity of the disease. Survival and tracheotomy were predefined as primary outcome measures. According to the NI mean, patients were categorized into a high NI group and a low NI group. Group differences were analyzed using parametric and non-parametric tests as appropriate. Survival was analyzed using the Kaplan-Meier method and Cox regression analysis.

RESULTS: Among the 191 ALS patients, 82 had upper limb onset, 50 had lower limb onset, and 59 showed bulbar onset. The mean age at onset was 55.5 years. The median diagnostic delay was 12 months, and the median survival time after symptom onset was 33 months. The mean NI was 2.4. The high NI group showed higher ALSFRS-R score compared to the low NI group. In the multivariate Cox regression analysis, NI, ALSFRS-R, diagnostic delay, and age at onset were associated with survival in ALS.

SUMMARY/CONCLUSION: NI may be used to determine the prognosis of ALS. In addition, the higher the ALSFRS-R score, the older the age at onset, and the shorter the delay of diagnosis were associated with the poor survival of ALS.

Bei Cao, MD
Resident and Fellow Member Award Recipient
55

VULNERABILITY OF EACH BRANCH OF MEDIAN NERVE IN CARPAL TUNNEL SYNDROME

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INTRODUCTION: It is widely believed that sensory are more sensitive than motor nerve conduction studies (NCs) for the diagnosis of CTS. Many studies have compared the diagnostic yields of various NCS techniques for diagnosing CTS. However, sensitivity depends not only on the vulnerability of the median nerve, but on measurement errors and cutoff values.

OBJECTIVE: To clarify the true vulnerability of each branch of the median nerve in CTS.

METHODS: Subjects consisted of 144 CTS patients and 66 control subjects. The impairment of a branch was defined as the prolongation of the onset latency, using the following 6 parameters: DMLAp—prolongation of the distal motor latency (DML) at the abductor pollicis brevis (ABP) from routine median motor NCs, DMLLp—prolongation of the DML at the second lumbrical from second lumbrical-interossei comparison method, DSLIap—prolongation of the antidromic distal sensory latency (DSL) at the index finger and DSLIop—prolongation of the orthodromic DSL at the index finger each from sensory NCs, DSLRp—prolongation of the DSL at the ring finger from ring-finger method, and DSLTp—prolongation of the DSL at the thumb from the thumb method.

RESULTS: The mean values for patients were 1.57 ms, 1.12 ms, 1.03 ms, 1.08 ms, 1.63 ms, and 1.09 ms for the parameters listed, respectively.

SUMMARY/CONCLUSION: The most severely impaired branch in CTS was the ring-finger sensory branch, narrowly followed by the motor branch to the APB. The sensory branch to the thumb was relatively preserved, comparable to the sensory branch to the index finger and the motor branch to the second lumbrical. The vulnerabilities of the branches of median nerve in CTS are not sensory predominant but specific to respective branches.

56

C5/C6/C7 MYOTOME OF UPPER LIMB MUSCLES DOCUMENTED BY MRI-CONFIRMED CERVICAL Spondylotic Radiculopathy

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INTRODUCTION: Myotomal chart is an important basis for clinical and needle EMG evaluations of neuromuscular disorders. However, there have been rather few studies based on firm evidence.

OBJECTIVE: To investigate C5/6/7 myotomes of upper limb muscles by reviewing clinical and needle EMG findings in cervical spondylotic radiculopathy patients having a single-root lesion confirmed by MRI.

METHODS: Patients were retrospectively enrolled from our needle EMG database from 2009 to 2017. Medical Research Council manual muscle testing scales and needle EMG findings of individual muscles on the affected side were reviewed.

RESULTS: Enrolled were 42 patients (13 C5, 9 C6, and 20 C7 cases). Muscle weakness was found in 13/13 deltoid, 13/13 infraspinatus, 11/13 biceps brachii (BB), and 10/11 brachioradialis (BR) among C5 cases; in 4/4 pronator teres (PT) and 5/9 wrist extensor among C6 cases; and in 12/20 triceps brachii (TB) and 4/20 extensor digitorum (ED) among C7 cases. Denervation potentials in needle EMG were found in 1/11 C5, 8/9 C6, and 4/12 C7 cases at PT; in 1/6 C5, 6/9 C6, and 2/4 C7 cases at extensor carpi radialis brevis (ECRB); in 5/9 C5 and 4/7 C6 cases at extensor carpi radialis longus (ECRl); and in 1/7 C6 and 14/18 C7 cases at flexor carpi radialis (FCR).

SUMMARY/CONCLUSION: The main innervation of deltoid, infraspinatus, and BB by C5, and that of TB by C7 coincide with most previous literature. Among muscles in which controversy remains, BR is mainly innervated by C5, ECRl by C5 and C6, ECRB and PT by C6, and FCR by C7.
57

NEUROPATHY IN PARKINSON DISEASE. A NEUROPHYSIOLOGICAL STUDIES.
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INTRODUCTION: The relationship between Parkinson’s disease (PD) and peripheral neuropathy has been called into attention recently. There is increasing evidence of α-synuclein deposition pointing to a form of small fiber neuropathy intrinsic to PD; advanced levodopa treatment, degenerative factors, and vitamin deficiency were also related.

OBJECTIVE: To learn the neurophysiology characteristics and determinants of neuropathy in patients with PD and clinical neuropathy.

METHODS: We performed a cross-sectional study of 36 patients with PD referred for EDX studies with clinical neuropathy suspected. We performed needle EMG on 5 or more muscles, and NCSs in fibular and tibial (motor) and sural and superficial fibular (sensitive) nerves in all patients, and median and ulnar, motor and sensitive, in 15 patients. We also determined correlations between PD duration, neuropathy status, and neurophysiology data score.

RESULTS: Twenty-one women (58.3%; mean age: 69.6 years) and 15 men (41.7%; mean age: 68 years) underwent EDX testing. All had a tremor and a mean of evolution of PD of 5 years. Thirty two patients are on oral levodopa treatment. EDX studies revealed 22 patients with neuropathy abnormalities; 14 were normal. Needle EMG did not show significant changes.

SUMMARY/CONCLUSION: Sensory neuropathy was the main finding. The age and the time of disease evolution were factors related to neuropathy. In our study, we found that 39% of the patients did not have neuropathic alterations despite clinical suspicion, which opens up new questions about the mechanisms of PD neuropathy and the possibility of fine fiber neuropathy in these patients, motivating further research.

58

WEST NILE VIRUS INFECTION WITH SEVERE DIAPHRAGMATIC PARALYSIS SECONDARY TO PHRENIC NERVE INVOLVEMENT: A CASE REPORT
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INTRODUCTION: West Nile virus (WNV), a mosquito-borne flavivirus, typically presents with influenza-like febrile illness but can also be associated with severe neurological manifestations. While meningitis and encephalitis are most common, subacute neuromuscular weakness secondary to diffuse lower motor neuron involvement (motor neuronopathy) as well as different types of neuropathies including predominantly demyelinating polyneuropathy can also be seen.

OBJECTIVE: To describe a patient with subacute onset of severe respiratory failure secondary to bilateral diaphragmatic paralysis following recent WNV infection.

CASE REPORT: A 79-year-old previously healthy man presented with severe dyspnea requiring intubation after several months of subfebrile illness and various symptoms including generalized fatigue. Neurological examination revealed decreased muscle power and bulk, and diminished but elicitable myotatic reflexes. The patient’s respiratory status was consistent with severe hypercapnic respiratory failure. Cardiopulmonary examination and pan-computed tomography scan did not reveal pathology. Fluoroscopic sniff study demonstrated complete bilateral diaphragmatic paralysis. Laboratory testing revealed decreased muscle power and bulk, and diminished but elicitable myotatic reflexes. After extubation, the patient received a course of high-dose IV steroids and full-dose IVIg with slight improvement in symptoms.

SUMMARY/CONCLUSION: WNV infection can be associated with profound diaphragmatic weakness due to demyelinating polyneuropathy involving the phrenic nerves. A high index of suspicion is required to diagnose and introduce treatment options earlier in the course.
59

LIMITATIONS OF EMG AND NERVE CONDUCTION STUDIES IN CLINICAL PRACTICE
Gabrielle Nguyen (Houston, TX), Suzanne Woodbury (Houston, TX)

INTRODUCTION: Chronic pain and weakness are significant factors in the onset of disability. Complete needle EMG and NCSs are often required to identify the state of nerve function as it may relate the presenting symptoms. However, recent studies have shown that acquired chronic muscle spasm, identified with simple needle EMG sampling with the presence of spontaneous electrical activity (SEA), is a common cause of both chronic pain and weakness. Current reporting techniques will typically indicate the presence or absence of SEA without indication of its functional significance.

OBJECTIVE: To illustrate the diagnostic utility of needle EMG in a complex patient with anatomic abnormalities who recently underwent a surgical procedure with bilateral QL blocks.

METHODS: A severity scale of SEA and parameters for reporting is proposed. Several levels of activity are to be discriminated and given point values for any muscle showing or adjacent to muscles demonstrating SEA. Increased insertional activity is included as it has been seen in spasms of intermediate duration. The proposed levels include: (1) No SEA or increased insertional activity, (2) Increased insertional activity whether or not it recurs on repeat insertion, (3) low level SEA, (4) moderate SEA, and (5) high level SEA. Requirements for measurement of SEA require that reciprocal inhibition by contralateral muscle groups cannot be demonstrated and that the muscle should be in a natural state of relaxation based upon body habitus.

RESULTS: Outcome data and correlation with pathophysiology can then be determined.

SUMMARY/CONCLUSION: Proposed addition of SEA reporting should allow for improved assessment of presenting symptoms of chronic pain and weakness.

60

BILATERAL FEMORAL NEUROPATHIES AFTER QUADRATUS LUMBOUM BLOCKS
Gabrielle Nguyen (Houston, TX), Suzanne Woodbury (Houston, TX)

INTRODUCTION: Etiology of weakness after quadratus lumborum (QL) block is not well described despite evidence of anesthetic spread to the lumbar paravertebral space and lumbar plexus. This case is an unusual presentation of bilateral femoral neuropathies in a patient with myelomeningocele who underwent abdominal surgery with QL blocks.

OBJECTIVE: To illustrate the diagnostic utility of needle EMG in a complex patient with anatomic abnormalities who recently underwent a surgical procedure with bilateral QL blocks.

CASE REPORT: An 18-year-old female with a lumbar myelomeningocele with L3 motor level, shunted hydrocephalus, and history of postnatal repair and prior posterior instrumented fusion for scoliosis was admitted for bladder augmentation for which bilateral ultrasound-guided QL blocks were performed. Postoperatively, she experienced lower extremity weakness (left greater than right), impaired sensation, and inability to ambulate. MRI was non-obtainable due to presence of spinal hardware. Due to a protracted course of weakness and lack of defined lesion on imaging, EDX testing was obtained. Evidence of bilateral femoral axonal neuropathies were found based on results from testing. Radiology recommended ultrasound to evaluate for presence of fluid collection as a source of nerve compression.

SUMMARY/CONCLUSION: Evidence of bilateral femoral axonal neuropathies was found based on the EDX results. Correlation of findings with ultrasound 2 months after onset of weakness revealed no persistent retroperitoneal fluid collection. Lower extremity weakness after QL block is uncommon, but can occur.

Gabrielle Nguyen, MD
Resident and Fellow Member Award Recipient
A FRACTURED “FUNNY BONE” INJURY IN A NEUROMUSCULAR PATIENT: A CASE REPORT
Jennifer Baima (Worcester, MA), Kate Daniello (Worcester, MA)

OBJECTIVE: To present an unusual case of trauma to a dysfunctional ulnar nerve.

CASE REPORT: A 44-year-old man with symptomatic hereditary polyneuropathy fell on ice, striking his left elbow. He developed elbow pain, medial arm and hand sensory loss, and weakness of the finger abductors, worse than his baseline. He had a fractured olecranon enthesophyte and was prescribed a sling. He could not tolerate the sling and discontinued it due to worsening symptoms. EDX studies demonstrated absent sensory responses. The left median motor study was unchanged. The left ulnar motor study to the abductor digit minimi (ADM) exhibited prolonged distal latency, reduced amplitude with mild temporal dispersion seen above the elbow, and slowed conduction velocity. The left ulnar motor study to the first dorsal interosseous (FDI) had borderline amplitude with slowed conduction velocity. There was increased insertional activity and no motor units visible in the left FDI. There were high amplitude, long duration polyphasic motor units with mildly reduced recruitment in the left ADM. On ultrasound, the left ulnar nerve had a cross sectional area of 16 mm² at the elbow (normal ≤10 mm²) and 8 mm² at the above and below elbow segments and was far medially displaced. He was prescribed a left cubital tunnel splint and occupational therapy.

SUMMARY/CONCLUSION: Even small fractures can be devastating in a patient with neuromuscular disease. Classic splinting options may cause more pain and dysfunction than expected.

POLYRADICULOPATHY ASSOCIATED WITH SJÖGREN SYNDROME IN GESTATING PATIENT.
Haiden Pérez (Bogota, Colombia), Jorge Díaz-Ruiz (Bogota, Colombia)

INTRODUCTION: The association of Sjögren’s syndrome and motor predominance polyradiculopathy is uncommon. We review the differential diagnosis in a patient with chronic, distal, and asymmetric predominant motor compromise and some aspects of the pathophysiology of this disease.

OBJECTIVE: To report a rare case of autoimmune disease with neurological involvement, a polyradiculopathy.

CASE REPORT: A 36-year-old patient, who during her pregnancy had an autoimmune disease, presented with rheumatoid arthritis and Sjögren’s syndrome. From the 12th week of pregnancy, she debuted with gait impairment and drop foot without ataxia and sensitive impairment and progressive worsening over 6 months, with contralateral motor and upper left limb involvement. She developed inability to walk and areflexia in the left lower limb and hyporeflexia in the left upper and lower right limb. An EDX study was compatible with polyradiculopathy of segments C8, L3, L4, and L5, only motor compromise. Her immunological profile showed positive rheumatoid factor and anti-Ro and anti-La positive results. She had no response to treatment with corticosteroids, and definitive management with rituximab.

CONCLUSION: Sjögren’s syndrome is associated with multiple types of involvement of the central and peripheral nervous systems; the pathophysiology is related to vasa nervorum vasculitis and in other cases the infiltration of the posterior root ganglia. The presentation as polyradiculopathy is one of the least reported in the medical literature. The functional commitment of the patient can become severe, hence the importance of timely diagnosis.

Haiden Pérez, MD
IFCN Award Recipient
EXTRACORPOREAL SHOCK WAVE THERAPY (ESWT) VERSUS LOCAL STEROIDS INJECTION IN THE MANAGEMENT OF CARPAL TUNNEL SYNDROME (CTS)
Gehad Swilam (Ismailia, Egypt), Mohamed Hefny (Ismailia, Egypt), Mohsen Elshahaly (Ismailia, Egypt)

INTRODUCTION: CTS is a combination of characteristic symptoms and signs that occur following compression of the median nerve within the carpal tunnel. EDX studies are useful in confirming the diagnosis and assessing the severity of CTS and excluding other neurologic diagnoses. The application of extracorporeal shock wave therapy (ESWT) in musculoskeletal disorders is the treatment for tendinopathies. In musculoskeletal treatments, shockwaves are not being used to disintegrate tissues, but rather to microscopically cause interstitial and extracellular biological responses and tissue regeneration.

OBJECTIVE: To evaluate the efficacy of ESWT in the management of CTS and compare it with local steroid injection.

METHODS: This study included 62 CTS patients randomized into 2 groups: a steroid injection group (injected with 1 ml of triamcinolone acetonide [40 mg]) and an ESWT group (received 2 sessions of ESWT with 1-week interval that comprised 2500 shocks at a frequency of 10 Hz and an intensity of 2 bars [BTL-5000 SWT power]). Patients were assessed initially and at 2 and 4 weeks by the visual analog score (VAS), EDX studies, and the Boston Carpal Tunnel Questionnaire (BCTQ).

RESULTS: Both groups were comparable in age, sex, and duration of symptoms, and significant improvement (p<0.05) of symptoms assessed by VAS and BCTQ. EDX studies of the median nerve show significant improvement (p<0.05) of distal motor latency (DML) and amplitude in both groups. There was no significant difference (p>0.05) in VAS score, BCTQ, DML, and amplitude in both groups at the third visit.

SUMMARY/CONCLUSION: ESWT and local steroid injection can be effective methods for management of CTS, but ESWT, being noninvasive, is better.

Gehad Swilam, Master Degree in Physical Medicine, Rheumatology and Rehabilitation
IFCN Award Recipient

LOWER MOTOR NEURON FINDINGS IN TYPE 1 SIALIDOSIS
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INTRODUCTION: Sialidosis or cherry red spot-myoclonus syndrome is an autosomal recessive lysosomal storage disease caused by mutation of the NEU1 gene, which encodes for sialidase. Clinical presentation depends on degree of sialidase activity, absent in type 2 and partial activity in type 1. Type 1 sialidosis can have adult onset and a mild presentation. Common features of type 1 sialidosis are progressive myoclonus, visual impairment with “cherry red spot,” and ataxia. An early case report showed peripheral nerve abnormalities.

OBJECTIVE: To evaluate the peripheral nervous system manifestations of type 1 sialidosis.

DESIGN/METHODS: Type 1 sialidosis patients were evaluated under protocol 76-HG-0238 (NCT00369421) using standard NCSs, needle EMG, short-latency somatosensory evoked potentials (SSEPs), electroencephalogram (EEG), and ultrasound (US) studies.

RESULTS: Seven patients (mean age: 29.5±5.2 years, range: 14–40) with confirmed sialidosis were evaluated. NCSs were normal except for the oldest patient with a mild sensory neuropathy. Needle EMG showed 4 patients with chronic neurogenic findings that favored the proximal leg. Muscle ultrasound was performed on 2 patients: a 29-year-old patient had muscle atrophy and hyperechogenicity in leg muscles, corresponding to neurogenic needle EMG findings, and a 14-year-old patient had a normal muscle US and needle EMG. Five patients had large SSEPs, typical of myoclonic disorders. Two had EEGs with interictal epileptiform discharges corresponding to myoclonic jerks. Five patients, including the above 2, had diffuse beta activity likely secondary to benzodiazepine use.

CONCLUSIONS: In addition to myoclonus, EDX findings suggest that type 1 sialidosis is associated with progressive lower motor neuron findings. This may contribute to ambulation difficulties later in life.
ELAMIPRETIDE IN THE MMPOWER-2 OPEN-LABEL EXTENSION TRIAL (OLE): LONG-TERM SAFETY AND TOLERABILITY
Amel Karaa (Boston, MA), Richard Haas (San Diego, CA), Amy Goldstein (Pittsburgh, PA), Gerard Vockley (Pittsburgh, PA), Bruce Cohen (Akron, OH)

INTRODUCTION: Patients (>90%) with primary mitochondrial myopathy (PMM) have symptoms of fatigue, exercise intolerance, and muscle weakness which adversely affect physical functioning and quality of life. Elamipretide (ELAM) penetrates cell membranes, localizing to the inner mitochondrial membrane where it associates with cardiolipin, thereby improving adenosine triphosphate production and exercise capacity. These effects have been demonstrated in multiple preclinical models and are now being confirmed in clinical trials.

OBJECTIVE: To assess the longterm safety and tolerability of single daily subcutaneous (SC) doses of 40 mg ELAM for up to 260 weeks in PMM patients.

METHODS: Subjects with genetically- and clinically-confirmed PMM who completed the End-of-Study visit in the MMPOWER-2 trial (a randomized, double-blind, placebo-controlled, crossover trial; ELAM 40 mg SC daily for 4 weeks, n=30) were eligible to enroll in the MMPOWER-2 open-label extension (OLE). All patients receive 40 mg ELAM SC daily. Safety, tolerability, and efficacy (functional and patient reported outcomes) parameters were captured. Subjects registered to participate in MMPOWER-2 OLE (n=28) will provide further efficacy and safety data.

RESULTS: At abstract submission, 17/28 participants (61%) received 12 months of open-label ELAM treatment. An additional 9 are between 6-12 months, and 2 more have <6 months OLE exposure. Two subjects discontinued (1 adverse event/1 withdrew consent). Updated information on patient exposure, safety, and efficacy will be provided.

SUMMARY/CONCLUSION: All subjects receiving at least 1 dose of ELAM will be included in the safety analysis. The efficacy evaluable population will consist of subjects receiving at least 1 dose with post-dose efficacy evaluations.
ELECTROPHYSIOLOGICAL OUTCOME OF ULTRASOUND GUIDED CAUDAL EPIDURAL STEROID INJECTION IN CHRONIC RADICULAR LOW BACK PAIN.
Maha Ibrahim (Ismailia, Egypt), Magdy Awadalla (Ismailia, Egypt), Aziza Omar (Ismailia, Egypt), Mohammad al Shatouri (Ismailia, Egypt)

INTRODUCTION: Back pain of radicular origin is a common musculoskeletal condition. Epidural injections are among the most commonly performed interventions for managing radicular pain. There are few studies on the electrophysiological outcomes of epidural steroid injections (ESIs).

OBJECTIVE: To assess the efficacy of ultrasound (US)-guided caudal ESIs in improving pain and nerve function as measured by electrophysiological testing in chronic radiculopathy.

METHODS: This is a randomized controlled trial where patients diagnosed with chronic radicular low back pain were randomized into 2 groups. The injection group (n=20) underwent a single US-guided caudal ESI of 40 mg steroids, with local anesthetic. The control group (n=20) underwent a 12-session physiotherapy program. Both groups were evaluated before and 2 weeks after the intervention using the visual analogue scale (VAS) for pain and electrophysiological testing comprising peroneal and tibial motor latencies and F response latencies and chronodispersion.

RESULTS: Both groups showed significant pain reduction on the VAS. The injection group showed a significant reduction in F wave chronodispersion post treatment (p<0.01). In the control group there were no significant differences in F wave parameters pre and post treatment (p>0.05).

SUMMARY/CONCLUSION: Caudal ESI was shown to improve nerve function as evident by improvement in the electrophysiological parameters sensitive to radiculopathy. It was found to be superior to standard physical therapy in that regard.

Maha Ibrahim, PhD
IFCN Award Recipient

TURBULENCE KINETIC ENERGY OF CEREBROSPINAL FLUID AT THE LUMBOSACRAL LEVEL IN PATIENTS WITH LUMBAR SPINAL STENOSIS
Keewon Kim (Seoul, South Korea)

INTRODUCTION: Lumbar spinal stenosis (LSS) is highly prevalent and exhibits a typical clinical manifestation, but its pathophysiology remains unclear. Altered cerebrospinal fluid (CSF) flow has been suspected as a cause of LSS, however, the mechanism of such alteration remains ambiguous.

OBJECTIVE: To (1) evaluate CSF dynamics at the lumbosacral level in LSS patients along with healthy control subjects, (2) compare hydrodynamic parameters between LSS patients and healthy control subjects, and (3) propose a possible mechanism of LSS based on the observed CSF dynamics.

METHODS: Phase-contrast MRI (PC-MRI) was conducted for 18 healthy control subjects and 9 LSS patients. The imaging was applied to measure the CSF flow velocities at L2 and S1. Turbulence kinetic energy (TKE) was calculated to identify the difference in energy level of the CSF between the 2 groups.

RESULTS: The CSF velocity and CSF TKE at L2 were attenuated in LSS patients compared to that in healthy control subjects (p<0.01 with CSF velocity and p<0.001 with CSF TKE). The CSF TKE was most effective in differentiating patients from control subjects than other CSF dynamic parameters (TKE area under the curve=0.920) and had no significant correlation with stenosis severity (r=0.326, p=0.09).

SUMMARY/CONCLUSION: The energy level of CSF is significantly decreased in LSS patients, compared to healthy control subjects, or even to asymptomatic patients with narrowed canals. The findings suggest that altered CSF dynamics due to decreased craniospinal compliance should be suspected in LSS patients, thus PC-MRI could be used as an effective diagnostic measure for LSS.
MYOFASCIAL HERNIATION AS UNCOMMON CAUSE OF LEG PAIN WITH NEUROPATHIC SYMPTOMS
Dora Leung (New York, NY), Ogonna Kenechi Nwawka (New York, NY)

INTRODUCTION: Muscle herniation, or myofascial herniation, of the leg is an uncommon and often asymptomatic condition. It may present in patients as chronic leg pain aggravated by activity, and limits function. If the adjacent superficial peroneal nerve is irritated or entrapped by the herniation, concomitant symptoms of neuropathy may occur.

CASE REPORT: A 50-year-old man presented with chronic bilateral calf pain. Symptoms have been stable for years and only occur with exercise, with pain localized to bilateral lateral calves with paresthesia in ankles. With activity, he develops stereotypic focal lateral calf and ankle swelling, associated with pain at the ankles. His physical examination reveals tender, focal soft tissue swelling of about 1 cm in diameter at lateral calves. Smaller protrusions are at the ankles anteriorly adjacent to the distal fibula. His neurological examination is normal except for diminished cutaneous sensation with paresthesia in the left lateral lower leg through dorsum of foot. Electrodiagnostic studies of the legs are normal. Ultrasound shows bilateral tibialis anterior muscle herniations at calves, and bilateral extensor digitorum longus muscle herniations at the distal leg adjacent to SPN. The left SPN is enlarged and regional sonopalpation reproduced paresthesia.

SUMMARY/CONCLUSION: Myofascial herniation is due to focal fascial sheath defect, usually in the leg. Although uncommon, it can be a cause of chronic leg pain. Physical activities which raise intracompartmental pressures may potentiate the herniation, and worsen symptoms. Herniation at the ankle may present as entrapment neuropathy of superficial peroneal nerve.

EMG GUIDED CHEMODENERVATION PROCEDURE OF ACQUIRED CHRONIC MUSCLE SPASM DESIGNATED AS CMECD™
Roger Coletti (Lewes, DE)

INTRODUCTION: Multiple prior abstract publications involving the novel procedure of needle EMG guided chemodenervation of chronic muscle spasm have been presented. Various details of the procedure were contained in each of these abstracts. However, sufficient information for undertaking this procedure was lacking. Clear designation of the described procedure was deemed necessary for physicians seeking complete procedural information with access to references and other supportive documentation.

OBJECTIVE: To make a clear and simple designation of this novel procedure to facilitate online search for procedural information and subsequent published research.

METHODS: A simple acronym, CMECD™, which represented “Coletti Method EMG Guided ChemoDenervation” was chosen and subsequently trademarked. Internet search under this acronym now readily identifies videos and the CMECD.info site holds all information presently compiled on this procedure. Trademark application was chosen to assure that there was consistency in the procedure if and when undertaken by various practitioners.

RESULTS: Online viewing of the procedural website, CMECD.info, is already allowing hundreds of views per month.

SUMMARY/CONCLUSION: This method of online presentation allows for dissemination of emerging medical treatments in a fashion more readily accessible to physicians and potential patients. Designation of a procedure with a readily searchable acronym, providing procedural, research, and outcome data should be considered a model for providing ready access to detailed information on emerging medical treatments.
71

UNIQUE MRI FINDINGS IN SEGMENTAL ZOSTER PARESIS
Brion Reichler (New York, NY), Darryl Sneag (New York, NY), Steven Daniels (New York, NY)

INTRODUCTION: Segmental zoster paresis (SZP) is a rare, but well-recognized, manifestation of herpes zoster infection. Motor and sensory deficits accompany the acute pain and cutaneous hypersensitivity typical of shingles. Several published case reports and series have shown signal hyperintensity and/or enlargement of the affected nerves.

OBJECTIVE: To present 2 cases of SZP, 1 with more typical imaging and 1 with novel MRI findings.

CASE REPORTS: Two elderly patients developed pain and rash in a leg, followed by sensory deficit and weakness. In patient 1, the rash involved the posterolateral thigh and calf, and weakness and numbness were in the sciatic distribution. In patient 2, the rash involved the lateral calf and foot dorsum, with sensorimotor deficit primarily in the common peroneal distribution. EDX testing was consistent with the suspected clinical localizations. Magnetic resonance neurography (MRN) of patient 1 showed the typical signal hyperintensity of the sciatic nerve from its formation through the mid-thigh. MRN of patient 2 showed segmental hyperintensity and enlargement of the common peroneal nerve just proximal to the fibular head, as well as an unusual thickened and lamellated appearance of the surrounding epineurium and perineural fascia.

CONCLUSION: We present a novel MRI appearance of the clinically-affected nerve in SZP, consisting of epineurial thickening and lamellation in association with signal hyperintensity and enlargement. These findings may reflect chronic hemorrhage and necrosis, with inflammation of the surrounding neural connective tissue. The failure to observe this in prior series may be attributable to the higher contrast and spatial resolution achievable with MRN.

72

INCIDENCE OF PHANTOM LIMB PAIN IN TRAUMATIC VERSUS NON-TRAUMATIC AMPUTATION
Minh Le (North Bay Village, FL), Marine Dididze (North Bay Village, FL), Seema Khurana (Miami, FL), Mario Olavarria (Miami, FL)

INTRODUCTION: There have been limited reports comparing incidence of acute phantom limb pain following traumatic and non-traumatic amputation. Prior studies demonstrated no correlation between etiology and subsequent occurrence of phantom pain, and they did not compare acute and subacute onset of symptoms.

OBJECTIVE: To evaluate occurrence of phantom limb pain following traumatic versus non-traumatic limb amputation.

CASE REPORTS: (1) A 43-year-old male following a motorcycle accident resulting in left leg complete and right leg partial traumatic amputation underwent left above the knee amputation (AKA) and right knee disarticulation. (2) A 68-year-old male status post fall from a ladder complicated by thromboses of the right superficial femoral, popliteal, and tibial arteries, right tibial plateau fracture, and deep venous thrombosis of the right popliteal vein underwent right lower extremity AKA.

RESULTS: (1) Prior to admission to the inpatient rehabilitation facility (IRF), the patient developed phantom limb pain that started few days following amputation. He received 13 days of IRF therapy with pain controlled by medications. Following discharge from the IRF, he reported significant improvement of phantom limb pain with pharmaceutical treatment. (2) The patient was discharged after a 7-day course of IRF; he denied phantom limb pain during his acute care stay rehabilitation course as well as at follow up.

SUMMARY/CONCLUSION: Occurrence of acute onset phantom limb pain may correlate with an amputation resulting from trauma. Further studies are warranted to evaluate the incidence of phantom limb pain following acute traumatic and non-traumatic amputation.
 Counseling for Substance Use Disorders: A Comparison of in-Person and Telehelath Delivery Models

INTRODUCTION: The importance and diagnostic value of ordering needle EMG studies for lumbar radiculopathy evaluation have been documented. No study yet has evaluated the components of EDX studies—NCSs, including H reflexes, and needle EMG, including spontaneous activity and voluntary motor unit action potentials—in predicting patient outcomes after transforaminal epidural steroid injection.

OBJECTIVE: To investigate the correlation between EDX study results and patient outcomes after lumbar transforaminal epidural injection in patients with lumbosacral radiculopathy.

METHODS: In this retrospective study, 38 patients completed pretreatment and post-treatment pain and functional tests and underwent EDX studies prior to transforaminal epidural injection. Improvements in pain and function were compared with the EDX findings.

RESULTS: The subjects showed significant improvements in the visual analog scale (VAS). The results of the EDX studies for lumbosacral radiculopathy were positive in 28 and negative in 10. At 3 months after the injections, significant differences in the VAS (2.5±1.4 versus 4.9±1.4, respectively) and Oswestry Disability Index (22.5±11.9 versus 30.0±17.2, respectively) were found between the patients with positive and those with negative results, but not between the components of the EDX studies.

CONCLUSION: Pain and functional improvements after transforaminal epidural injection were correlated with the positive EDX results but not with any of the individual components of the EDX studies for lumbosacral radiculopathy.

TRAMADOL AND SEROTONIN SYNDROME

Francis Lagattuta (Santa Maria, CA), Chelsea Langer (Santa Maria, CA), Matthew Hadilaksono (Santa Maria, CA), Cristina Tipei (Santa Maria, CA), Andrew Hoosier (Santa Maria, CA), Lane Lagattuta (Kansas City, MO)

INTRODUCTION: Tramadol, used for mild-to-moderate pain, is a mild motor unit receptor as well as a serotonin reuptake inhibitor. As many patients with chronic pain are also diagnosed with depression, it is common to have concurrent prescriptions of antidepressants which have a similar mechanism of action. There is a black box warning that this may cause serotonin syndrome.

OBJECTIVE: To determine how many patients on tramadol developed serotonin syndrome with or without other medications.

METHODS: A database of 25,000 patients at multiple pain clinics was retrospectively reviewed for prescriptions of tramadol in the last 12 months. These patient's charts were reviewed for abnormal side effects, including serotonin syndrome.

RESULTS: There were 3798 patients on tramadol alone; 58 patients on tramadol and venlafaxine; 195 patients on tramadol and duloxetine; and 364 patients on tramadol and nortriptyline. None of these patients suffered from serotonin syndrome; 5% developed nausea, vomiting, or an uneasy feeling and stopped taking the medication.

SUMMARY/CONCLUSION: Although tramadol has previously been linked to serotonin syndrome, this study shows that is a rare occurrence and, if monitored appropriately, tramadol can be used alone or with other antidepressants in chronic pain patients with depression. Mental health providers use combination antidepressants in many cases with minimal serotonin syndrome as well. Other studies show that tramadol has a very low abuse potential and may be a better choice of analgesic for longterm treatment for mild-to-moderate chronic pain.
75
TREATMENT OF SMALL FIBER NEUROPATHY WITH PENTOXIFYLLINE AND ALPHA LIPOIC ACID
Francis Lagattuta (Santa Maria, CA), Chelsea Langer (Santa Maria, CA), Cristina Tipei (Santa Maria, CA), Lane Lagattuta (Kansas City, MO), Joseph Lagattuta (Olympia Fields, IL)

INTRODUCTION: Small fiber neuropathy (SFN) is a disease of the unmyelinated C fibers or the thinly myelinated fibers that causes burning, aching, and cramping pain in the limbs. This condition is a source of chronic pain.

OBJECTIVE: To see if medications intended to increase circulation regenerate small myelinated nerves and unmyelinated C fibers in patients diagnosed with SFN from an epidermal nerve fiber density (ENFD) skin biopsy.

METHODS: In this retrospective cohort from a pain management clinic, 104 SFN patients were treated with pentoxifylline and alpha lipoic acid (ALA) (50) or no regenerative medication (54). The main outcomes were the ENFD results and values for biopsies taken at the calf (CA), distal thigh (DT), and proximal thigh (PT) at baseline and after at least 4 months of treatment. Abnormal ENFD results were categorized as length-dependent or non–length-dependent by comparing PT with CA biopsy sites.

RESULTS: Among patients taking medication, 39% (13) had improved ENFD results, compared to 28% (12) patients taking no medications (p=0.54). Specific ENFD values improved among patients taking medications compared to those who were not: 28 patients (57%) versus 22 (41%) increased CA score (p=0.09); 30 (61%) versus 22 (41%) improved DT score (p=0.03); and 29 (59%) versus 20 (37%) improved PT score (p=0.03). Among patients with an abnormal second biopsy, 71% (44) were length-dependent.

SUMMARY/CONCLUSION: Pentoxifylline alters red blood cells’ morphology to enter the capillaries and repair damaged tissues; ALA regenerates these same fibers. Our results show a regeneration of fibers following treatment with these medications.

76
INTRA-EPIDERMAL NERVE FIBER DENSITY ABNORMALITIES IN DIABETIC PATIENTS WITH NEUROPATHIC SYMPTOMS WHO EXHIBIT NORMAL ELECTRODIAGNOSTIC FINDINGS
Matthew Hadilaksono (Santa Maria, CA), James Tipei (Santa Maria, CA), Cristina Tipei (Santa Maria, CA), Chelsea Langer (Santa Maria, CA), Francis Lagattuta (Santa Maria, CA)

INTRODUCTION: Diabetic peripheral neuropathy has conventionally been diagnosed with needle EMG/NCSs and by the presence of its clinical symptoms. Recent studies have shown a reduction in intraepidermal nerve fiber density (IENFD) even in diabetic patients without clinical symptoms of neuropathy. Early changes in these small unmyelinated C fibers may be the etiology of pain in many diabetic patients who exhibit normal findings on needle EMG/NCSs.

OBJECTIVE: To evaluate the IENFD results in diabetic patients with neuropathic symptoms who had normal EDX findings.

METHODS: In this study, we analyzed 149 patients with a history of diabetes who exhibited neuropathic symptoms with normal needle EMG/NCSs results and subsequently had IENFD skin biopsy. Skin biopsy results on these patients were then classified as either normal or abnormal based on age- and sex-adjusted normative values. Abnormal IENFD results were categorized as length-dependent or non–length-dependent by comparing proximal thigh to calf skin biopsy sites.

RESULTS: Of 149 diabetic patients with normal needle EMG/NCSs, 110 (74%) exhibited abnormal compared to 39 (26%) with normal IENFD results (p<0.001). Among 110 patients with abnormal IENFD results, 73 (66%) were length-dependent versus 37 (34%) who were non–length-dependent (p<0.001).

SUMMARY/CONCLUSION: A significant number of diabetic patients with pain or early signs of neuropathy, not otherwise detected by needle EMG/NCSs, exhibit abnormalities in their IENFD in a length–dependent manner. IENFD analysis aids in the detection of these small fiber neuropathic changes and allows for the initiation of early intervention.
IS THERE AN OPTIMAL SITE FOR QSART-MEDIATED DIAGNOSIS OF SMALL FIBER NEUROPATHY?
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INTRODUCTION: Sudomotor dysfunction may be the earliest manifestation of a distal small fiber neuropathy (SFN). Diagnostic determination of SFN commonly involves the quantitative sudomotor axon reflex test (QSART) coupled with quantification of skin biopsy (SBx) epidermal nerve fiber density (ENFD). In patients with SFN, abnormal SBx ENFD typically exhibits 100% sensitivity with greater than 95% specificity. How well QSART findings correlate with SBx ENFD findings, however, may depend on the anatomical test site evaluated.

OBJECTIVE: To determine which of the 4 QSART anatomical sites (forearm, proximal leg, distal leg, and foot) proves diagnostically optimal for SFN.

METHODS: This was a retrospective chart review of QSART and SBx findings from 35 patients with needle EMG-negative SFN.

RESULTS: Nineteen (54.3%) patients exhibited positive QSART and SBx findings. By comparison, 6 (17.1%) tested negative for both tests. Discordance was observed in 10 (28.6%) patients. All-site abnormalities were seen in 9 (25.7%) patients and correlated 100% with abnormal ENFD, compared to none with normal ENFD. Of patients with abnormal ENFD and ≤2 abnormal QSART sites, 100% had foot-site abnormalities, while 66.7% had abnormal proximal or distal leg sites. Only 1 ENFD normal patient had an abnormal foot QSART finding. In contrast, proximal or distal leg QSART sites were abnormal in all ENFD normal patients.

SUMMARY/CONCLUSION: QSART foot sites are more sensitive and specific than proximal or distal leg sites. All-site abnormalities correlated 100% with abnormal SBx ENFD findings. The combined use of foot-evaluated QSART findings with SBx ENFD is recommended to increase diagnostic yield.

UNIQUE CONSIDERATIONS FOR ELECTRODIAGNOSTIC TESTING POST ELECTRICAL INJURY
Barathi Sreenivasan (Toronto, Canada)

INTRODUCTION: Electrical injury in patients poses unique issues regarding tolerance for EDX testing and pain, which in turn affects clinical practice.

OBJECTIVE: To present a case of a patient who sustained electrical injury and discuss challenges and approaches to EDX testing in this unique population.

CASE REPORT: A 23-year-old male employed as a lineman sustained a work-related left upper extremity electrical injury. This required forearm fasciotomy and median nerve release immediately post injury. The patient had attempted to return to work 6 months after the injury, but was unsuccessful due to psychological distress upon returning to the scene of his injury and cold intolerance in the left upper extremity. The patient was referred 7 months post injury with worsening paresthesias, cold intolerance, and numbness in the left upper extremity. The Fear of Pain Anxiety Symptom Scale Short Form was administered to identify pain related fear and anxiety issues. The EDX practitioner reviewed coping style strategies with the patient prior to and during EDX testing. At initial assessment, the patient was given 1 week to prepare for the examination along with a prescription for anxiolytic medication. The Wong–Baker Faces Pain Scale, Visual Analog Scale, and Numerical Rating Scale were administered prior to and after EDX testing to assess patient predicted and actual pain levels. Using these strategies, the patient successfully completed EDX testing.

SUMMARY/CONCLUSION: Challenges surrounding EDX testing post electrical injury can be addressed using pain assessment, coping style discussion, pain assessments, timing of testing, and anxiolytic use.
IMPROVING PATIENT KNOWLEDGE ON ELECTROMYOGRAPHY AND NERVE CONDUCTION STUDY—A QUALITY IMPROVEMENT INITIATIVE.
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INTRODUCTION: Patients referred for needle EMG/NCSs who have little or no knowledge about the tests have a lot of anxiety, technical issues, delays during the tests, or even incomplete tests.

OBJECTIVE: To increase patients’ knowledge of the needle EMG/NCS examination prior to testing and to increase overall patient satisfaction.

METHODS: A total of 20 patients were evaluated after they had been referred for needle EMG/NCSs. The intervention involved asking them to watch the AANEM video “What to Expect During Nerve Conduction Study and EMG Test” a day prior to their examination. The results were evaluated by a scoring system on the day of their appointment. These were analyzed using IBM SPSS Version 22. We utilized a Plan-Do-Study-Act cycle to proceed with the study.

RESULTS: Nineteen of 20 patients who watched the video prior to testing felt it was helpful. Knowledge differences about the tests before and after the intervention were statistically significant (p<0.0001). Prior to the intervention, 90% failed; after the intervention, 75% passed. Patients who saw the video did not use lotions or creams and no anticoagulation before the test. Differences in anxiety levels before and after the intervention were not considered statistically significant (p=0.17), and 9 reported their anxiety levels had actually increased.

SUMMARY/CONCLUSION: Based on these results, we conclude that providing an educational video on needle EMG/NCSs prior to testing will increase patient’s knowledge, increase overall satisfaction towards the tests, and help decrease technical difficulties encountered.

EFFECTS OF TRACTION ON INTERPRETATION OF LUMBAR BONE MINERAL DENSITY IN PATIENTS WITH DUCHENNE MUSCULAR DYSTROPHY
Yong Beom Shin (Busan, South Korea), Je-Sang Lee (Busan, South Korea)

OBJECTIVE: To compare the performance of dual-energy X-ray absorptiometry (DXA) and quantitative computed tomography (QCT) in evaluating the bone mineral density (BMD) of patients with Duchenne muscular dystrophy (DMD) and scoliosis.

MATERIALS/METHODS: This study included 29 patients with DMD (mean age: 19.72±6.13 years). The scoliosis and vertebral rotation angles obtained before and after traction were compared, and the BMD values obtained by DXA were compared to those obtained by QCT. The scoliosis angle was presented as Cobb’s angle. In addition to the degree of curvature for each patient, the Cobb’s angle of L1 to L4 was separately measured (used for bone density analysis in DXA). During traction, each patient’s shoulder and hip regions were retracted to the point at which the distance between the shoulder and its ipsilateral anterior-superior iliac spine remained equal in all imaging tests.

RESULTS: The Cobb’s angle significantly decreased from 30.38±24.83 degrees before to 22.78±20.41 degrees after traction (p<0.0001). When compared with the BMD values measured by QCT, the BMD values and Z-score derived from DXA showed a higher degree of correlation when traction was applied. We also found that the pre- and post-traction Z-score (≤−1.1 and −1.36, respectively) used in the DXA measurements as cutoff values for the diagnosis of osteoporosis were more accurate in identifying patients with osteoporosis.

CONCLUSION: Lumbar BMD measured by DXA in patients with DMD and scoliosis allowed a more accurate diagnosis of osteoporosis when traction was applied.

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81

CLINICAL RELEVANCE OF MARTIN GRUBER ANASTOMOSIS
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INTRODUCTION: Martin–Gruber anastomosis (MGA) is the most common anomalous innervation (7.7-34% of the population). Clinical importance of MGA is highlighted.

CASE REPORTS: (1) A 52-year-old patient had a left distal humerus compound fracture. This was fixed surgically, and ulnar nerve damage was noted. He has left hand numbness over the little and ring fingers with weakness of wrist flexion. Fingers abduction/adduction are good. NCSs revealed proximal left ulnar neuropathy with MGA involving median motor fibers to the ulnar abductor digiti minimi and ulnar/first dorsal interosseous muscles. Needle EMG revealed denervation changes in proximal ulnar muscles. MGA has helped his hand muscles function. (2) A 39-year-old mom has pain, numbness, and tingling over her right hand in the median distribution. This started during her pregnancy and persisted after delivery. NCSs confirmed a right focal median neuropathy at the wrist evidenced by slowing of median sensory nerve conduction velocities across the wrists and prolonged median/lumbrical motor distal latency. Median sensory responses are good in amplitude. Stimulation of the median/abductor pollicis brevis motor nerve at the wrist failed to induce a compound muscle action potential, though this was achieved when stimulated proximally at the elbow. She has median motor fibers anastomosis to ulnar motor nerve. However, the severity grade was misled by the presence of MGA.

SUMMARY/CONCLUSION: The presence of MGA can be protective to patients. In the first case, despite serious ulnar nerve injury proximally at the elbow, hand motor function is relatively maintained. In the second case, even in common CTS, the presence of MGA helps preserves thumb motor fibers and function.

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82

GEOGRAPHY IMPACTS MORTALITY IN DUCHENNE MUSCULAR DYSTROPHY PATIENTS ADMITTED WITH PNEUMONIA
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INTRODUCTION: Pneumonia is among the leading causes of death in patients with Duchenne muscular dystrophy (DMD). Social determinants of health—including socioeconomic status, race and ethnicity, and environmental conditions—have been shown to impact healthcare outcomes; however, the role of these determinants on patients with rare neuromuscular diseases is not well understood.

OBJECTIVE: To measure how social determinants of health impact mortality in patients with DMD.

METHODS: Using the Nationwide Inpatient Sample (NIS), we conducted a cross-sectional study of inpatient mortality in DMD patients admitted to U.S. hospitals with pneumonia. Data was collected from the years 2003 to 2014. ICD-9 billing codes were used to identify patients with DMD and pneumonia. Univariate and multivariable logistic regression was used to determine risk factors for mortality. A propensity score was created to determine a patient’s likelihood of death, and it was used as a variable in the logistic regression models.

RESULTS: The NIS reported 1740 DMD patients admitted to hospitals with pneumonia. Mortality was 7% (118/1740). Patients from the Mountain region had 3.3 times greater odds of mortality than patients from the Midwest (95% CI: 1.49-7.26). Rural admissions (OR=1.97; 95% CI: 1.05-3.71) and admissions to low DMD volume hospitals (OR=1.61; 95% CI: 1.04-2.50) also increased risk of mortality.

SUMMARY/CONCLUSION: Geographic location—not race, income, or insurance type—impacted mortality in DMD patients admitted with pneumonia. It is our hypothesis that proximity to specialized neuromuscular care impacts outcomes in this population.
CURRENT PERSPECTIVES OF NEUROLOGISTS REGARDING APPROACH TO THYMECTOMY IN NON-THYMOMATOUS MYASTHENIA GRAVIS
Jenna McClane (Haddonfield, NJ), John Gaughan (Camden, NJ), Krystal Hunter (Camden, NJ), Frank Bowen (Camden, NJ), Joseph Campellone (Camden, NJ)

INTRODUCTION: Evidence supports the efficacy of extended transsternal thymectomy in improvement of clinical outcomes in non-thymomatous myasthenia gravis (MG). Despite less rigorous evidence, minimally invasive thymectomy techniques are frequently performed.

OBJECTIVE: To analyze perspectives regarding thymectomy utilization in the management of MG, and to identify factors that may influence practice trends.

METHODS: A questionnaire addressing perceptions and practices of thymectomy was developed and distributed to neurologists through links on web-based forums. Cross tabulations were carried out by demographic factors and groups were compared using Fisher’s exact test.

RESULTS: The majority of 56 neurologists responded that they believe thymectomy results in improved clinical outcomes (69.5%) and that maximal and minimal techniques are equally effective (61.8%). Among those who consider the approaches to be unequal, maximal approaches are regarded superior (37.2% versus 5.5%; p=0.0004); this is associated with surgical availability (p=0.03). Only 19.6% of those who consider maximal approach to be superior endorse recommending maximal thymectomy for their patients, with all demographic associations being nonsignificant.

SUMMARY/CONCLUSION: Minimally invasive thymectomies continue to be utilized in the management of non-thymomatous MG, despite the lack of high-grade evidence supporting longterm clinical improvement. This study indicates that the majority of neurologists consider both approaches to surgery to be equally effective, and that neurologists are unlikely to recommend the maximal approach, even if they believe it will result in a better outcome. In the context of a paucity of evidence, these trends warrant further investigation.

CURRENT PRACTICE PATTERNS IN CIDP: A CROSS-SECTIONAL SURVEY OF NEUROMUSCULAR EXPERTS AND COMMUNITY NEUROLOGISTS IN THE UNITED STATES
Deborah Gelinas (Research Triangle Park, NC), Jonathan Katz (San Francisco, CA), Paul Nisbet (Mt Pleasant, SC), John England (New Orleans, LA)

INTRODUCTION: Chronic inflammatory demyelinating polyneuropathy (CIDP) is a treatable disease caused by autoimmune inflammation of the peripheral nerves, yet accurate diagnosis and successful treatment of CIDP can be challenging. The primary goal of treatment is to improve function and maintain longterm remission without overtreating the patient. Balancing these goals to achieve optimal disease control may be difficult, even to seasoned neurologists. As IV immunoglobulin (IVIg) therapy is an effective yet expensive treatment, it is imperative that patients are neither denied treatment nor maintained on treatment unnecessarily.

OBJECTIVE: To evaluate how neurologists make decisions regarding CIDP.

METHODS: We conducted a study in 2 phases: (1) qualitative interviews with 6 neuromuscular experts and (2) quantitative survey of 100 community neurologists.

RESULTS: In contrast to experts who uniformly are informed by European Federation of Neurological Societies/Peripheral Nerve Society guidelines, only 13% of community neurologists cited using it. In addition, variability in treatment approaches existed regarding dose of IVIg used, length of IVIg therapy before determining response, outcome measures used to determine IVIg response, and weaning. Community neurologists were more likely to underdose and give less specific patient education about the rationale of IVIg use and treatment duration. The finding that approximately half of community neurologists endorsed EDX criteria which do not support CIDP diagnosis indicated that treaters often lack the expertise to incorporate diagnostic guidelines requiring sophisticated neurophysiologic studies.

SUMMARY/CONCLUSION: More education on CIDP diagnosis and treatment is needed, particularly in the midst of high information flow and multiple guidelines.
ASSessment of Parasympathetic Failure in Diabetics, Pre-Diabetics and Non-Diabetics: A Veterans Affairs Study.
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INTRODUCTION: Valsalva ratio (VR) and heart rate response to deep breathing (HRDB) are the best measures of parasympathetic function and have been shown to be both reproducible and reliable. Formal studies to determine which of these measures may be a more sensitive indicator of parasympathetic activity in non-diabetics, pre-diabetics, and diabetics, however, are lacking.

OBJECTIVE: To examine the sensitivity of HRDB or VR for parasympathetic function in diabetics, pre-diabetics, and non-diabetics seen at Edward Hines Veterans Affairs hospital.

METHODS: We examined autonomic function studies in 154 patients over the past 2 years for our objective goal. Pre-diabetes is defined as glycosylated hemoglobin of ≥5.7 and diabetes (type 2) ≥ 6.4%.

RESULTS: We found that in non-diabetics and pre-diabetics, the percentage of HRDB abnormalities was higher than the rate of VR abnormalities, at 14.3 and 4.8% in non-diabetics and 18.8 and 6.3% in pre-diabetics, respectively. In the diabetic population, 6.3% had an abnormal VR, whereas only 1.8% demonstrated an abnormal HRDB. The diabetic population, however, was much more likely to have combined abnormalities in both HRDB and VR at 26.8%, compared with only 14.3% of non-diabetics and 6.3% of pre-diabetics.

SUMMARY/CONCLUSION: These results suggest that HRDB is more often abnormal in the pre-diabetic population, however combined abnormalities in both HRDB and VR is more often abnormal in the diabetic population, which is consistent with current literature. Unfortunately, limitations of performing autonomic testing in patients with cardiac pacemakers reduced the size of the study population. Other reliable strategies for evaluating parasympathetic function need to be developed.
A CASE OF MUSCLE BIOPSY CONFIRMED INFLAMMATORY MYOSITIS WITH COEXISTING SERONEGATIVE MYASTHENIA GRAVIS ASSOCIATED WITH IPILIMUMAB AND PEMBROLIZUMAB USE IN A PATIENT WITH ADVANCED MELANOMA

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INTRODUCTION: Ipilimumab and pembrolizumab are immune checkpoint inhibitors (ICPIs) used for certain malignancies. They can be associated with neurological immune-related adverse events (irAEs), including myasthenia gravis (MG) and myositis.

OBJECTIVE: To report a patient with melanoma who developed MG and myositis after treatment with ipilimumab and pembrolizumab.

CASE REPORT: A 64-year-old woman with metastatic melanoma developed generalized pain, ptosis, diplopia, dysphagia and proximal weakness after 1 dose of ipilimumab. She was previously treated with pembrolizumab for 14 months, and the last dose was 2 months prior to ipilimumab treatment. Diagnostic evaluation showed negative MG serologic studies, decremental responses to repetitive nerve stimulation, myopathic features on needle EMG, and a muscle biopsy that showed active myopathic changes associated with endomysial inflammation. Ipilimumab was stopped, and the patient was treated with pyridostigmine, steroids, and IV immunoglobulin with resolution of the myasthenic syndrome. The myopathy improved with mild residual weakness. Unfortunately, her melanoma continued to progress despite further treatments, and she died 9 months after the neurologic presentation.

RESULTS: To our knowledge, this is the first case report of muscle biopsy-confirmed inflammatory myopathy with coexisting seronegative MG associated with ipilimumab and pembrolizumab. There have been 2 cases of MG and elevated creatinine kinase (without muscle biopsy confirmation) after ipilimumab use and 3 cases after pembrolizumab. There have been rare reports of muscle biopsy-confirmed myositis with MG associated with nivolumab.

SUMMARY/CONCLUSION: As indications for ICPIs expand, physicians will encounter neurological irAEs more frequently. Prompt recognition of neuromuscular complications is essential for timely, appropriate management.
GROW YOUR OWN- A NOVEL PROGRAM TO TRAIN NEUROPHYSIOLOGY TECHNOLOGISTS
Ashley Roberts (Huntsville, MO), Raghav Govindarajan (Columbia, MO)

BACKGROUND: With shifts open for long periods of time and a very rapidly growing department, we were trying to find ways to fill our positions for neurophysiology technologists.

OBJECTIVE: To outline the steps we undertook to build our own neurophysiology technologist school utilizing the resources of our laboratory.

METHOD: We approached the human resources (HR) and then presented a business plan to the hospital administration with HR input. Once approved, we interviewed students from within the university—all areas including nurses, radiology technologists, food and hygiene staff, and many more. They had to have good performance reviews and be recommended by their supervisor or manager. We went through an interview process and chose them based on a composite score. We partnered with an online neurodiagnostic school to provide the theoretical content and we designed the practical aspect of training.

RESULTS: We selected 11 students during 2015–2018; 5 students in 2015, 2 students in 2016, and 4 in 2017 (mean age: 36 years, range: 23–48). There were 10 women and 10 Caucasians and 1 Hispanic. Six came from a nursing background, 3 from patient transfer services, and 2 from a radiology technologist background. Seven have successfully completed the school and have been board certified by the American Board of Registration of Electroencephalographic and Evoked Potential Technologists (ABRET). All students who completed their board certification will have a 2-year contract with the hospital.

CONCLUSION: Developing and training hospital staff from varied backgrounds is feasible and might address shortage of board certified neurophysiology technologists.

DIAGNOSIS OF PATIENTS WITH DUCHENNE MUSCULAR DYSTROPHY (DMD): RESULTS FROM A GLOBAL SURVEY OF HEALTHCARE PROVIDERS FROM NINE COUNTRIES
Siva Narayanan (South Plainfield, NJ), Panayiota Trifillis (South Plainfield, NJ), Demet Olesen (Zug, Switzerland)

INTRODUCTION: There are often disparate practice patterns in the diagnosis of Duchenne muscular dystrophy (DMD) across clinical settings.

OBJECTIVE: To evaluate the practice patterns associated with diagnosis of DMD in routine clinical practice settings.

METHODS: A quantitative survey was implemented in the U.S, Europe5 (Germany/France/Italy/Spain/UK), Turkey, Colombia, and Brazil among specialists treating patients with DMD. Physicians must have practiced between 2–35yrs and spent ≥25% of time in direct patient care. A 50-minute survey captured physician/site characteristics, dynamics of patient diagnostics, genetic testing, perceptions of early intervention and disease management, specific DMD treatment attributes, and stakeholder interactions.

RESULTS: Preliminary analysis included 170 physicians (pediatric neurologists: 51.8%, neuromuscular specialists: 28.2%, and adult neurologists: 12.4%; duration in practice: 16.5 years; United States: 24.7%, Europe [5 countries]: 45.3%, Turkey: 7.6%, Colombia: 8.8%, and Brazil: 13.5%); mostly affiliated with muscle centers (80.6%) and hospitals (80.0%). Mean number of DMD patients in each practice was 43.0; >90% were managed by multiple healthcare providers. Physicians participating in this study diagnosed 72% of patients; the rest were diagnosed by those in other specialties. Mean patient age when family initially noticed symptoms was 34.7 months (±24.1 months), when their physician first became aware of symptoms was 42.3 months (±27.9 months), and confirmed DMD diagnosis was 53.9 months (±30.3 months). Genetic testing for DMD diagnosis was conducted in 67.1% of patients; 82.3% and 58.2% had serum creatine kinase (CK) and muscle biopsy tested, respectively. Reasons for foregoing genetic testing included reliance on results from other tests (e.g., serum CK, muscle biopsy), lack of reimbursement or insurance coverage, and family unwilling/uninterested.

CONCLUSION: There is a delay between the time parents of DMD patients become aware of symptoms and confirmed diagnosis. One-third of the patients did not receive genetic testing. Implications of these practice patterns on patient management and outcomes warrant scrutiny.
91

DO PATIENTS WITH MULTIPLE COMORBIDITIES REQUIRE SCREENING FOR VENOUS THROMBOEMBOLISM ON ADMISSION TO INPATIENT REHABILITATION FACILITY?
Marine Dididze (North Bay Village, FL), Seema Khurana (Miami, FL)

INTRODUCTION: History of multiple comorbidities increases the risk of venous thromboembolism (VTE) in elderly and/or postoperative patients.

OBJECTIVE: To address controversial reports regarding diagnostic measurements to detect VTE at admission to an inpatient rehabilitation facility (IRF).

CASE REPORTS: Four patients were diagnosed with VTE in the IRF between July-November 2017. All had multiple comorbidities and received prophylactic anticoagulation. (1) A 75-year-old female with hysterectomy, vaginal bleeding, chemoradiation, chronic kidney disease (CKD) with urostomy, breast cancer status-post partial mastectomy developed cervical (C)1 and odontoid process fractures after a fall and underwent C1-2 posterior instrumented fusion. (2) A 72-year-old female with heart failure, myocardial infarction, ablation, and degenerative spine disease underwent thoracic (T)5-sacrum fusion, complicated with spinal cord ischemia and bilateral paraplegia. (3) A 58-year-old male with hypertrophic heart disease, CKD, nephrotic syndrome, diabetes mellitus (DM) status-post mechanical fall resulting in hip fracture underwent hip arthroplasty. (4) A 94-year-old female with hypertension, DM, and stroke.

RESULTS: (1) Left lower extremity VTE; was treated with therapeutic anticoagulation. (2) Urinary tract infection, VTE of left lower extremity, and anemia that improved after transfusion; was started on antibiotics, therapeutic anticoagulation, and was transferred to acute care for inferior vena cava filter placement. (3) Pulmonary embolism; was transferred to acute care. (4) Right lower extremity VTE; was treated with therapeutic anticoagulation.

SUMMARY/CONCLUSION: Venous ultrasound performed on admission to an IRF may assist with early diagnosis and management of VTE in elderly and/or postoperative patients with history of multiple comorbidities.

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92

URINARY RETENTION FOLLOWING QUETIAPINE: A CASE REPORT
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INTRODUCTION: The most common reported adverse effects of quetiapine are somnolence, constipation, and weight gain. Urinary retention has been reported in cases with high doses of quetiapine and when quetiapine was combined with duloxetine or olanzapine.

OBJECTIVE: To report the first case of urinary retention associated with therapeutic doses of quetiapine.

CASE REPORT: A 74-year-old female with a past medical history of hypertension, temporal lobe seizures, lacunar infarcts, bipolar disorder (BPD), asthma, chronic obstructive pulmonary disease, chronic colitis, thoracolumbar degenerative scoliosis with grade 2-3 spondylolisthesis, and multiple spine surgeries in the past underwent elective posterior thoracic-sacral T11-S1 spinal fusion. Postoperatively, she required vasopressor and blood transfusion; Jackson–Pratt drains had high output, but were removed prior to transfer to the inpatient rehabilitation facility (IRF). At admission, the patient had impaired mobility, transfers and activities of daily living. She was actively engaged in therapy, progressed well, and was scheduled for discharge. On IRF day 10, the patient developed urinary retention and required insertion of an indwelling urinary catheter. The patient’s vitals were stable, physical examination unremarkable, complete blood cell count, serum chemistry, and urine analysis normal, and MRI of the lumbar spine did not reveal any acute changes. The patient’s medications were reviewed. She was on quetiapine 50 mg 2 times/day for her BPD for over 5 years. The dose was gradually decreased to 25 mg daily over 2 days; urinary retention resolved the next day, and she was discharged home.

SUMMARY/CONCLUSION: This case suggests that a higher index of suspicion for urinary retention may be beneficial when dosing quetiapine.

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93
EFFECT OF YOGA ON OVERALL QUALITY OF LIFE IN CHILDREN WITH DUCHENNIE MUSCULAR DYSTROPHY
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INTRODUCTION: Duchenne muscular dystrophy (DMD) is a steadily progressive muscle disorder leading to gradual loss of motor function and early death. Physiotherapy has been used as conventional care in the management of DMD, by facilitating the musculoskeletal and respiratory functions. Yoga is evolving as one of the additional therapies in the field of rehabilitation. In DMD, yoga already has shown improved cardiac autonomic balance and pulmonary functions. Hence, the present study aims at the effect of yoga on overall quality of life (QOL) in DMD children.

OBJECTIVE: To study the added effect of yoga practices on the quality of life of children with DMD.

METHODS: The study was conducted in tertiary care neurology hospital at Bangalore, Karnataka, India, and included 124 children with DMD who were 5-10 years of age and self-ambulant or required minimal assistance who were then randomly allocated to 2 groups. Group I (physiotherapy only) performed home-based physiotherapy twice daily for 45 minutes. Group II (yoga and physiotherapy) performed 45 minutes of yoga and physiotherapy in the morning and evening, respectively. QOL was assessed using Pediatric Quality of Life Inventory® Neuromuscular Module. RmANOVA was used to compare the effects, and a post hoc test using the Friedman test was also conducted.

RESULTS: Total QOL changed from 2111.7±210.6 to 2188.9±249.5 in group I and 2150±198.0 to 2139.5±267.6 in group II (p=0.255).

SUMMARY/CONCLUSION: The QOL was maintained equally well in the DMD children without any significant difference between the physiotherapy and yoga groups.

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AANEM Foundation International Fellowship Award Recipient

94
LAMOTRIGINE FOR RHABDOMYOLYSIS AND MYOTONIA IN G1306A MUTATION OF THE SCN4A GENE: A CASE STUDY
Hani Kushlaf (Cincinnati, OH)

INTRODUCTION: Myotonia fluctuans without rhabdomyolysis has been reported in the G1306A mutation of SCN4A. Lamotrigine is effective for nondystrophic myotonia.

OBJECTIVE: To describe the clinical presentation and lamotrigine therapy of a patient with rhabdomyolysis and myotonia due to G1306A mutation in SCN4A.

CASE REPORT: A 20-year-old woman presented to the ER with 2 episodes of exertional rhabdomyolysis, with creatine kinase (CK) of 124,915 and 90,425 U/L, respectively. Her CK between the episodes was 1838 U/L. She has life-long history of muscle stiffness. The stiffness worsened with exertion, but not by cold weather, fasting, or potassium-rich foods. Her mother, maternal uncle, and 2 brothers also have muscle stiffness. There is no family history of rhabdomyolysis. Muscle stiffness worsened during pregnancy in mother. Examination revealed a muscular habitus, normal strength, and thenar percussion myotonia, but no grip myotonia or paramyotonia. Electrodiagnosis revealed normal NCSs and profuse myotonic discharges in arm and leg muscles without motor unit potential changes. Short exercise testing showed no change in ulnar compound muscle action potential amplitude recording from the abductor digiti minimi. Serum lactate, acylcarnitine, and amino acid profiles were normal. CLCN1 and SCN4A sequencing revealed a heterozygous G1306A mutation in SCN4A known to cause myotonia fluctuans. She had another episode of nonexertional rhabdomyolysis (CK 11,167 U/L) and developed significant aggressive behavior on 300 mg twice a day of oxcarbazepine. Lamotrigine at 75 mg twice a day prevented recurrence of the rhabdomyolysis and improved myotonic stiffness.

SUMMARY/CONCLUSION: G1306A mutation of SCN4A known to cause myotonia fluctuans can present with rhabdomyolysis and myotonia. The rhabdomyolysis may be prevented by lamotrigine. Additional studies are needed.

Pradnya Dhargave, MD
AANEM Foundation International Fellowship Award Recipient
**GLOBAL PHASE III EFFICACY, SAFETY, AND TOLERABILITY STUDY OF THE NOVEL SUBCUTANEOUS TREATMENT HYQVIA AND GAMMAGARD LIQUID/KIOVIG IN CHRONIC INFLAMMATORY DEMYELINATING POLYRADICULONEUROPATHY (CIDP)**

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**INTRODUCTION:** Chronic inflammatory demyelinating polyradiculoneuropathy (CIDP) is an acquired, immune-mediated, progressive or relapsing sensory and motor neuropathy. IV immunoglobulin (IVIg) therapy is a mainstay CIDP treatment, but it requires venous access and is associated with an increased risk of systemic adverse events. HYQVIA (Immune Globulin Infusion 10% [Human]) is a novel treatment that allows for subcutaneous self-administration of large doses of immunoglobulin, at infusion rates and frequencies similar to IVIg, but with potentially better systemic tolerability.

**OBJECTIVE:** To describe the ongoing randomized, double-blind, placebo-controlled study designed mainly to provide evidence for the use of HYQVIA as a maintenance therapy that enables self-infusion of a therapeutic dose every 2-4 weeks (NCT02549170). Additionally, GAMMAGARD LIQUID/KIOVIG will be evaluated.

**METHODS:** Enrollment of 174 adults aged ≥18 years is planned. Subjects with typical CIDP receiving stable IVIg for ≥12 weeks prior to screening will be randomized equally to HYQVIA or placebo. The primary outcome measure is the relapse rate (proportion of subjects with increase of ≥1 point in the adjusted Inflammatory Neuropathy Cause And Treatment disability scale score relative to baseline). The primary analysis is the between-group comparison of relapse rates between HYQVIA and placebo. GAMMAGARD LIQUID/KIOVIG will be used as rescue therapy. The safety of subjects is being monitored by an external Data Monitoring Committee (DMC).

**RESULTS:** The study is ongoing. The DMC has recommended that the study continue without modifications.

**SUMMARY/CONCLUSION:** This study is designed to provide evidence for the use of HYQVIA and GAMMAGARD LIQUID/KIOVIG as an Ig treatment option in adult patients with CIDP.

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**PRACTICAL APPLICATION OF SUBCUTANEOUS IMMUNOGLOBULIN FOR MAINTENANCE TREATMENT IN CHRONIC INFLAMMATORY DEMYELINATING POLYNEUROPATHY – RESULTS FROM A MULTICENTER, RANDOMIZED, DOUBLE-BLIND, PLACEBO-CONTROLLED STUDY**

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**INTRODUCTION:** Patients with chronic inflammatory demyelinating polyneuropathy (CIDP) often require long-term IV immunoglobulin (IVIg) maintenance therapy. IVIg is associated with systemic adverse events (AEs) such as headaches. Subcutaneous Ig (SCIg) offers an alternative administration option with anticipated improvements in patient convenience and safety. The Polyneuropathy and Treatment with Hizentra® (PATH) study evaluated IgPro20 as a SCIg maintenance treatment.

**OBJECTIVE:** To determine common SCIg infusion parameters for use in clinical practice.

**METHODS:** In a randomized, double-blind study, patients (n=172) received 0.2 or 0.4 g/kg IgPro20 weekly, or placebo. The primary outcome was percentage of patients with CIDP relapse (determined by adjusted Inflammatory Neuropathy Cause and Treatment score) or withdrawal during 24 weeks of treatment. AEs per infusion were recorded.

**RESULTS:** Infusions were performed at 2 weekly sessions (median: 1 hour/session) at appropriate sites. Patients infused at a median of 4 sites (range: 1–8) in parallel based on total volume infused and their preference. Patients infused a median of 4 g/20 mL/site (max 10 g/50 mL), with a median infusion rate of 20 mL/hr/site (max 50 mL/hr/site). AE rates were low (0.06/infusion), the most common were local reactions (94.5% mild, 5.5% moderate). The systemic AE rate was 0.04/infusion. Neither infusion rate nor volume altered the rate of AEs. Most patients preferred SCIg over their previous IVIg.

**SUMMARY/CONCLUSION:** IgPro20 is a flexible and efficacious maintenance therapy for CIDP, tolerated over a range of infusion volumes and rates. Subcutaneous may be a preferred route of administration for many patients.
A MULTICENTER, DOUBLE-BLIND, PLACEBO-CONTROLLED, MULTIPLE-DOSE STUDY ASSESSING THE SAFETY AND EFFICACY OF MNK-1411 IN PATIENTS WITH DUCHENNE MUSCULAR DYSTROPHY
Bryan Due (Bedminster, NJ), Patrice Becker (Bedminster, NJ), Tom Crawford (Baltimore, MD)

INTRODUCTION: Duchenne muscular dystrophy (DMD) is a recessive X-linked neuromuscular disorder resulting in progressive muscle degeneration and loss of ambulation. MNK-1411 is a 24-amino acid synthetic adrenocorticotropic hormone analogue and melanocortin receptor (MCR) agonist with the potential to slow DMD progression via MCR-mediated properties by reducing inflammation and/or attenuating muscle damage.

OBJECTIVE: To evaluate the safety and efficacy of MNK-1411 in male DMD patients aged 4-8 years.

METHODS: This is a phase 2, multicenter, double-blind, placebo-controlled, multiple-dose study (NCT03400852). Patients randomized 2:2:1:1 into the 24-week double-blind phase will receive weight-based doses of subcutaneous MNK-1411 or volume-matched placebo (2 times/week): Group A, 0.5-mg MNK-1411 (0.5 mL for patients >20 kg) or 0.4-mg MNK-1411 (0.4 mL for patients ≤20kg); Group B, 0.25-mg MNK-1411 (0.25 mL for patients >20 kg) or 0.2-mg MNK-1411 (0.2 mL for patients ≤20kg); Group C, 0.5-mL or 0.4-mL placebo; and Group D, 0.25-mL or 0.2-mL placebo. Patients who complete the blinded phase will be eligible to enter a 24-week open-label extension phase and continue receiving the same treatment volume. The primary efficacy endpoint is change from baseline in the 10-meter walk/run at week 24. Adverse events will be monitored throughout.

RESULTS: Approximately 130 patients will be enrolled at 50 sites globally; the trial will have 80% power to detect a treatment difference between groups at a significance level of 0.05.

SUMMARY/CONCLUSION: This study will potentially provide data to support the safety and efficacy of MNK-1411 for treatment of DMD.

MECHANISM OF ACTION AND LONG-TERM TOLERABILITY OF RECOMBINANT HUMAN HYALURONIDASE-FACILITATED SUBCUTANEOUS IMMUNE GLOBULIN 10% (HYQVIA [IGHY]) IN PRIMARY IMMUNODEFICIENCY DISEASES (PIDD)
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INTRODUCTION: Immunoglobulin therapy is administered intravenously (IVIg) or subcutaneously (SCIg). SCIg allows for self-administration at home with a low risk of systemic adverse events (AEs); however, the infusion volume of SCIg is limited by hyaluronan, a component of the extracellular matrix that causes resistance to bulk fluid flow. IGHy is a novel SCIg product that utilizes recombinant human hyaluronidase (rHuPH20) to increase SC tissue permeability. IGHy can be self-infused at rates, volumes, and frequencies similar to IVIg.

OBJECTIVE: To describe the mechanism of action and longterm safety of IGHy.

METHODS: Safety and tolerability data were collected from a phase 3 and extension study in primary immunodeficiency disease (PIDD) patients who received IGHy for up to 3.5 years.

RESULTS: rHuPH20, highly specific for the β1-4 linkage in glycosaminoglycans, rapidly and transiently depolymerizes hyaluronan without degrading the structural protein components of the skin. rHuPH20 facilitates IGHy infusion volumes up to 600 mL in a single site at rates up to 300 mL/h/site. IGHy was well tolerated in PIDD patients. The local AE rate was 2.65/patient-year; the majority were mild or moderate. No serious systemic AEs were related to IGHy. No patients developed neutralizing antibodies to rHuPH20.

SUMMARY/CONCLUSION: Longterm tolerability of IGHy has been confirmed in PIDD patients. The infusion characteristics and attributes of IGHy make it an attractive candidate for study in diseases that require high-dose immunoglobulin to achieve immunomodulatory effects, such as chronic inflammatory demyelinating polyradiculoneuropathy (CIDP), in which IVIg is the mainstay treatment. A phase 3 trial in CIDP patients is ongoing (NCT02549170).
INTRODUCTION: Hereditary transthyretin-mediated (hATTR) amyloidosis is a rare, multisystemic, life-threatening disease that leads to progressive fine and gross motor impairments resulting in an inability to perform activities of daily living (ADLs). In the phase 3 APOLLO study, patisiran, an investigational ribonucleic acid interference therapeutic, resulted in significant improvement in neuropathy and quality of life compared to placebo in hATTR amyloidosis patients, and was generally well tolerated.

OBJECTIVE: To evaluate the impact of placebo and patisiran treatment on impairments in ADLs in hATTR amyloidosis patients enrolled in APOLLO.

METHODS: APOLLO was a multicenter, randomized (2:1), double-blind study of patisiran 0.3 mg/kg or placebo administered IV q3W in hATTR amyloidosis patients with polyneuropathy (NCT01960348). The Rasch-Built Overall Disability Scale (R-ODS), administered to measure activity and social participation limitations, contains 24 patient-ranked items on a 3-point scale (0, 1, 2), where lower total scores correspond to higher levels of impairment.

RESULTS: APOLLO enrolled 225 patients (mean age: 60.5 years, range: 24-83; 74% male, 43% V30M). R-ODS was similar between groups at baseline whereas significant improvement was observed at 18 months: a LS mean treatment difference (patisiran-placebo) of +9.0 points (p=4.07x10^-16). A lower percentage of patisiran patients had difficulty reading a newspaper/book (31%) or standing (53 and 80%, respectively). Worsening was observed across the full spectrum of activity intensity in placebo patients. Detailed data to be presented.

SUMMARY/CONCLUSION: Patisiran had a significant impact on preserving ADLs that would have otherwise degraded rapidly without treatment.
102
SAFETY OF PATISIRAN, AN INVESTIGATIONAL RNAI THERAPEUTIC, IN PATIENTS WITH HEREDITARY ATTR AMYLOIDOSIS: AN ANALYSIS OF THE EXPANDED ACCESS PROTOCOL IN THE UNITED STATES

Michael Polydefkis (Baltimore, MD), Michael Shy (Iowa City, IA), Brian Drachman (Philadelphia, PA), Martha Grogan (Rochester, MN), Thomas Brannagan (New York, NY), Chafic Karam (Portland, OR), Amanda Peltier (Nashville, TN), Sasa Zivkovic (Pittsburgh, PA), Richard Hurd (Cambridge, MA), Pritesh Gandhi (Cambridge, MA), Angela Partisano (Cambridge, MA), Jared Gollob (Cambridge, MA), Anastasia McManus (Cambridge, MA), John Berk (Boston, MA)

INTRODUCTION: Hereditary transthyretin-mediated (hATTR) amyloidosis is a life-threatening, multisystemic disease with heterogeneous manifestations. Currently, there are no approved pharmacotherapies to address the underlying cause of the disease. Treatment with patisiran resulted in significant improvement in neuropathy and quality of life compared to placebo in hATTR amyloidosis with polyneuropathy in the phase 3 APOLLO study, and was generally well-tolerated. The Expanded Access Protocol (EAP) in the United States is a mechanism through which clinicians may be able to gain access to an investigational agent for patients with an unmet medical need.

OBJECTIVE: To evaluate the safety of patisiran from the EAP in the U.S.

METHODS: Patisiran EAP is an open-label, multicenter study in the U.S. (NCT02939820) available for patients with genotype-confirmed hATTR amyloidosis and symptomatic polyneuropathy who meet eligibility criteria. Eligible patients receive patisiran 0.3 mg/kg IV every 3 weeks. The primary endpoint is the incidence and severity of adverse events. Secondary endpoints include changes in Polyneuropathy Disability (PND) score and serum TTR levels.

RESULTS: In the U.S., 93 patients have been dosed in the ongoing patisiran EAP between December 2016 and February 2018 (mean age: 64 years, range: 26-80; 76% male); non-Val30Met mutations: 78%. Baseline disease severity measures include: mean Karnofsky Performance Score: 75 (range: 50-100); PND I: 47%; PND II: 25%; PND IIIA/B: 28%; heart failure (New York Heart Association Class I/II): 41%. As of February 28, 2018, mean treatment duration is 27 weeks (range: 1-62). Interim safety with patisiran will be presented.

SUMMARY/CONCLUSION: EAP continues to demonstrate that patisiran can be safely administered consistent with APOLLO results.

103
A PHASE 1 STUDY TO EVALUATE BIOEQUIVALENCE BETWEEN BHV-0223 40 MG ZYDIS® SUBLINGUAL FORMULATION AND RILUZOLE 50 MG ORAL TABLET IN HEALTHY VOLUNTEERS

Irfan Qureshi (New Haven, CT), Vladimir Coric (New Haven, CT), Kimberly Gentile (New Haven, CT), Richard Larouche (Quebec City, Canada), Mario Tanguay (Quebec City, Canada), Robert Berman (New Haven, CT)

INTRODUCTION: BHV-0223 is a novel 40 mg rapidly sublingually disintegrating (Zydis®) formulation of riluzole that offers an enhanced treatment option for people with ALS.

OBJECTIVE: To evaluate rate and extent of absorption of BHV-0223 versus riluzole 50 mg oral tablet (Rilutek®) under fasting conditions (Part I); food effect on pharmacokinetics (PKs) of BHV-0223 (Part II); absorption of Rilutek when crushed and administered sublingually (Part III).

METHODS: Part I was an open-label, 2-period, 2-sequence, single-dose crossover study. Fasting healthy volunteers (HVs) were randomized to 1 of 2 treatment sequences (69/sequence): BHV-0223 followed by Rilutek, or Rilutek followed by BHV-0223. Parts II and III were each sequential, open-label, 1-period, single-dose studies, in which, fed HVs (67) received BHV-0223, and fasted HVs (6) received crushed Rilutek administered sublingually, respectively. Safety and plasma PK parameters were evaluated.

RESULTS: In Part I, BHV-0223 achieved area under the curve (AUC) and maximum concentration exposures of approximately 90 and 113%, respectively, compared to Rilutek. The CI 90% were within the 80-125% range required by FDA for bioequivalence. BHV-0223 generated AUC levels with a fed-to-fasted ratio of 92%. Crushed, sublingual Rilutek delivered AUC levels with a ratio of 6%, compared to oral Rilutek.

SUMMARY/CONCLUSION: BHV-0223 is bioequivalent to, and thus offers similar efficacy as, Rilutek 50 mg oral tablet; but also potentially increases usability and reduces burden on patients (no need to swallow and no negative food effect requiring fasting based on AUC); improves safety/tolerability (lower risk of dose-related liver function abnormalities); and enhances the pharmacological profile (less PK variability).
104
DEMOGRAPHICS OF PATIENTS ON TTR STABILIZERS AND/OR DOXYCYCLINE AND REASONS FOR REQUESTING ACCESS TO PATISIRAN: ANALYSIS OF hATTR AMYLOIDOSIS PATIENTS IN THE PATISIRAN PRE-APPROVAL ACCESS PROGRAM
Michael Shy (Iowa City, IA), Michael Polydefkis (Baltimore, MA), Brian Drachman (Philadelphia, PA), Martha Grogan (Rochester, MN), Thomas Brannagan (New York, NY), Chafic Karam (Portland, OR), Amanda Peltier (Nashville, TN), Sasa Zivkovic (Pittsburgh, PA), Richard Hurd (Cambridge, MA), Pritesh Gandhi (Cambridge, MA), Angela Partisano (Cambridge, MA), Jared Gollob (Cambridge, MA), Anastasia McManus (Cambridge, MA), John Berk (Boston, MA)

INTRODUCTION: Hereditary transthyretin-mediated (hATTR) amyloidosis is a life-threatening, multisystemic disease with heterogeneous manifestations that includes sensory and motor, autonomic, and cardiac symptoms. The phase 3 APOLLO study demonstrated that patisiran, an investigational ribonucleic acid interference therapeutic, significantly improved neuropathy and quality of life compared to placebo in hATTR amyloidosis with polyneuropathy and was generally well-tolerated. The Pre-Approval Access Program (PAAP) was established to provide patients with unmet medical need access to patisiran.

OBJECTIVE: To describe demographics and reasons for requesting patisiran through a PAAP among patients with hATTR amyloidosis with prior history of diflunisal, doxycycline, and/or tafamidis in the United States and Europe (EU).

METHODS: The patisiran PAAP is an open-label, multicenter program, consisting of Early Access Protocol in the U.S. and Compassionate Use in EU. The PAAP provides patients with genotype-confirmed hATTR amyloidosis and symptomatic polyneuropathy who meet eligibility criteria access to patisiran. Patients with prior treatment with a TTR stabilizer or doxycycline may be eligible to participate.

RESULTS: Between June 2016 and February 2018, 164 patients were granted preliminary approval subject to local regulatory approval, where necessary, to participate in the patisiran PAAP. Of those, 121 patients (mean age: 63 years, range: 26-80; 79% male) had a history of treatment with diflunisal (83), doxycycline (17), and/or tafamidis (32). The most common physician-reported reason for requesting patisiran PAAP was disease progression (61%).

SUMMARY/CONCLUSION: Disease progression on prior therapies was the leading reason for requesting the patisiran PAAP, highlighting the unmet need for novel treatment options.

105
ASSESSING EFFECTS OF BHV-0223 40 MG ZYDIS® SUBLINGUAL FORMULATION AND RILUZOLE 50 MG ORAL TABLET ON LIVER FUNCTION TEST PARAMETERS UTILIZING DILISYM®
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INTRODUCTION: BHV-0223 is a novel 40 mg rapidly sublingually disintegrating (Zydis®) formulation of riluzole, bioequivalent to conventional riluzole 50 mg oral tablets that offers a lower-dose treatment option for ALS and potentially less risk of liver toxicity. For patients on oral riluzole, approximately 50% experience alanine transaminase (ALT) levels above upper limit of normal (ULN), 8% above 3 times ULN, and 2% above 5 times ULN.

OBJECTIVE: To quantitatively and mechanistically compare the liver toxicity potential of oral riluzole versus BHV-0223, combining clinical and mechanistic in vitro data, using DILIsym®.

METHODS: DILIsym (DILIsym Services, Research Triangle Park, NC) is a validated multi-scale computational model that supports evaluation of liver toxicity risks. BHV-0223 (40 mg twice/day) and oral riluzole (50 mg twice/day) were simulated by combining physiologically based pharmacokinetic modeling with mechanistic liver toxicity parameters derived from in vitro assays. Frequencies of ALT elevations were predicted in the simulated populations (SimPops).

RESULTS: In the SimPops analysis, ALT>3 times ULN was observed in 3.9% (11/285) versus 1.4% (4/285) of individuals with oral riluzole and sublingual BHV-0223, respectively. The validity of the DILIsym representation of riluzole and assumptions is supported by its ability to predict rates of ALT elevations for oral riluzole comparable to that observed in clinical data.

SUMMARY/CONCLUSION: Combining a mechanistic, quantitative representation of hepatotoxicity with inter-individual variability in both susceptibility and liver exposure suggests that sublingual BHV-0223 confers diminished rates of liver toxicity compared to oral tablets of riluzole, consistent with having a lower overall dose of riluzole and bypassing first-pass liver metabolism.
106

OPEN-LABEL EXTENSION OF THE PHASE 3 STUDY NEURO-TTR TO ASSESS THE LONG-TERM EFFICACY AND SAFETY OF INOTERSEN IN PATIENTS WITH HEREDITARY TRANSTHYRETIN (HATTR) AMYLOIDOSIS

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INTRODUCTION: Hereditary transthyretin (hATTR) amyloidosis is a severe, progressive, disabling, and fatal disease caused by systemic deposition of transthyretin amyloid, eventually leading to multiorgan failure.

OBJECTIVE: To report longterm efficacy and safety of inotersen, an antisense oligonucleotide inhibitor of transthyretin protein production, in the phase 3 open-label extension (OLE) study (NCT02175004).

METHODS: Patients with hATTR who completed the phase 3 NEURO-TTR study were eligible to receive inotersen (300-mg weekly subcutaneous doses) for up to 5 years in this OLE. The OLE monitored adverse events and change from baseline in the Norfolk Quality of Life-Diabetic Neuropathy (Norfolk QOL-DN) total score (136 points total, high scores indicate worse QoL) and modified Neuropathy Impairment Score +7 (mNIS+7) (346 points total, high scores indicate worse neuropathy).

RESULTS: At the time of an interim analysis, 114 patients had enrolled in the OLE. Most of the patients were white (95%) and male (70%) and at OLE baseline (mean age: 61.4 years) 69% had cardiomyopathy. Mean disease duration from time of symptom onset to OLE baseline was 81.8 months. Mean OLE baseline mNIS+7 composite scores and Norfolk QOL-DN total scores were 92.0 and 55.2, respectively. OLE followup results will be presented.

SUMMARY/CONCLUSION: Results of the OLE showed continued benefit as measured by Norfolk QoL-DN and mNIS+7, and a safety profile similar to that observed in the placebo-controlled study.

107

INOTERSEN IMPROVES NORFOLK QUALITY OF LIFE-DIABETIC NEUROPATHY (NORFOLK QOL-DN) MEASURES IN PATIENTS WITH HEREDITARY TRANSTHYRETIN (HATTR) AMYLOIDOSIS IN THE PHASE 3 STUDY NEURO-TTR

Michael Polydefkis (Baltimore, MD), Marcia Waddington Cruz (Rio de Janeiro, Brazil), Peter Dyck (Rochester, MN), Morton Scheinberg (Sao Paulo, Brazil), John Berk (Boston, MA), Fabio Barroso (Buenos Aires, Argentina), Thomas Brannagan (New York, NY), Brian Drachman (Philadelphia, PA), Stephen Heitner (Portland, OR), Peter Gorevic (New York, NY), Brett Monia (Carlsbad, CA), Morie Gertz (Rochester, MN), Merrill Benson (Indianapolis, IN), Annabel Wang (Orange, CA)

INTRODUCTION: Hereditary transthyretin (hATTR) amyloidosis is a severe, progressive, fatal disease that significantly impacts quality of life (QOL).

OBJECTIVE: To evaluate the impact of inotersen, an antisense oligonucleotide inhibitor of transthyretin protein production, on QOL in patients with hATTR with polyneuropathy in the NEURO-TTR study (NCT01737398).

METHODS: Adults (n=172) with hATTR (stage 1 or 2) were randomized (2:1) and received 300 mg weekly subcutaneous doses of inotersen or placebo for 15 months of treatment. The Norfolk Quality of Life-Diabetic Neuropathy (Norfolk QOL-DN), a 5-domain nerve fiber-specific questionnaire totaling 136 points (higher score signifies worse QOL), was used to evaluate QOL. The 5 domains include physical functioning/large-fiber neuropathy (56 points), symptoms (32 points), activities of daily living (ADLs) (20 points), small-fiber neuropathy (16 points), and autonomic neuropathy (12 points). QOL was also measured using the SF-36v2® Health Survey (SF-36v2).

RESULTS: Statistically significant improvement in LS mean change from baseline Norfolk QOL-DN total score (95% CI) favoring inotersen over placebo was observed at week 35 (−6.14 [−11.77 to −0.52], p=0.032) and week 66 (−11.68 [−18.29 to −5.06], p=0.0006). Significant improvements in favor of inotersen compared with placebo were also observed at week 66 in SF-36v2 and most Norfolk QOL-DN subdomains, which included physical functioning/large-fiber neuropathy (−6.33 [−10.03 to −2.62], p=0.001), ADLs (−2.10 [−3.34 to −0.85], p=0.001), and symptoms (−2.80 [−4.47 to −1.13], p=0.001). Key safety findings of thrombocytopenia and renal events were monitorable and manageable.

SUMMARY/CONCLUSION: Inotersen-treated patients showed significant improvement versus placebo-treated patients in QOL measures.
108
INOTERSEN IMPROVES MODIFIED NEUROPATHY IMPAIRMENT SCORE PLUS 7 (MNIS+7) MEASURES IN PATIENTS WITH HEREDITARY TRANSTHYRETIN (hATTR) AMYLOIDOSIS IN THE PHASE 3 STUDY NEURO-TTR
Peter Dyck (Rochester, MN), William Litchy (Rochester, MN), Annabel Wang (Orange, CA), Marcia Waddington Cruz (Rio de Janeiro, Brazil), Michael Polydefkis (Baltimore, MD), Morton Scheinberg (Sao Paulo, Brazil), John Berk (Boston, MA), Fabio Barroso (Buenos Aires, Argentina), Thomas Brannagan (New York, NY), Brian Drachman (Philadelphia, PA), Stephen Heitner (Portland, OR), Peter Gorevic (New York, NY), Brett Monia (Carlsbad, CA), Morie Gertz (Rochester, MN), Merrill Benson (Indianapolis, IN)

INTRODUCTION: Hereditary transthyretin (hATTR) amyloidosis is a rare, progressive, fatal disease associated with disabling polyneuropathy.

OBJECTIVE: To evaluate the effects of inotersen, an antisense oligonucleotide inhibitor of transthyretin protein production, on neuropathy measures in patients with hATTR (NEURO-TTR, NCT01737398).

METHODS: Adults (n=172) with hATTR (stage 1 or 2) were randomized (2:1) and received 300 mg weekly subcutaneous doses of inotersen or placebo for 15 months. Modified neuropathy impairment score plus 7 (mNIS+7)—which comprises 2 composite scores, NIS (244 points) and modified +7 (m+7) (102.32 points), totaling 346.32 points (higher scores indicate worse neuropathy)—assessed neuropathy.

RESULTS: A total of 47% of inotersen-treated patients improved or stabilized their neurologic function by mNIS+7 at week 66. Statistically significant improvement in LS mean (LSM) from baseline in mNIS+7 (95% CI) in favor of inotersen compared with placebo was observed at week 35 (−8.69 [−13.49 to −3.90], p=0.0005) and week 66 (−19.73 [−26.43 to −13.03], p<0.0001). Significant improvements were also observed at week 66 in LSM change from baseline for several components of mNIS+7, including NIS (−13.25 [−17.65 to −8.85], p<0.001), m+7 (−6.49 [−10.32 to −2.66], p=0.001), NIS muscle-weakness (−8.59 [−11.92 to −5.26], p<0.001), NIS reflexes (−1.19 [−2.32 to −0.05], p=0.040), NIS sensory component (−2.97 [−4.30 to −1.63], p<0.001), m+7 nerve conduction (−0.53 [−0.99 to −0.07], p=0.025), and m+7 heat-pain (−3.54 [−5.67 to −1.42], p=0.001). Key safety findings of thrombocytopenia and renal events were monitorable and manageable.

SUMMARY/CONCLUSION: Inotersen-treated patients demonstrated significant benefit in motor and sensory assessments of neuropathy.

109
SAFETY AND EFFICACY OF INOTERSEN IN PATIENTS WITH HEREDITARY TRANSTHYRETIN AMYLOIDOSIS WITH POLYNEUROPATHY (NEURO-TTR)
Morie Gertz (Rochester, MN), Annabel Wang (Orange, CA), Marcia Waddington Cruz (Rio de Janeiro, Brazil), Michael Polydefkis (Baltimore, MD), Peter Dyck (Rochester, MN), Morton Scheinberg (Sao Paulo, Brazil), John Berk (Boston, MA), Fabio Barroso (Buenos Aires, Argentina), Thomas Brannagan (New York, NY), Brian Drachman (Philadelphia, PA), Stephen Heitner (Portland, OR), Peter Gorevic (New York, NY), Brett Monia (Carlsbad, CA), Merrill Benson (Indianapolis, IN)

INTRODUCTION: Hereditary transthyretin (hATTR) amyloidosis is a rare, progressive, fatal disease that manifests with a buildup of TTR protein in major organ systems, resulting in organ failure.

OBJECTIVE: To report the safety and efficacy of inotersen, an antisense oligonucleotide inhibitor of TTR protein production, for the treatment of patients with hATTR in a global, randomized, double-blind, placebo-controlled phase 3 study (NEURO-TTR, NCT01737398).

METHODS: Adults (n=172) with stage 1 or 2 hATTR disease were randomized (2:1) and received 300 mg weekly subcutaneous doses of inotersen or placebo for 15 months. The primary endpoints were change from baseline in the Norfolk Quality of Life–Diabetic Neuropathy (Norfolk QOL-DN) total score and modified Neuropathy Impairment Score +7 (mNIS+7) at week 66.

RESULTS: At baseline, the study population was 69% male (mean age: 59 years; range: 27-81), and 63% (108/172) had cardiomyopathy. The study cohort included 27 TTR mutations, with 52% of patients expressing the Val30Met mutation. The 15-month treatment period was completed by 80% of patients. Inotersen-treated patients experienced statistically significant benefit in both primary endpoints, mNIS+7 (p<0.0001) and Norfolk QoL-DN total score (p=0.0006), compared with placebo. Key safety findings of thrombocytopenia and renal events were monitorable and manageable. More than 95% of patients who completed treatment entered the open-label extension study.

SUMMARY/CONCLUSION: Inotersen-treated patients demonstrated significant benefit on both primary clinical endpoints, indicating quality of life improvements and prevention of neurological disease progression in patients with hATTR. Nearly half of all patients receiving inotersen improved or stabilized their neurologic function.
POOLED SAFETY ANALYSIS OF RANDOMIZED, PROSPECTIVE STUDIES ON INCOBOTULINUMTOXINA FOR THE TREATMENT OF CERVICAL DYSTONIA, BLEPHAROSPASM, AND UPPER LIMB SPASTICITY

Michael Munin (Pittsburgh, PA), Michael Hast (Raleigh, NC), Angelika Hanschmann (Frankfurt, Germany)

INTRODUCTION: Results from individual clinical studies support the favorable safety profile of incobotulinumtoxinA.

OBJECTIVE: To assess incidence of adverse events (AEs) in incobotulinumtoxinA clinical trials across approved indications.

METHODS: Studies in cervical dystonia (CD), blepharospasm, and upper limb spasticity (ULS) from the Merz Integrated Clinical Database were included. Safety data were pooled by indication and grouped according to single-dose and repeat-dose studies. Assessments included: overall incidence of AEs, treatment-related AEs, and serious treatment-related AEs.

RESULTS: Nine single-dose studies (3 studies/indication; 1169 total subjects) and 6 repeat-dose studies (2 studies/indication; 922 total subjects) were included. Total doses ranged from 25 U (blepharospasm studies) to 400 U (upper limb spasticity studies). Overall incidence of treatment-related AEs in single-dose studies were 22.5% (CD), 23.6% (blepharospasm), and 5.9% (ULS). The most frequent treatment-related AEs in CD studies were dysphagia (10.7%) and neck pain (4.4%). In blepharospasm studies, the most frequent treatment-related AEs were eyelid ptosis (10.3%) and dry eye (5.3%). Treatment-related AEs were less frequent in the ULS trials; the most common were injection site hematoma (1.1%), hypoesthesia (0.6%), dry mouth (0.6%), and muscle weakness (0.6%). In repeat-dose studies, incidence of treatment-related AEs decreased by treatment cycle (incidence in first/last cycle: CD 29.4/9.8%; blepharospasm 33.1/19.4%; ULS 3.7/0%). There were no serious treatment-related AEs.

SUMMARY/CONCLUSION: There were no new or unexpected safety findings of incobotulinumtoxinA observed in individual clinical studies.

SERUM AUTO-ANTIBODIES POSITIVITY INDUCED BY INTRAVENOUS IMMUNOGLOBULIN (IVIG) INFUSION

Joseph Conway (Saint Louis, MO), Leila Bostan-Shirin (Saint Louis, MO), Roula Al-Dahhak (Saint Louis, MO)

INTRODUCTION: Evidence from controlled clinical trials has established IV immunoglobulin (IVIg) as a first line therapy for inflammatory autoimmune neuropathies such as Guillain–Barré syndrome, chronic inflammatory demyelinating polyradiculoneuropathy, and multifocal motor neuropathy. Several infusion-related reactions are well documented in the literature, including common reactions such as headache, myalgia, and chills. Rare and more serious reactions such as thromboembolic events, acute renal tubular necrosis, and anaphylaxis are also documented. Few data exist on the effects that IVIg has on various autoantibody laboratory values, and the relation these antibodies may have on inducing autoimmune related symptoms.

OBJECTIVE: To study the effects of IVIg on various autoantibody laboratory values and the clinical manifestations to these antibodies.

METHODS: Three adult patients who received 1 course of IVIg for autoimmune neuromuscular conditions had laboratory evaluation for various autoantibodies to different systemic autoimmune disorders immediately before and after completion of the IVIg treatment of 2 gm/kg. These autoantibodies were rechecked 6 weeks post completion of the therapy.

RESULTS: In all 3 patients, the autoantibodies were normal at baseline and the titers increased upon completion of the therapy. One patient was symptomatic; the remaining 2 patients were asymptomatic despite elevation of the autoantibodies. The levels returned to normal 6 weeks later.

SUMMARY/CONCLUSION: As the result of these findings, we encourage continued investigation of the contents of IVIg and the purification thereof in order to prevent autoimmune related symptoms in some recipients.
ROLE OF IVIG AND PLEX IN NEUROMUSCULAR CONDITIONS
Ehtesham Khalid (Nashville, TN), Christopher Lee (Nashville, TN), Peter Donofrio (Nashville, TN), Amanda Peltier (Brentwood, TN)

INTRODUCTION: IV immunoglobulin (IVIg) and plasma exchange (PE) are usually the initial treatment plan for autoimmune neuromuscular disorders. The combination has been tried as well, but so far there is no validated study to clarify the question of whether combination is better than either therapy alone. We evaluated whether either IVIg or PE or a combination resulted in improved clinical outcome in common autoimmune neuromuscular disorders including myasthenia gravis (MG), Guillain–Barré syndrome (GBS) and chronic inflammatory demyelinating polyneuropathy (CIDP).

METHOD: We selected 87 adult patients with confirmed MG (30), GBS (34) and CIDP (23) who were admitted between 2010 to June 2017. 66 males and 51 females were initially included but based on deficient data and confirmed diagnosis we finally analyzed data for 87 patients. Patient were divided based on treatment of either PLEX or IVIG at the time of admission including patients who received both therapies with interval between both therapies was documented. Clinical parameters used for patient improvement were documented modified Rankin scale, clinical exam at admission and post admission outpatient setting.

RESULTS: Subjects (184) received either 75 U (74), 100 U (74), or placebo (36). The most common sialorrhea etiologies were PD (70.6%) and stroke (17.9%). The 100 U group demonstrated −0.13 g/min (SE 0.026, 95% CI) LS mean uSFR reduction and +1.25-point (SE 0.144, 95% CI) LS mean improvement on GICS at week 4. Both co-primary outcomes were significantly greater in the 100 U group versus placebo at week 4 (p<0.005). The 75 U dose was numerically more effective than placebo but did not reach statistical significance. uSFR and GICS improvements were observed through week 16. DSFS and mROMP drooling assessments supported effectiveness of both doses. The safety and tolerability profile was favorable, with no new/unexpected safety signals.

SUMMARY/CONCLUSION: This study of the combination of IVIg and PE in either order beside the usual course of treatment with either therapy alone in our cohort of patients found no statistical difference in response with combination versus either therapy, although only 13 patients received both therapies, which is a small patient population to validate the results.

Ehtesham Khalid,
Resident and Fellow Member Award Recipient
A COMPARISON OF THE EFFECT OF SUBCUTANEOUS VS INTRAVENOUS IMMUNOGLOBULIN THERAPY ON QUALITY OF LIFE IN PATIENTS WITH CIDP
Tuan Vu (Tampa, FL), Tucker Natalie (Tampa, FL), Raul Alsina (Tampa, FL), Brittany Harvey (Tampa, FL), Jerrica Farias (Tampa, FL), Clifton Gooch (Tampa, FL)

INTRODUCTION: Chronic inflammatory demyelinating polyneuropathy (CIDP) is an autoimmune neuropathy responsive to IV immunoglobulin (IVIg) therapy. However, IVIg therapy causes systemic side effects in about 5% of patients. An alternative is subcutaneous immunoglobulin (SClg), which when used in other diseases has fewer systemic side effects and can be self-administered.

OBJECTIVE: To test the hypothesis that SClg is well tolerated and is associated with better quality of life (QOL) as compared to IVIg.

METHODS: This is a pilot, open-label, switchover study. The local Institutional Review Board approved the protocol, and the FDA gave an Investigational New Drug exemption. The first SClg infusion (20% solution of human normal IgG [Hizentra®, CSL Behring AG]) began 1 week after the last IVIg dose. The total weekly SClg dose was equal to one-quarter of the subject's previous IVIg dose. Adverse reactions were monitored via patient diary, questionnaires, examination, and laboratory studies. QOL and satisfaction with treatment were assessed with the Rasch-built Overall Disability Scale, CIP-PRO20 scale, and Treatment Satisfaction Questionnaire for Medication.

RESULTS: Of the 12 subjects who completed the study, 8 chose to stay on SClg, 2 had to go back to IVIg due to insurance coverage issues, and 2 chose to remain off immunoglobulins. The study shows that SClg was well tolerated with significantly improved scores in all 3 QOL and satisfaction measures.

SUMMARY/CONCLUSION: Our data showed that SClg is well tolerated and is associated with improved QOL. The majority of subjects opted to remain on SClg at the conclusion of the study.

EFFECTS OF HIGH FREQUENCY, HIGH DOSE GRANULOCYTE COLONY STIMULATING FACTOR (GCSF) ON THE IMMUNE SYSTEM OF PATIENTS WITH ALS
Samuel Dang (Tampa, FL), Tuan Vu (Tampa, FL), Phillip Pham (Tampa, FL), Xiaoyang Lin (Tampa, FL), Clifton Gooch (Tampa, FL), Chuanhai Cao (Tampa, FL)

INTRODUCTION: Granulocyte colony stimulating factor (GCSF) is a known glycoprotein, acting as both a cytokine and hormone, stimulating bone marrow production of both granulocytes and stem cells. Some studies have shown evidence of neuroprotection.

OBJECTIVE: To study the various immunomodulatory effects over time of using a high frequency, high dose regimen of GCSF (Neupogen® [filgrastim], Amgen Pharma) on ALS patients.

METHODS: The study was approved by the University of South Florida Institutional Review Board. GCSF was given at 10 mg/kg daily for 5 consecutive days monthly. Four subjects with ALS received monthly GCSF treatment (range: 2-12 months). For flow cytometry assays, peripheral bone marrow cells were stained with 2 antibody cocktails, CD45-Alex Fluor 700 and CD34-Fitc (BD bioscience, CA). For cytokine and chemokine detection, plasma samples of each subject at each time point were incubated with a cocktail of antibody conjugated beads, followed by labeling with avidin-conjugated secondary antibody. Labeling was detected with Bio-Rad Bio-Plex®, and the concentration of each analyte was calculated using its standard curve.

RESULTS: CD34+ cell levels increased after treatment with a dose dependent response. The correlation of GCSF versus nerve growth factor was demonstrated. GCSF also correlated to increases in levels of brain-derived neurotrophic factor. Some immune cytokines and factors, such as TNFa, were all modulated after treatment with GCSF.

SUMMARY/CONCLUSION: Our results indicate that GCSF can modulate immune function by increasing CD34+ cell numbers and TNFa level. Whether such modulatory effect impacts the course of ALS needs further study.
### 116 DESIGN OF A PHASE 3 TRIAL TO EVALUATE THE LONG-TERM EFFICACY AND SAFETY OF ATALUREN IN PATIENTS WITH NONSENSE MUTATION DUCHENNE MUSCULAR DYSTROPHY

Panayiota Trifillis (South Plainfield, NJ), Traci Schilling (South Plainfield, NJ), Edward O'Mara (South Plainfield, NJ), Joseph McIntosh (South Plainfield, NJ)

INTRODUCTION: Ataluren is conditionally approved by the European Medicines Agency (EMA) to treat nonsense mutation Duchenne muscular dystrophy (nmDMD).

OBJECTIVE: To present the design of a phase 3, randomized, double-blind, placebo-controlled trial with an open-label extension period evaluating long term efficacy and safety of ataluren in nmDMD (Study 041).

METHODS: Inclusion criteria are evidence of nmDMD, age ≥5 years, corticosteroid use ≥12 months, 6-minute walk distance (6MWD) ≥150 m, and performance of timed function tests (TFTs) within 30 seconds. Patients will receive ataluren 40 mg/kg/day in 3 doses (10, 10, and 20 mg/kg) or placebo for 72 weeks. All patients will receive open-label ataluren in the 72-week extension to compare outcomes in patients who received ataluren from baseline to week 144 (early-start ataluren) versus those receiving ataluren from week 72 to 144 (delayed-start ataluren). Primary endpoint is slope of change from baseline to week 72 in 6MWD in patients aged ≥7 to ≤16 years with baseline 6MWD ≥300 m and time to stand from supine ≥5 seconds. Secondary and exploratory outcome measures include TFTs, North Star Ambulatory Assessment, muscle strength (in patients <7 years), upper limb function (in patients ≥7 years), health-related quality of life, as well as MRI at a subset of sites. Safety parameters will be assessed throughout.

SUMMARY/CONCLUSION: This study incorporates knowledge gained from previous studies as well as current EMA and FDA guidance on the use of longer trials in DMD drug development.

### 117 META-ANALYSES OF DEFLAZACORT VS PREDNISONE/PREDNISOLONE IN PATIENTS WITH NONSENSE MUTATION DUCHENNE MUSCULAR DYSTROPHY

Perry Shieh (Los Angeles, CA), Edward O'Mara (South Plainfield, NJ), Gary Elfring (South Plainfield, NJ), Panayiota Trifillis (South Plainfield, NJ), Claudio Santos (South Plainfield, NJ), Julie Parsons (Aurora, CO), Susan Apkon (Seattle, WA), Basil Darras (Boston, MA), Craig McDonald (Sacramento, CA)

INTRODUCTION: Corticosteroids can slow the loss of motor function in patients with Duchenne muscular dystrophy (DMD) and are considered part of the standard of care. The phase 2B (Study 007) and phase 3 (ACT DMD) clinical trials of ataluren are the largest, randomized, double-blind, placebo-controlled studies in nonsense mutation DMD to date.

OBJECTIVE: To compare evidence, in a meta-analysis of the placebo arm of both studies, of the efficacy of deflazacort versus prednisone/prednisolone by assessing post-hoc the 6 minute walk test (6MWT) in patients with phenotypic and genotypic evidence of DMD aged ≥7 years, a baseline 6-minute walk distance (6MWD) ≥ 150 m, and ≤80% of predicted for their age and height.

METHODS: Patients in the placebo arm of each study received deflazacort (64) or prednisone/prednisolone (82) for 48 weeks after being on that same treatment for ≥12 months prior to the study start. The primary endpoint was change from baseline to week 48 in 6MWD. Safety parameters were also assessed.

RESULTS: The weighted estimate of the treatment differences in 6MWD (mean, ±SEM) is 34.1±13.5 m (95% CI of 7.6-60.7), showing a significant difference (p=0.006) favoring deflazacort. Respective adverse events ≥10% for deflazacort or prednisone/prednisolone were: vomiting (21.9%, 19.5%), headache (18.8%, 20.7%), nasopharyngitis (12.5%, 24.4%), fall (14.1%, 18.3%), diarrhea (12.5%, 14.6%), upper abdominal pain (7.8%, 17.1%), cough (9.4%, 15.9%), pain in extremity (12.5%, 11.0%), and pyrexia (9.4%, 12.2%).

SUMMARY/CONCLUSION: Deflazacort appeared to be more effective than prednisone/prednisolone in delaying progression of DMD.
**118**

**NEUROMUSCULAR TRANSMISSION OF HAND MUSCLES IN PATIENTS WITH ALS**

*Dong Zhang (Jinan, China)*

**INTRODUCTION:** Split hand phenomenon is seen in more than half of ALS patients, and the mechanism is unknown. Current studies have shown that the cortex, the anterior horn of spinal cord, and peripheral motor axons may be involved.

**OBJECTIVE:** To study the neuromuscular transmission of different hand muscles in ALS patients and the relationship with split hand phenomenon.

**METHODS:** Patients with definite or probable ALS were enrolled. Repetitive nerve stimulation was performed on the abductor pollicis brevis (APB), abductor minimi (ADM) and first dorsalis interosseus (FDI) muscles.

**RESULTS:** Enrolled subjects consisted of 51 ALS patients. The decrements of the APB, ADM, and FDI were 12.9±8.2%, 6.7±5.4%, and 9.6±7.7%, respectively. There was statistical significance between the decrements of the ADM and APB (p=0.000) as well as the ADM and FDI (p=0.035). The decrements of the APB, ADM, and FDI were negatively correlated with their compound muscle action potential (CMAP), respectively, (r=−0.547, p=0.000; r=−0.489, p=0.000; r=−0.515, p=0.001, respectively). The difference between the decrements of the APB and ADM was negatively correlated with the division ratio (CMAP-APB/CMAP-ADM) (r=−0.514, p=0.000).

**SUMMARY/CONCLUSION:** Dysfunction of neuromuscular transmission was found in hand muscles of ALS patients, with the APB involved most significantly. The dysfunction of neuromuscular transmission might be involved in the formation of the split hand phenomenon.

*Dong Zhang, MD*

*IFCN Award Recipient*

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**119**

**MONOMELIC AMYOTROPHY. IMPORTANCE OF CLINICAL, NEUROPHYSIOLOGICAL AND NEUROIMAGING CORRELATION.**

*Otto Hernandez Fustes (Curitiba, Brazil), Amanda Hernandez Marques (Curitiba, Brazil), Adriana Hernandez Fustes (Curitiba, Brazil), Olga Judith Hernandez Fustes (Curitiba, Brazil)*

**INTRODUCTION:** Diseases that affect lower motor neurons constitute a challenge in clinical practice, demanding knowledge of neurological semiology as well as a multidisciplinary approach. It includes neurophysiological studies and neuroimaging, particularly MRI, to enable a topographic and etiologic diagnosis, assuring the correct treatment and diagnosis. Keizo Hirayama described the monomelic amyotrophy in 1959.

**OBJECTIVE:** To report a 66-year-old male with Hirayama disease (HD) and discuss the importance of clinical, EDX studies, and MRI.

**RESULTS:** A man presented with a 4 years' history of weakness in the right hand that evolved, 2 years later, to right upper limb paresis with muscular atrophy and fasciculations. The patient denied alterations in sight, speech, or deglutition. Neurological examination showed muscular atrophy, predominantly distal, thenar and hypothenar, in the right upper limb with fasciculations and areflexia. Brain and spine MRI showed normal tractography and insidious spondylosis, without medullar alteration. Needle EMG of the upper and lower limbs showed signs of chronic denervation of severe intensity and axonal loss.

**SUMMARY/CONCLUSION:** HD affects primarily men, and is associated with muscle atrophy and decreased muscle strength of the distal upper limb, usually unilateral or asymmetric, with slow or no progression after the initial worsening phase. The differential diagnosis includes the distal form of spinal muscular atrophy, ALS, post-polio syndrome, multifocal motor neuropathy, as well as structural lesions of the cervical cord. Our patient did not present cervical spinal cord atrophy. An early and correct diagnosis is necessary and may lead to therapeutic opportunity to slow down progression or to improve hand disability.
PARANEOPlastic MOTOR NEURON DISEASE
Meghana Gaekwad (Pittsburgh, PA), Anem Kohli (Pittsburgh, PA), Sandeep Rana (Pittsburgh, PA)

INTRODUCTION: Anti-Hu antibody is a well-described paraneoplastic syndrome most commonly associated with small cell lung cancer. These antibodies have been detected in patients presenting with a rapid development of diverse neurological manifestations, preceding the diagnosis of cancer in about 80% of cases, with the most common presentation being sensory neuronopathy or limbic encephalomyelitis. We present a case that presented as progressive motor neuron disease.

OBJECTIVE: To increase awareness of a rare paraneoplastic syndrome presenting as rapidly progressive asymmetrical weakness closely mimicking motor neuron disease.

CASE REPORT: A 68-year-old male with small cell lung cancer, treated with carboplatin and etoposide presented 2 months after completion of treatment with progressive dysarthria, weakness, and difficulty ambulating. Physical examination revealed asymmetrical weakness in all extremity muscles with atrophy, intact sensations, and rare fasciculations. MRI of the brain was negative, and MRI of the spine revealed modest degenerative changes which were not commensurate with his presentation. EDX studies revealed acute on chronic denervating process involving paraspinal cervical and lumbar myotomes. Cerebrospinal fluid (CSF) studies showed high titers of anti-Hu antibodies, and CSF cytology was negative for meningeal carcinomatosis. He was treated with IV immunoglobulin infusions, and further oncology workup revealed multiple pleural metastatic lesions.

SUMMARY/CONCLUSION: Cases of anti-Hu paraneoplastic syndrome that mimic motor neuron disease have been reported in literature. We highlight our case to increase awareness of this rare presentation and underscore the importance of screening for anti-Hu antibodies and lung cancer in patients presenting with rapidly progressive motor neuron disease, particularly in chronic smokers.
122
CERVICAL SPINE MAGNETIC RESONANCE IMAGING WITH NECK FLEXION IN THE EARLY DIAGNOSIS OF HIRAYAMA DISEASE
Nan Jiang (Birmingham, AL), Eroboghene Ubogu (Birmingham, AL)

INTRODUCTION: Hirayama disease is a rare asymmetric growth-associated spinal cord compression injury that typically affects young men. Early diagnosis could prevent unnecessary tests and interventions that may contribute to disease progression.

OBJECTIVE: To describe 3 Hirayama disease cases, emphasizing how delayed diagnosis affected outcomes in 2 patients and early recognition facilitated improved outcomes in 1 patient.

METHODS: This was a medical record review from a single tertiary care institution.

RESULTS: Average age at presentation was 17 years (range: 15-20) and all were male. Case 1 presented with right finger and wrist extension weakness, was diagnosed with a compressive posterior interosseous neuropathy, and underwent decompressive surgery without improvement; 32 months later, EDX studies demonstrated C7–T1 myotomal disease. Case 2 presented with sequential hand weakness and was diagnosed with plexiform neurofibromatosis by initial cervical spine MRI after EDX studies showed C7–T1 myotomal disease. In both cases, comprehensive laboratory tests were unrevealing. Subsequent cervical spine MRI with contrast and neck flexion, 4 and 7 years after initial presentation, demonstrated classic epidural venous enhancement associated with focal cervical cord atrophy seen in Hirayama disease. Minimal improvement in strength has been seen 6 and 7 months after correct diagnosis, respectively. Case 3 presented with bilateral hand tremors and right triceps atrophy. EDX findings were same as above, with diagnostic neuroimaging performed 1 month after presentation. Symptom improvement has been seen over the last 4 months.

SUMMARY/CONCLUSION: These cases emphasize the importance of early cervical spine MRI with contrast and flexion in young men with focal motor neuronopathy in order to diagnose Hirayama disease.

123
TRANSFORMATION OF MYASTHENIA GRAVIS (MG) WITHOUT THYMOMA IN AMYOTROPHIC LATERAL SCLEROSIS, OR THEIR COEXISTENCE? – A CASE REPORT
Nina Khizanishvili (Tbilisi, Georgia), Maia Beridze (Tbilisi, Georgia), Roman Shakarishvili (Tbilisi, Georgia), Nana Kvirvelia (Tbilisi, Georgia)

OBJECTIVE: To investigate a patient diagnosed with myasthenia gravis (MG) without thymoma who developed ALS.

CASE REPORT: A 74-year-old male, diagnosed with a generalized form of MG, underwent neurological examination, EDX studies, a neostigmine test, serological laboratory testing, and mediastinum computed tomography (CT). Neurologically, the patient was found to have bilateral ptosis, diplopia, swallowing and speech difficulties, and weakness in upper extremities. Ptosis and diplopia first appeared about 1 year ago, shortly after influenza infection, and resolved spontaneously after 3 months. There was a decreased M response during repetitive nerve stimulation, positive neostigmine test, a high level of antibodies against acetylcholine receptors (8.7 nmol/L), and thymus hyperplasia by mediastinal CT. Treatment with pyridostigmine and then prednisolone (pyridostigmine stopped, continued treatment with maintenance dose of prednisolone) was effective. The patient’s health improved until his next visit after 3 years which revealed weakness of bulbar, neck, and proximal muscles accompanied with absent gag reflex and wasting and fasciculations of lateral borders of the tongue and proximal muscles of upper limbs. Ptosis and ophthalmoparesis without diplopia remained. Needle EMG showed characteristic changes for anterior horn pathology. ALS was diagnosed and riluzole was added to the treatment. His clinical condition deteriorated gradually: speech/swallowing difficulties, fasciculations, and wasting spread out to all body and facial muscles. After 8 month from ALS diagnosis, he was referred to the ICU, started mechanical ventilation and underwent plasma exchange. He died 4 months later due to heart failure.

SUMMARY/CONCLUSION: The present case is the rare example of MG coexisting with ALS, an etiologically complex, multisystem neurodegenerative disease.

Nina Khizanishvili, MD
AANEM Foundation International Fellowship Award Recipient
124
SARCIDS INDUCED NECROTIZING INFLAMMATORY MYOPATHY: CLINICAL MANIFESTATION, HISTOPATHOLOGY, IMMUNOCHEMISTRY, ELECTROMYOGRAPHY AND RADIOLOGICAL FINDINGS
Yasir Al-Khalili (Philadelphia, PA), Ossama El Kadi (Philadelphia, PA)

INTRODUCTION: Symptomatic musculoskeletal involvement in sarcoidosis is rare, affecting 1.4% of sarcoidosis patients. The most common form of clinical presentation is chronic myopathy typically affecting postmenopausal women. Other less common forms are palpable nodules and acute myositis.

OBJECTIVE: To present a case of a male patient with sarcoidosis presenting with acute necrotizing myopathy superimposed on chronic myopathy.

CASE REPORT: A 49-year-old with a history of sarcoidosis diagnosed at age 28 presented with chronic fatigue, weight loss, and mild generalized weakness. He had been treated with prednisone and methotrexate until 3 years ago when his weakness progressed and involved his hands and distal leg muscles (spasms). He had a creatine kinase of 5549 U/L. MRI of the left thigh showed increased signal within all muscles of the left thigh and no atrophy. MRI of the lumbar spine showed abnormal signal and post contrast enhancement of the gluteus minimus muscles bilaterally. Needle EMG showed a mixture of denervation and myopathic changes in the lower extremities. Fibrillations in all muscles in left leg. Chronic denervation findings in the left upper arms. Right quadriceps biopsy shows predominance of degenerating/necrotic fibers with myophagocytosis with associated minimal inflammation in addition to features of chronic myopathy and mild denervation. CD68 immunohistochemistry stain highlights macrophages while CD3 and CD20 show minimal inflammation. Major histocompatibility complex (MHC)-1 shows focal and patchy myofiber membrane staining, suggesting an immune-mediated nature of the findings.

CONCLUSION: Sarcoid acute immune-mediated necrotizing myopathy is a rare condition requiring a multidisciplinary approach to diagnose and treat.

Yasir Al-Khalili, MD
Resident and Fellow Member Award Recipient

125
BETHLEM MYOPATHY: CLINICAL PRESENTATION, GENETICS AND MOLECULAR REVIEW: CASE SERIES
Yasir Al-Khalili (Philadelphia, PA), Aziz Shaibani (Houston, TX)

INTRODUCTION: Bethlem myopathy (BM) is a benign myopathy with onset in early infancy, distal contracture, and slow progression. Dysfunction is reported after age 50. Defects in collagen 6 lead to breaking the link between the cytoskeleton and extracellular matrix.

OBJECTIVE: To present 2 patients with atypical BM presentations with some cardinal features. Genetic testing showed mutations in genes other than the most common, COL6A.

CASE REPORTS: Patient A is a 25-year-old female who walked on her toes since childhood with new weakness in the last 5 years with muscle cramps. Her deltoids were graded 4/5, hip flexors 4/5. She had a normal needle EMG. Genetic testing showed mutations in COL6A1, SYNE1, and LAMA2. Patient B is a 37-year-old female with weakness in the arms and legs since birth and stiffness in muscles. Her deltoids were graded 3/5, biceps 4/5, hip flexors 3/5, and ankle extensors 3/5. Her needle EMG showed mixed duration units with early recruitment. Genetic testing showed mutations in COL6A1 and SYNE1. LAMA2 encodes a subunit of merosin extracellular matrix protein in striated muscles and is reported in congenital muscular dystrophy and childhood onset limb girdle muscular dystrophy. SYNE1 encodes the spectrin protein that links plasma membrane to actin cytoskeleton and is reported in Emery–Dreifuss muscular dystrophy and spinocerebellar ataxia.

CONCLUSION: BM is a mild proximal myopathy with limb girdle distribution. Our cases had atypical findings: only 11% of BM patients have distal muscle involvement, and swallowing difficulty is rare. Despite BM’s progressive nature, our patient’s symptoms were stable for 20 years. Mutations found might explain the unique features.

Yasir Al-Khalili, MD
Resident and Fellow Member Award Recipient
POLYMYOSITIS AND TREMOR IN BEHÇET’S DISEASE  
Carlos Arteaga Rodriguez (Curitiba, Brazil), Otto Hernandez Fustes (Curitiba, Brazil), Renato Munhoz (Curitiba, Brazil), Olga Judith Hernandez Fustes (Curitiba, Brazil)

INTRODUCTION: Behçet’s disease (BD) has a worldwide distribution, but it is considered rare in the Americas. Since its first description, several other clinical manifestations have been reported and added to the syndrome. Neurological manifestations found in 10-30% of the patients are recognized as neuro-Behçet’s disease (NB), however myositis and movement disorders are rarely associated.

OBJECTIVE: To report a patient with BD where polymyositis was the first and most important clinical manifestation in addition to tremor.

CASE REPORT: A 55-year-old white man presented with a multisystemic clinical picture consistent with BD, according to the criteria of the International Study Group for BD. Screening tests for collagen, vascular disorders, and tumor markers and serologic studies for infectious diseases were normal or negative. The histopathological examination showed vascular inflammation and lymphocytic infiltrate, characteristic features of this disorder. Needle EMG showed proximal myopathic features on all limbs, with normal NCSs. Somatosensory evoked potentials were normal. Audiometry showed moderate-to-severe bilateral neurosensorial hearing loss. MRI of the brain showing hyperintense signal in the pons and diffuse in the white matter was consistent with ischemic small vessel disease.

SUMMARY/CONCLUSION: Given the polymorphous and multisystemic nature of the syndrome, it’s unsurprising that reports of unusual manifestations such as movement disorders will further expand the NB spectrum. The first and most important feature was generalized muscle involvement. Besides that, our patient showed tremor, a rare association. BD must be considered as a differential diagnosis of localized or generalized inflammatory muscle disorders, especially with findings of multiple tissue and organ lesions.

Otto J. Hernandez Fustes, MD, MSc
AANEM Foundation International Fellowship Award Recipient

ELECTROPHYSIOLOGICAL AND ULTRASOUND STUDIES IN PATIENTS WITH CONSEQUENCES OF THE ACUTE COMPARTMENT SYNDROME DUE EXTREMITY TRAUMA  
Oksana Haiko (Kyiv, Ukraine), Sergiy Strafun (Kyiv, Ukraine), Albina Tretiakova (Kyiv, Ukraine), Yulianna Halii (Kyiv, Ukraine)

INTRODUCTION: There is dearth of electrophysiological and ultrasound (US) studies on consequences of acute compartment syndrome (ACS) due to extremity trauma (ET).

OBJECTIVE: To describe the usefulness of NCSs, needle EMG, and muscle US in evaluating nerve and muscle pathology of patients with consequences of ACS due to ET.

METHODS: The results of the clinical examination, NCSs, needle EMG, and US of 54 patients who suffered ACS of the upper or lower extremity are presented. The consequences of an ischemic process (necrosis or fibrosis) were revealed in 201 muscles; 74 muscles were observed in dynamic EMG.

RESULTS: The needle EMG and US data depended on the duration of time after the ACS occurred, the extent and distribution of ischemic damage in the muscles, and the presence of traumatic nerve injury (TNI) proximal to the affected compartment level. Three types of muscle damage were distinguished: total ischemic (TI), partial ischemic (PI), and combined ischemic and denervation (CID). Neuropathy in 1 or more nerves due to ischemia or TNI was found in 96.3% of those studied. Only in 17.8% cases with TI and PI, we observed weak positive EMG dynamics of the muscle function improvement (FI) as a result of rehabilitation or reconstructive surgery. In 37.9 % cases with CID, we observed clearly positive EMG dynamics of the FI as a result of muscle reinnervation.

SUMMARY/CONCLUSION: NCSs, needle EMG, and US are useful to determine the nature and severity of the muscle damage and neuropathy, prognosis, and treatment tactics in patients with consequences of the ACS due to ET.

Oksana Haiko, MD, PhD
IFCN Award Recipient
ACUTE RESPIRATORY FAILURE (ARF) AS THE FIRST MANIFESTATION IN MYOTONIC DYSTROPHY TYPE I (DM1): CASE REPORT.

Juan Ignacio Lopez (Capital Federal, Argentina)

INTRODUCTION: Myotonic dystrophy type 1 (DM1) is the most common worldwide autosomal dominant muscular dystrophy due to the polynucleotide CTG. Because of the great diversity of symptoms, the disease may be overlooked. Respiratory failure is a common complication of DM1, but it usually appears later in the disease course or in the setting of anesthesia or surgery.

CASE REPORT: A 37-year-old male with a history of morbid obesity and orthopnea was admitted in the ICU with acute respiratory failure (ARF) due to a community-acquired pneumonia. He required mechanical ventilation during 2 months, with difficulty to be weaned off. At discharge, he presented weakness and was diagnosed with critical illness myopathy and neuropathy. A year and a half later he consulted the neuromuscular unit with dyspnea, severe orthopnea, and weakness in 4 limbs. Physical examination revealed facial and neck weakness, ptosis, nasal voice, and generalized weakness with distal predominance; deep tendon reflexes were abolished, except for bicipital ones; no sensory disturbances. His creatine kinase was 36 U/L. Needle EMG showed generalized myotonic discharges in all examined muscles. Muscle biopsy showed numerous internal nuclei, fiber size variation, and marked atrophy of type 1 fibers, suggestive of DM1. Genetic testing is pending.

SUMMARY/CONCLUSION: DM1 is often characterized by myotonia and weakness of the facial and limb muscles. Because symptoms may rise insidiously, affected individuals may not require medical attention until a severe illness, such as ARF, arises. DM1 should be considered in the differential diagnosis of ARF in adults.

Juan Ignacio Lopez, MD
IFCN Award Recipient
A NOVEL CASE OF CO-EXISTENCE OF TDP-43 AND C5B-9 STAINING IN A PATIENT WITH INCLUSION BODY MYOSITIS; OVERLAPPING OF PATHOGENESIS?
Sankar Bandyopadhyay (Hershey, PA)

INTRODUCTION: C5b-9 staining from muscle tissue is seen in humoral immune-mediated myositis (e.g., dermatomyositis) and not in inclusion body myositis (IBM). A novel case of IBM with C5b-9 was reported by the author in 2016. TDP-43 staining, very commonly seen in patients with ALS, Huntington's disease, frontotemporal dementia, is seen from muscle tissue in sporadic IBM in 78-100% of cases. Coexistence of C5b-9 and TDP-43 staining is novel.

OBJECTIVE: To study a patient with IBM and overlapping of staining.

CASE REPORT: A 77-year-old man presented with a 2-year history of progressive lower extremity weakness, later with weakness of grips, without any cranial or sensory symptoms, and with objective 5−/5 weakness on examination. The rest of the neurological examination was normal. His creatine kinase was 415 U/L with unremarkable laboratory tests. Upper and lower extremity NCSs were normal. Needle EMG showed small myopathic units, positive sharp waves, and fibrillations from the rectus femoris, iliopsoas, and tibialis anterior muscles. A muscle biopsy from the left quadriceps showed types 1 and 2 atrophy, rimmed vacuoles, sarcolemmal deposits of C5b-9 positive granular material, and strong positive staining with TDP-43. A diagnosis was made of IBM with rare C5b-9 staining (second case to be reported) and previously unreported coexistence with TDP-43 staining.

SUMMARY/CONCLUSION: Sporadic IBM continues to be illusive and full of new findings, in our case with a question of overlapping pathogenesis. Pooled data from scattered observations, such as ours, may be useful in determining if sporadic IBM has subgroups with such overlapping, which is important for decisions regarding immunosuppressive medicines.

HYPOKALEMIC PARALYSIS: A CLINICO-ELECTROPHYSIOLOGICAL STUDY FROM A TROPICAL COUNTRY
Mrinal Acharya (Kolkata, India), Avishek Chowdhury (Kolkata, India), Shyamal Kumar Das (Kolkata, India)

OBJECTIVE: To report the clinical, biochemical, and electrophysiological parameters and etiological profile in acute flaccid paralysis (AFP) patients admitted with hypokalemia in a tertiary care teaching hospital.

METHODS: Patients were evaluated clinically and electrophysiologically for weakness and biochemically to look for the etiology of their hypokalemia.

RESULTS: Included were 53 consecutive patients (24 female, 29 male; age range: 18-51 years). Secondary causes of hypokalemia included thyrotoxicosis (6), Gitelman (5), Bartter (2), Sjögren (3), renal tubular acidosis (5), and primary hyperaldosteronism (1). Hypokalemic periodic paralysis was found in 11; 15 had no identifiable etiology. Isolated paraparesis were present in 5, whereas quadripareisis in 48 with predominant proximal involvement. Truncal and neck muscle involvement were present in 46 and 29, respectively. Deep tendon reflexes (DTRs) were reduced in 22, normal in 28, and brisk in 3. Creatine phosphokinase was elevated in 21. U wave and prolonged PR interval were present in 13 and 6, respectively. Mean serum potassium was significantly lower in the secondary compared to primary group (2.14 versus 2.76). Severe hypokalemia was present in 20, acidosis in 9, and alkalosis in 12. Reduced compound muscle action potentials (CMAPs) were present in 25. Though sensory symptoms were present in 6, no sensory abnormality was found. A myopathic pattern was present in 16/24 who underwent needle EMG.

CONCLUSION: A secondary cause for hypokalemic paralysis should be suspected if patients have severe hypokalemia or abnormal serum pH, as did nearly half of our study group. Reduced/absent DTRs with/without reduced CMAP is frequent, so serum potassium must be evaluated in any case of areflexic AFP. Sensory symptoms may be present without any EDX abnormality.

Mrinal Kumar Acharya, MBBS, MD
AANEM Foundation International Fellowship Award Recipient
132

VARIABLE PHENOTYPES ASSOCIATED WITH ANO5 GENE MUTATIONS: REPORT OF 5 PATIENTS
José Crespo (Buenos Aires, Argentina), Fatima Pantiu (Buenos Aires, Argentina), Luciana León Cejas (Buenos Aires, Argentina), Cintia Marchesoni (Buenos Aires, Argentina), Elisa Cisneros (Caba, Argentina), Ana Pardal (Buenos Aires, Argentina), Ricardo Reisin (Buenos Aires, Argentina)

INTRODUCTION: Anoctamin 5 (ANO5) deficiency as a cause of autosomal recessive muscular dystrophy was described in 2010. ANO5 mutations may present as limb girdle muscular dystrophy (LGMD) type 2L, Miyoshi muscular dystrophy, as well as asymptomatic hyperCKemia (ACK).

OBJECTIVE: To present the clinical and neurophysiological characteristics of patients identified in our service with ANO5 mutations.

METHODS: We prospectively evaluated, clinically and genetically, patients who presented with ACK or symptomatic myopathy. Next-generation sequencing (NGS) was used for the evaluation of the following genes: CAV3, SGCA, CAPN3, DYSF, TCAP, GAA, HNRNPDL, ANO5, FKRP, SGCG, and SGCB.

RESULTS: We evaluated 32 patients (19 female; mean age: 44.9 years, range: 16-81). Five patients (3 female, mean age: 25.2 years) presented with 2 heterozygous mutations of ANO5. Three presented with ACK and normal strength. The remaining patients presented with proximal muscle weakness and atrophy in both lower limbs, exercise intolerance, fatigue, and elevated creatine kinase; 1 had a normal MRI and needle EMG. Among those patients with ACK, 2 had myopathic needle EMGs, 2 had fatty replacement in the quadriceps and gastrocnemius muscles on MRI, and only 1 showed reduced maximal expiratory pressure. None had cardiac involvement.

SUMMARY/CONCLUSION: ANO5 mutations are common among patients with ACK. Fatty replacement and respiratory involvement may be present even without muscular weakness. NGS is a useful noninvasive technique to identify these patients.

José M. Crespo, MD
IFCN Award Recipient

133

A NOVEL PHENOTYPE OF MIYOSHI MYOPATHY OR LGMD2B MUSCULAR DYSTROPHY WITH EARLY SEVERE CONTRACTURES AND NORMAL CK, SIMULATING ATYPICAL BETHLEM MYOPATHY
Sankar Bandypadhyay (Hershey, PA)

INTRODUCTION: Early contractures, common in Emery–Dreifuss or Bethlem muscular dystrophy, is unreported in Miyoshi myopathy. Normal creatine kinase (CK), reported in Bethlem, is surprising in Miyoshi.

OBJECTIVE: To describe a previously unreported phenotype in genetically-confirmed Miyoshi myopathy.

CASE REPORT: A 53-year-old man presented with 2 years of progressive weakness of arms, forearms, and thighs with flexion contracture (uncorrectable by passive stretching). He showed wasting of the biceps, triceps, deltoid (lesser degree), thigh flexors, and peroneal compartment muscles, with relative sparing of the gastrocnemius and tibialis anterior. Weakness proportionate to atrophy and generalized hyporeflexia was seen. Sensory examination and bulbar functions were normal. CK was normal at 162 U/L. Needle EMG showed fibrillations from the triceps, tibialis anterior, and medial gastrocnemius. A biopsy from his left biceps muscle showed atrophic fibers, fiber splitting, and endomysial fibrosis. Staining for acid phosphatase, dystrophin, merosin, emerin, dysferlin, and desmin was normal. Immunostaining for collagen 4 and 6 was unremarkable. Dried blood spot test and extensive metabolic myopathy workup were negative. A 35 gene limb girdle muscular dystrophy (LGMD) next generation sequencing showed 1 copy of c.6124C>T (p.R2042C) pathogenic variant of the DYSF gene. A diagnosis of Miyoshi muscular dystrophy 1 or LGMD2B was confirmed.

SUMMARY/CONCLUSION: A new clinical variant previously unreported with early contracture (like in Emery–Dreifuss MD) with normal CK (seen in Bethlem myopathy) was seen with a genetically-confirmed Miyoshi dysferlinopathy or LGMD2B. Normal dysferlin staining from biopsied muscle points to limitations of muscle biopsy with genetic testing being available for MDs.
134
MEDIAL SCAPULA WINGING DUE TO DIRECT TRAUMATIC INJURY TO THE INSERTION OF THE SERRATUS ANTERIOR MUSCLE: A CASE REPORT
David Ronin (Park Ridge, IL), Mitchell Y. Sun (Park Ridge, IL), Mark Lis (Park Ridge, IL), Carolyn Lis (Park Ridge, IL), Jessica B. Ronin (Park Ridge, IL)

INTRODUCTION: We report a rare case of medial scapular winging with no EDX evidence of long thoracic nerve involvement.

OBJECTIVE: To report an unusual case of young woman who developed medial scapular winging due to a serratus anterior muscle tear.

CASE REPORT: A 17-year-old female landed on her posterior right shoulder after performing a somersault. X-rays were negative for a shoulder fracture. Initially, her symptoms improved. However, 9 months later, as the patient pushed herself off the counter to reach a waffle maker, she felt a pop and severe pain in the right shoulder. Physical therapy did not relieve her symptoms. Nine months thereafter we examined the patient and noted severe winging of the medial border of the scapula. The patient had severe right shoulder pain. Scapula winging was more pronounced by pushing against resistance while standing. NCSs of the bilateral spinal accessory nerves and right long thoracic nerve were normal. Needle EMG studies of the right trapezius and rhomboid major muscles were normal. However, needle EMG of the right serratus anterior muscle showed normal insertional activity but no voluntary motor unit potentials. An MRI of the right shoulder, brain, and cervical spine revealed no abnormalities. MRI of the right scapula showed very mild marrow edema along the inferior aspect of the scapula.

SUMMARY/CONCLUSION: Traumatic injury to the serratus anterior muscle should be included in the differential diagnosis of medial scapula winging.

135
ATYPICAL PRESENTATION OF MCARDLE'S
William Jens (Hershey, PA), Mary Elizabeth Kovacik Eicher (Hershey, PA), Aiesha Ahmed (Hershey, PA)

INTRODUCTION: McArdle's disease results from an inherited deficit of glycogen myophosphorylase. The presentation is variable but onset is typically under age 15, but can present in adulthood. Classic symptoms include proximal arm more than leg weakness, exercise intolerance, and myalgia. We present a case of McArdle's with presentation of late onset, gradually progressive axial weakness.

CASE REPORT: A 78-year-old male farmer presented with complaint of poor endurance. He did not mention limb weakness but upon asking acknowledged to having trouble sitting up from lying down and noted issues with poor posture. On questioning, he had found himself becoming weak with time and having poor exercise tolerance with myalgia, which he had attributed to age. He recently noticed shortness of breath going up a flight of stairs and could not do any exercises for an extended period. Pertinent physical examination findings revealed 4+ spinate and hip flexors bilaterally, significant difficulty rising from lying down, with marked lordosis, protuberant abdomen, and kyphosis. Pertinent workup included an elevated creatine kinase of 1269 U/L and a needle EMG/NCS showing a myopathic pattern in proximal muscles on needle examination. Muscle biopsy revealed vacuolar myopathy with loss of stainable phosphorylase activity. McArdle's disease was diagnosed.

SUMMARY/CONCLUSION: Our case highlights that glycogen storage diseases, especially McArdle's disease, should be in the differential even in cases which are not classical in presentation (exercise intolerance with myoglobinuria) as our case showed a less common presentation of only initial axial weakness in an adult which was noted by lordosis and weak core muscles along with fatigue.

William Jens, DO
Resident and Fellow Member Award Recipient
A CASE OF PROXIMAL MYOPATHY DUE TO AMYLOID DEPOSITION IN A PATIENT WITH HEREDITARY TRANSTHYRETIN AMYLOIDOSIS

Marcus Vinicius Pinto (Rochester, MN), Jennifer Tracy (Rochester, MN), Michelle Mauermann (Rochester, MN)

INTRODUCTION: Hereditary transthyretin amyloidosis (hATTR) typically presents as an axonal length-dependent polyneuropathy and/or cardiomyopathy, however phenotypes are heterogeneous. Myopathy has been studied in primary systemic amyloidosis but is rarely reported in hATTR.

OBJECTIVE: To describe a patient with hATTR with amyloid myopathy.

CASE REPORT: A 69-year-old man with known Thr60Ala hATTR cardiomyopathy presented with 2 years of progressive proximal lower limb muscle weakness followed by numbness and coldness of his feet with gait imbalance. During this time he also experienced jaw claudication, diarrhea alternating with constipation, and syncope. Neurological examination showed hand weakness, proximal and distal leg weakness with Gower’s sign, length-dependent pan modality sensation loss, and absent reflexes. Creatine kinase (CK) was normal. Needle EMG/NCSs showed an axonal length-dependent sensorimotor polyneuropathy and a superimposed myopathy with fibrillation potentials. Left gluteus medius biopsy showed regenerating and structurally abnormal fibers with extensive amyloid deposition in vessel walls and surrounding and encasing adjacent muscle fibers. Skin punch biopsy of the foot and distal leg showed large amyloid deposits around dermal vessels and subdermal adipose tissue.

DISCUSSION: A prominent proximal myopathy in hATTR due to amyloid deposition is rare and has not been previously reported with Thr60Ala mutation. Patients with hATTR often present with a polyneuropathy which is usually the most prominent feature. The clinical clues in this case were jaw claudication and proximal lower limb weakness. As seen in myopathy with primary systemic amyloidosis, CK may be normal. Physicians should include hATTR in the differential diagnosis of concomitant neuropathy and myopathy.

A DISEASE SPECIFIC FOCAL NEUROMYOTONIA WITH A DISTINCT PHENOTYPE

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INTRODUCTION: A finger flexion deformity preferentially involving the middle and ring fingers is usually diagnosed as a focal dystonia or Dupuytren’s contractures. Neuromyotonia is a disorder of peripheral nerve hyperexcitability that results in continuous muscle activity.

OBJECTIVE: To present 2 cases of finger flexion deformity in the setting of chronic obstructive pulmonary disease (COPD). Electrodiagnostic studies in these patients were characterized by focal neuromyotonia in select muscles.

CASE REPORTS: Two women, aged 66 and 76, presented with history of involuntary finger flexion of their middle and ring fingers for 3 years and 1 year, respectively. They described the deformity as a tightness and pulling in the fingers which was significant enough to interfere with daily activities. Both had a history of oxygen-dependent COPD, were diagnosed with cardiac arrhythmias and had undergone cardiac valve replacements. One of the patients had a grip myotonia without percussion myotonia. Electrodiagnostic studies were significant for widespread neuromyotonic discharges in one and focal neuromyotonia in the other, preferentially involving the forearm flexor muscles. Lacosamide was started in one patient and lamotrigine in the other due to underlying severe cardiac disease.

SUMMARY/CONCLUSION: (1) Isolated finger flexion deformity seen in the setting of COPD treated with beta-stimulants can be a result of focal neuromyotonia affecting predominantly the flexor muscles. (2) There may be an association with cardiac conduction defects and/or cardiac valve disease.
TAKE TWO: UTILITY OF THE REPEAT MUSCLE BIOPSY
Samah Aburahma (Irbid, Jordan), Dianna Quan (Aurora, CO), Matthew Wicklund (Aurora, CO)

INTRODUCTION: Muscle biopsy constitutes one of the important diagnostic tools ultimately requested in patients presenting with muscle symptoms such as myalgias, cramps, exercise intolerance, and elevated serum creatine kinase. There have been several reports on the utility and yield of muscle biopsy; few analyses have addressed utility and yield of repeat muscle biopsy.

OBJECTIVE: To identify variables (clinical, laboratory, and ancillary tests) that predict clinically-contributory results on repeat muscle biopsy.

METHODS: This is a work in progress, a retrospective review identifying cases through the neuromuscular pathology laboratory at University of Colorado Hospital (UCH). All biopsy samples interpreted at UCH from 1985-2017 were included. Clinical data, laboratory results, and ancillary testing are being collected from medical records. The following were considered specific findings: features of inclusion body myositis (IBM), dermatomyositis (DM), polymyositis (PM), acute inflammation, or metabolic myopathy. The following were considered nonspecific: myopathic/denervation features, nonspecific inflammation, type 2 atrophy, or end-stage pathology.

RESULTS: The review identified 158 patients. Median interval between biopsies was 1 year (4 months to 22 years). Initial biopsy was abnormal in 83%; 29% showing specific findings. Repeat biopsy was abnormal in 84%; of which 51% were different, 34% specific, and 18% different plus specific. All different plus specific repeat biopsies were either IBM (63%), DM, or PM. Time interval did not significantly affect yield of repeat biopsy. Initial biopsies with IBM, PM, or DM were significantly more likely (p<0.0001) to have a specific repeat biopsy, but not necessarily different.

SUMMARY/CONCLUSION: Current data shed light on utility of repeat muscle biopsy in inflammatory myopathies/IBM. Further variables remain to be studied.

Samah Aburahma, MD
Resident and Fellow Member Award Recipient

CASE OF BETHLEM MYOPATHY MISDIAGNOSED AS BECKER’S MUSCULAR DYSTROPHY
Neeraj Singh (Albany, NY), Derrece Reid (Albany, NY)

INTRODUCTION: Accurate diagnosis of neuromuscular disorders requires thorough neurological examination and histopathology. We describe here a case of Bethlem myopathy initially misdiagnosed as Becker muscular dystrophy (BMD).

OBJECTIVE: To understand examination, histopathologic, and genetic findings of Bethlem myopathy, and how they differ from those of BMD.

CASE REPORT: A 65-year-old right-handed man with bilateral hand contractures suffered myocardial infarct, with disproportionately elevated creatine kinase (900 IU/L). This was evaluated with a left gastrocnemius muscle biopsy, which suggested BMD after a series of muscle stains. After a few years of progressive weakness, neurological examination revealed marked gastrocnemius and hamstring atrophy. The late age of symptom onset and lack of upper extremity atrophy made muscular dystrophy less likely. A muscle biopsy review revealed endomysial lymphocytic inflammation and intramuscular fibrous tissue, thought to be consistent with an inflammatory myopathy. A genetic panel revealed rare COL6A1 and COL6A2 gene mutations, consistent with Bethlem myopathy, which has similar histopathologic findings.

SUMMARY/CONCLUSION: The patient's history of myocardial infarct, bilateral hand contractures, and late-onset progressive leg muscle atrophy support a diagnosis of myopathy over muscular dystrophy. Histopathologic and genetic tests clarified the diagnosis as Bethlem myopathy. Familiarity with these findings will help others recognize this rare disorder earlier.
140
A CASE OF REDUCING BODY MYOPATHY WITH RARE FHL1 MUTATION
Leila Darki (Los Angeles, CA), Said Beydoun (Los Angeles, CA)

INTRODUCTION: Reducing body myopathy (RBM) is a rare disorder associated with FHL1 gene mutation.

OBJECTIVE: To describe a case of RBM with a novel de novo mutation in FHL1.

CASE STUDY: A 17-year-old female patient developed symptoms of proximal upper extremity weakness at age 12. She later developed elbow contracture at age 14. With disease progression, distal and proximal leg muscles became affected. On her initial presentation to us, she had significant weakness, in a scapuloperoneal distribution, and presence of significant contracture at the elbows, hamstrings, and Achilles tendons. Creatine kinase level was significantly elevated. Her parents and brother were reported to be healthy. Muscle biopsy showed degenerative fibers and morphological findings of myofibrillar myopathy. The menadione–nitro-blue tetrazolium (NBT) staining visualized the presence of reducing bodies, confirmed by electron microscopy. There were no prominent dystrophic features. Genetic testing revealed pathologic variant in the LMNA gene (P. Arg435Cys) suggestive of a heterozygous carrier for autosomal recessive LMNA-related conditions. In addition, a variant of uncertain significance, c.368A>G (p.His 123Arg), was identified in FHL1.

SUMMARY/CONCLUSION: The histological findings of RBM, absence of dystrophic features, and presence of mutation at residue known to be pathogenic when substituted by other amino acids raised the possibility of a pathologic FHL1 variant. To our knowledge this is a third case that revealed a heterozygous C.368A>G as a pathologic variant. The first case presented as left calf atrophy and the second one, the daughter of case 1, had shoulder girdle weakness.

141
NECROTIZING MYOPATHY IN ASSOCIATION WITH METASTATIC MELANOMA WITHOUT SKIN MANIFESTATIONS
Tristin Allen-Jouaibi (Durham, NC), Karissa Gable (Durham, NC)

INTRODUCTION: In recent years, the literature has supported an association between malignancy and some inflammatory myopathies, resulting in recommendations for malignancy surveillance. Specifically, this risk in association with necrotizing myopathy is emerging. Recent reports link anti-3-hydroxy-3-methylglutaryl-coenzyme A reductase (HMGCR) antibodies and malignancy, along with those whose myositis specific antibodies are negative.

OBJECTIVE: To present a case of seronegative necrotizing myopathy associated with metastatic melanoma without skin manifestations.

CASE REPORT: A 55-year-old woman with a history of melanoma (stage 1, T1) status post resection 12 years prior presented with 7 months of progressive proximal weakness. Creatine kinase (CK) was 5451 U/L. EDX testing demonstrated an active myopathy. Biopsy of the biceps muscle demonstrated a moderately-severe necrotizing myopathy with minimal inflammation. A myositis antibody panel, HMGCR and signal recognition particle antibodies, serologic testing, and imaging were negative. CK improved to 1097 U/L with prednisone along with strength. Two months following initial evaluation, a painless palpable axillary lymph node was discovered. Needle biopsy demonstrated metastatic melanoma. Notably, the patient was compliant with recommended skin checks with dermatology, and no evidence of skin manifestation of melanoma was found. She underwent treatment with trametinib/dabrafenib and prednisone was discontinued. Following chemotherapy, CK normalized to 136 U/L and normal muscle strength was noted at 1.5 years following symptom onset.

SUMMARY/CONCLUSION: Our case demonstrates the need for aggressive cancer surveillance in patients presenting with necrotizing myopathy, particularly those with a known history of malignancy.

Tristin Allen-Jouaibi, MD
Resident and Fellow Member Award Recipient
PEMBROLIZUMAB-ASSOCIATED NECROTIZING MYOPATHY WITH MULTI-MINICORES
Jose David Avila (Danville, PA)

INTRODUCTION: Neuromuscular complications of programmed cell death-1 inhibitors have recently been recognized. Myositis, myasthenia gravis, and neuropathies have been reported. Necrotizing myopathy is rare and carries a poor prognosis. Multi-minicores are small areas of myofibrillar disruption that lack mitochondria. They are typically associated with SEPN1 and RYR1 gene mutations.

OBJECTIVE: To describe a case of pembrolizumab-induced necrotizing myopathy with multi-minicores on muscle histopathology.

CASE REPORT: A 70-year-old woman presented with 1 month of generalized weakness. She had a history of metastatic squamous cell carcinoma of the floor of the mouth and had received 2 cycles of pembrolizumab before her presentation. She initially complained of myalgia. Pembrolizumab was held and she was started on prednisone 60 mg daily. She then developed dysphagia. Creatine kinase was 584 U/L (normal <200). She continued to deteriorate and was admitted for further evaluation. Examination demonstrated weakness involving neck extensors more than flexors, and proximal limbs bilaterally. There was no eyelid ptosis or ophthalmoparesis. EDX study showed an irritable myopathy. Jo1, signal recognition particle, hydroxy-3-methylglutaryl-coenzyme A-reductase (HMGCR), acetylcholine receptor, and voltage gated calcium channel antibodies were negative. A muscle biopsy demonstrated a necrotizing myopathy with multi-minicores. She was treated with weekly plasma exchange (PE) for 4 weeks with minor improvement. She continued on PE but died 2 months later of an unknown cause.

SUMMARY/CONCLUSION: Necrotizing myopathy is a rare neuromuscular complication of pembrolizumab therapy. The presence of multi-minicores in this case expands the pathologic spectrum of this condition and may offer some insight into its pathogenesis.

FIRING RATES AND VARIABILITY DIFFERENCES BETWEEN MOTOR UNITS AND SPONTANEOUS ACTIVITY IN NEEDLE EMG
Gregory Robbins (Philadelphia, PA), Bradley Tucker (Philadelphia, PA), Daniel Stashuk (Waterloo, CA), Timothy Dillingham (Philadelphia, PA)

INTRODUCTION: Motor unit action potentials (MUAPs) may resemble positive sharp waves in configuration based upon the needle relationship to the motor unit territory. Regularity and consistency of firing, however, distinguish spontaneous activity (SA) from MUAPs. A measure to assess the degree of firing regularity is needed for quantitative evaluation of SA in the paraspinal muscles of the neck and back. Previous studies have shown marked differences in prevalence of paraspinal SA.

OBJECTIVE: To quantify firing rates and regularity of SA and MUAPs using a modern, digital interface: decomposition-based quantitative EMG (DQEMG) and Audacity.

METHODS: Prospective recordings were obtained from patients referred for routine needle EMG evaluation of a variety of complaints. The recordings were interfaced through a version of DQEMG software customized to calculate descriptive statistics for these waveforms.

RESULTS: 48 MUAP recordings (41 subjects) and 82 fibrillation/positive sharp wave (Fib/PSW) recordings (63 subjects) were analyzed. Of 131 recordings, 107 successfully interfaced with DQEMG. The remaining were analyzed with Audacity. Mean firing rates for MUAPs were 11.2 Hz (SD 3.6) and for SA, 6.9 Hz (SD 2.6). The average proportional consecutive interval differences (APCID) showed 11.3-67.8 (ratio) for MUAPs and 0.6-35.0 (ratio) for Fibs/PSWs. Only 3/82 APCID values from SA exceeded the lowest value for MUAPs. There was considerable overlap for mean consecutive differences and standard deviation of interpotential intervals. The distributions of all parameters were skewed to the right.

SUMMARY/CONCLUSION: APCID appears to well differentiate SA from MUAPs and will be useful for future quantitative studies examining the prevalence of SA in tested muscles.

Gregory Robbins, MD
Resident and Fellow Member Award Recipient
EMG FINDINGS OF A MARTIN-GRUBER ANASTOMOSIS IN A PATIENT FOLLOWING 100% ULNAR NERVE CONDUCTION BLOCK AT THE ELBOW

INTRODUCTION: A Martin–Gruber anastomosis (MGA) is a normal anatomic variant connection between the ulnar and median nerves in the forearm. NCSs show that stimulation of the ulnar nerve at the wrist elicits a compound muscle action potential amplitude approximately 120% larger than when stimulated below and above the elbow.

CASE REPORT: A 55-year-old female with a history of left elbow injuries resulting in an elbow flexion contracture presented with worsening elbow pain, numbness, tingling, and hypersensitivity of the ring and little fingers. She had reproduction of her symptoms with percussion at the cubital tunnel and pain with elbow flexion. She had 4/5 strength in hand intrinsic muscles with decreased light touch and pinprick sensation in the ring and little fingers. Needle EMG showed a chronic left ulnar neuropathy at elbow with incomplete reinnervation and ongoing denervation with an incidental MGA with 40% crossover. She underwent an elbow replacement with decompression of the ulnar nerve. Following surgery she had hand numbness, but maintained some intrinsic hand function. Repeat NCSs showed 100% axon loss at the elbow. The study also showed a low amplitude ulnar motor response at the wrist only due to fibers from the MGA. On needle EMG, there was evidence of denervation without reinnervation in the first dorsal interosseous and abductor digiti minimi.

SUMMARY/CONCLUSION: Typically, an MGA is an incidental finding; however, here it proved to be advantageous. This patient’s MGA proximal to the ulnar nerve injury led to preservation of some ulnar nerve fibers at the wrist, thereby preserving some hand function.

MULTIPLE SENSORY MONONEUROPATHIES AS A COMPLICATION OF LONG SAPHENOUS VEIN HARVEST: AN UNUSUAL CASE
Laura Malmut (Chicago, IL), Jacqueline Neal (Chicago, IL)

INTRODUCTION: Neuropathy is a rare complication of long saphenous vein (LSV) harvest. Saphenous nerve injury may occur from surgical handling due to the close proximity of the nerve and the LSV below the knee. The peroneal nerve may be subject to injury by compression of the fibular head during surgical positioning. The sural nerve is rarely affected. Multiple concomitant sensory neuropathies following LSV harvest have not previously been reported.

OBJECTIVE: To describe a rare case of multiple concomitant sensory neuropathies following LSV harvest.

CASE REPORT: A middle-aged male veteran presented with right lower extremity numbness following recent coronary artery bypass grafting (CABG) with LSV harvest. Following CABG, the patient developed a new distribution of numbness in the right anterior and lateral leg and the full dorsum of the foot with intact strength. EDX studies revealed a non-localizable unilateral axonal process in the right saphenous, superficial peroneal, and sural sensory nerves with no evidence of motor involvement or lumbosacral radiculopathy.

SUMMARY/CONCLUSION: The constellation of findings suggests right saphenous, superficial peroneal, and sural sensory mononeuropathies that occurred during surgery or in the immediate postoperative period. The distribution of nerve injury may be related to a combination of factors, including surgical handling, frog-leg positioning or safety-strap use during surgery, and postoperative Ace wrapping. Neuropathy following LSV harvest appears to be a multifactorial process that can affect multiple peripheral nerves, and consideration for thorough EDX evaluation in patients who develop numbness postoperatively may be beneficial.
THE VALIDITY OF THE FILIPINO VERSION OF THE MICHIGAN NEUROPATHY SCREENING INSTRUMENT AS A MEASURE OF DISTAL SYMMETRIC PERIPHERAL NEUROPATHY AMONG DIABETIC PATIENTS AT THE UERMMMCI OUTPATIENT DEPARTMENT
Ma Luisa Gwenn Pabellano Tiongson (Quezon City, Philippines), Glennis Fiona Javelosa (Quezon City, Philippines), Armand Delo Tan (Quezon City, Philippines)

INTRODUCTION: Peripheral neuropathy is seen in 50% of diabetic patients. The presence of peripheral neuropathy was found to be a primary risk factor for a major limb amputation. The need for a simplified diagnostic test for screening of diabetic patients in the outpatient department is apparent.

OBJECTIVE: To compare the accuracy of the Filipino version of the Michigan Neuropathy Screening Instrument (MNSI) against needle EMG/NCSs as the gold standard to establish that this tool may be used for screening peripheral neuropathy among Filipinos.

METHODS: We tested 103 patients with type 2 diabetes mellitus and determined the sensitivity and specificity of the Filipino version of the MNSI by comparing it to needle EMG/NCSs as a gold standard. Also identified were risk factors, such as body mass index, hypertension, smoking history, diabetes duration, and level of glycemic control.

RESULTS: The sensitivity of the combined Filipino MNSI was 74.7%, with a specificity of 25%. The computed sensitivity of the Filipino MNSI questionnaire was 64.6%, but with a specificity of 33.3%. The MNSI questionnaire scores had a statistically significant correlation to the degree of neuropathy as measured by needle EMG/nerve conduction velocity (NCV). The MNSI clinical examination yielded a sensitivity of 48.1% and a specificity of 62.5%.

SUMMARY/CONCLUSION: The Filipino MNSI may be used as a screening tool for distal symmetric peripheral neuropathy among diabetics due to its high sensitivity (74.7%). A positive Filipino MNSI will signal the need for further investigation using needle EMG/NCV studies.

Ma Luisa Gwenn F. Pabellano-Tiongson, MD
IFCN Award Recipient

OVERLAPPING AMONG CHRONIC IDIOPATHIC DEMYELINATING POLYRADICULONEUROPATHY AND RECURRENT SHORT SEGMENT MYELITIS.
Sergio Morales (Buenos Aires, Argentina), Jose Di Pace (Buenos Aires, Argentina), Edgar Carnero (Buenos Aires, Argentina), Alejandra Gomez (Buenos Aires, Argentina), Monica Perassolo (Buenos Aires, Argentina)

INTRODUCTION: Chronic inflammatory demyelinating polyradiculoneuropathy (CIDP) and acute short-segment transverse myelitis (ASTM) are demyelinating diseases. They tend to follow a relapsing course. Thus, an overlapping of both may be possible.

OBJECTIVE: To describe a case of overlapping CIDP and recurrent ASTM.

CASE REPORT: A 37-year-old male presented with 1 month of progressive quadriplegia with right side predominance and sensitive T3-4 levels. Brain and spine tomography scans and routine laboratory tests were normal. Lumbar puncture was performed; albumin cytological dissociation was found. Oligoclonal bands as well as infection serologies and onconeural and antiganglioside antibodies were negative. He was treated with methylprednisolone for 3 days with partial improvement. A needle EMG showed prolonged distal latencies and blockade of conduction with a reduction in amplitude in both motor and sensory nerves. IV immunoglobulin (IVIg) was started, with improvement. Two weeks later he returned for weakness and compromise of cranial nerves IX and X, and new cycle of IVIg was performed with clinical recovery. Spinal cord MRI showed short-segment (T2-3) lesion. Brain MRI was normal. A new pulse of methylprednisolone was initiated and showed improvement. He was discharged, and combination of both oral corticosteroid and mycophenolate were started. Several months later, he presented a new episode of weakness, and a new spinal cord MRI showed short segment (T7-8) lesion on T2 and T1 hyperintensity post-contrast. Recurrent ASTM was diagnosed. A new methylprednisolone cycle was initiated with improvement.

SUMMARY/CONCLUSION: Overlapping among CIDP and recurrent ASTM is rarely seen in adults; to our knowledge there are no cases reported in Latin America.

Sergio Morales, MD
IFCN Award Recipient
POLYNEUROPATHY AFTER ACUTE INTOXICATION WITH TRICHLORPHON
Otto Hernandez Fustes (Curitiba, Brazil)
Eduardo Hummelgen (Campina Grande do Sul, Brazil),
Georgette M. E. Ferreira (Campina Grande do Sul, Brazil),
Olga Judith Hernandez Fustes (Curitiba, Brazil)

INTRODUCTION: Trichlorfon is an oral antihelminthic for the treatment of a ruminant's parasitosis. It is an organophosphate (OP) with systemic activity. It is highly toxic and its effects are caused by the inhibition of the enzyme acetylcholinesterase, which hydrolyzes acetylcholine, liberated in the synaptic junction of the autonomous and central nervous systems and the neuromuscular junction. Neuromuscular manifestations of OP intoxication are classically divided as: an acute syndrome (characterized by cholinergic crisis), an intermediate reversible syndrome, and a denominated delayed neuropathy.

OBJECTIVE: To report a patient who, after a suicidal attempt with trichlorfon, developed a severe sensorimotor polyneuropathy with axonal predominance.

CASE REPORT: A 37-year-old female, previously healthy, with no familial history of neurological diseases presented with muscular weakness and paraesthesia in lower limbs with 3 months of evolution that appeared 30 days after a suicidal attempt by trichlorfon ingestion. A general physical examination showed no alterations. Neurological examination showed distal hypoesthesia in the lower limbs, patellar hyporeflexia, abolished ankle jerk, and paraparesis, with bilateral foot dorsiflexion with muscle strength grade 3. Laboratory tests were normal. Needle EMG showed signs of denervation of the left femoral quadriceps, and bilaterally in the tibialis anterior, gastrocnemius, fibularis longus, and extensor digitorum brevis muscles. NCSs revealed bilaterally diminished motor unit action potentials of the tibial and fibular nerve, with discrete retarded distal latency and sural nerve inexcitability.

SUMMARY/CONCLUSION: Neuropathy associated with chronic or acute exposition to OPs is uncommon. Our patient presented a delayed polyneuropathy after acute intoxication, with no signs of central nervous system compromise.

Otto J. Hernandez Fustes, MD, MSc
AANEM Foundation International Fellowship Award Recipient

ETHYLENE OXIDE AS A CAUSE OF POLYNEUROPATHY
Otto Hernandez Fustes (Curitiba, Brazil), Rossana A. I. Ambrozewicz (Curitiba, Brazil), Andressa Feitosa (Curitiba, Brazil), Catarina De Machi Assunção (Curitiba, Brazil)

INTRODUCTION: Ethylene oxide (EO) exposition is exceptional these days, practically reserved to occupational contact. For this reason, intoxication of this flammable gas used in the production of chemical substances and medical and surgical material sterilization is extremely uncommon. The effects of acute intoxication with EO include skin lesions, dyspnea, cyanosis, vomiting, and cloudy consciousness. The first description of a patient with neurological manifestations due to chronic EO exposition was in 1979.

OBJECTIVE: To report a patient who developed sensorimotor polyneuropathy after contact with EO.

CASE REPORT: A 20-year-old male who was previously healthy, working as an operator at a sterilizer, with no familial history of neurological diseases presented with muscular weakness, no fever, and no respiratory or gastrointestinal manifestations. A general physical examination showed no alterations. Neurological examination showed distal hypoesthesia in the lower limbs, decreased knee and ankle jerks, and muscle strength grade 4 for bilateral foot dorsiflexion. Laboratory studies were normal, including thyroid and hepatic function and immunological and infectious markers. Initial needle EMG showed delayed distal motor latency and diminished motor unit action potentials of the fibular nerve bilaterally and diminished sensory nerve action potentials (SNAPs) of the superficial fibular nerve, as well as diminished recruitment patterns in the extensor digitorum brevis muscle. Needle EMG 6 months later showed improvement of the SNAP amplitude of the superficial fibular nerve, accompanied by clinical improvement.

SUMMARY/CONCLUSION: Neuropathy caused by EO is a rare condition, with few cases found in the literature. Our patient's symptoms appeared after his second exposition to EO which lasted hours.

Otto J. Hernandez Fustes, MD, MSc
AANEM Foundation International Fellowship Award Recipient
INTRAVERSIVE IMMUNOGLOBULIN IN THE TREATMENT OF GUILLAIN BARRE SYNDROME IN A NEPALESE TERTIARY CENTRE
Rajeev Ojha (Kathmandu, Nepal), Krishna Oli (Kathmandu, Nepal), Ragesh Karn (Kathmandu, Nepal), Rajeev Ojha (Kathmandu, Nepal)

INTRODUCTION: IV immunoglobulin (IVIg) therapy is relatively costly, but approved therapy for Guillain–Barré syndrome (GBS) which is an acute, frequently severe, and fulminant autoimmune polyradiculoneuropathy.

OBJECTIVE: To understand the management and outcome in GBS patients in whom IVIg was used.

METHODS: All consecutive patients over age 16 who were admitted to the Department of Neurology of Tribhuvan University Teaching Hospital, Kathmandu, Nepal, from March 2016 to February 2017 were retrospectively evaluated. All demographic, historical, and clinical data were collected.

RESULTS: A total of 46 patients were included (mean age: 36 years, range: 16-80) with male patients being predominant (70% versus 30%). Thirty-two patients (70%) were axonal variant, acute motor axonal neuropathy being more common (18 patients). IVIg was used in 23 patients (50%), of which 17 were axonal variant and 6 were demyelinating (p=0.522). IVIg course was repeated in 1 patient due to the clinical fluctuation. Twelve patients (26.1%) needed mechanical intubation, of which 11 were axonal variant and 1 was demyelinating variant (p=0.073). Mortality was reported in 2 patients (4%), 1 during the recovery phase due to dysautonomia and another in the ICU due to pneumonia and sepsis. No adverse reactions of the drug were seen in patients during the IVIg infusion period.

SUMMARY/CONCLUSION: IVIg is easier to administer and has less adverse effects. Although expensive, it is an effective treatment option in resource limited center like ours, where there is no facility for plasma exchange.

Rajeev Ojha, MD, DM
IFCN Award Recipient

HATTR AMYLOIDOSIS IN A CELIAC DISEASE PATIENT
Stefanie Wolf (Cincinnati, OH), Hani Kushlaf (Cincinnati, OH)

INTRODUCTION: Hereditary ATTR (hATTR) amyloidosis is an autosomal dominant disease characterized by the production of mutant transthyretin protein with amyloid deposition primarily in the heart and peripheral nerves. The occurrence of hATTR amyloidosis in celiac disease has not been reported.

OBJECTIVE: To report the clinical characteristics and diagnostic workup of a patient with celiac disease who developed hATTR amyloidosis.

CASE REPORT: A 75-year-old male with history of celiac disease on a gluten-free diet developed paresthesia/pain in both hands at age 71. Bilateral carpal tunnel release did not help. A year later, he developed progressive pain/numbness and weakness in his legs to the point of becoming wheelchair bound at age 76. He developed syncopal episodes at age 72 and was found to have intermittent bradycardia and second degree atrioventricular block. A pacemaker was implanted. Initially, he had a normal coronary angiogram and echocardiogram but congestive heart failure ensued over time. He had mild lightheadedness upon standing, occasional bouts of severe diarrhea, urinary urgency, and erectile dysfunction. No family history of neuropathy. Examination revealed severe distal/mild-to-moderate proximal limb weakness, areflexia, and distal pinprick greater than vibration sensory loss. Electrodiagnosis revealed severe sensorimotor axonal polyneuropathy with superimposed bilateral CTS. Autonomic testing showed distal postganglionic sudomotor impairment and mild-to-moderate cardioadrenergic and mild cardiovagal impairment but no orthostatic hypotension. No improvement after IV immunoglobulin therapy for 1 year. TTR sequencing revealed pathogenic Thr80Ala mutation.

SUMMARY/CONCLUSION: HATTR amyloidosis can occur in celiac disease. The progressive neuropathy, cardiomyopathy, bilateral CTS, and autonomic abnormalities while on a gluten-free diet should prompt consideration of hATTR amyloidosis.

Stefanie Wolf, MD
Resident and Fellow Member Award Recipient
**CLINICAL AND ELECTROPHYSIOLOGIC FEATURES OF FUNCTIONAL RECOVERY AFTER HUMERAL SHAFT FRACTURE ASSOCIATED WITH RADIAL NERVE INJURY: CONSERVATIVE TREATMENT AND NERVE GRAFTING.**

Oksana Haiko (Kyiv, Ukraine), Sergiy Strafun (Kyiv, Ukraine), Yulianna Halii (Kyiv, Ukraine)

**INTRODUCTION:** It is important for orthopedic surgeons to have predictors of good outcome (GO) in radial nerve injuries (RNIs) after a humeral shaft fracture so that appropriate management can be started early.

**OBJECTIVE:** To evaluate the clinical and electrophysiologic predictors of GO in patients with RNIs after conservative treatment (CT) and nerve grafting (NG).

**METHODS:** A dynamic study including clinical, NCS, and needle EMG examinations was performed on 36 patients (RNI, complete or nearly complete axon loss) after CT (26) and NG (10). All patients had GO, which was defined as muscle strength (MS) grade 3 or higher in wrist extensors on the Medical Research Council scale.

**RESULTS:** The initial needle EMG signs of muscles reinnervation (IR) after CT were determined at the mean time (MT): 3.6 months (MS grade 0-1, discrete interference pattern), the ongoing reinnervation (OR): 4.7 months (MS grade 2, reduced interference pattern), and the effective reinnervation (ER): 6.2 months (MS grade ≥3, full interference pattern) after trauma. The IR in the patients after NG were determined at the MT: 5.7 months, the OR: 8.9 months, the ER: 12.8 months after NG.

**SUMMARY/CONCLUSION:** Our study demonstrates the expected time of IR, OR, and ER in patients with RNIs after humeral shaft fracture who had GO after CT and NG. These data can be useful for orthopedic surgeons to predict the effectiveness of the recovery process.

Oksana Haiko, MD, PhD
IFCN Award Recipient

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Shuja Sheikh (Wharton, NJ), Janaki Patel (Newark, NJ), Hael Abdulrazeq (Newark, NJ), Mousa Hamad (Newark, NJ), Abu Nasar (Newark, NJ), Nizar Souayah (Newark, NJ)

**INTRODUCTION:** Previous studies suggested that diabetes may delay ALS onset and slow its progression.

**OBJECTIVE:** To investigate the association between diabetes mellitus (DM) types 1 and 2 and ALS.

**METHODS:** We used data from the New York Statewide Planning and Research Cooperation System database for 1998-2014. Data was analyzed using IBM SPSS software.

**RESULTS:** Of the 7102 patients with ALS in the database, 0.59% had DM1 and 9.6% had DM2. The mean age of ALS patients with DM1 was not significantly different from patients with DM2 as well from ALS patients without diabetes (65±15.7 versus 68±10.9, p=0.237). Patients who have ALS and DM2 were less likely to be discharged to home and more likely to be discharged to a skilled nursing facility or short-term hospital as compared to ALS patients without DM2 (34% versus 45% and 52% versus 41% respectively, p<0.001). The rates of death or hospice discharge for those with ALS with or without DM2 was 14%. No significant differences in discharge status were found in ALS patients with and without DM1.

**SUMMARY/CONCLUSION:** Our study demonstrated no significant difference in the age, death rate, and hospice discharge of ALS patients diagnosed with DM compared to ALS patients without diabetes. ALS patients were more likely to be discharged to a skilled nursing facility or short-term hospital if they have DM2 as a comorbidity, but not DM1. Patients with DM2 were also less likely to be discharged to home as compared to ALS patients without DM2.

Shuja Sheikh, MD
Resident and Fellow Member Award Recipient
154

PATTERNS AND INCIDENCE OF MARTIN GRUBER ANASTOMOSIS IN A DGH OF WEST YORKSHIRE

Myat Thura (Halifax, United Kingdom), Khine Lwin (Halifax, United Kingdom), Ei-Mon Tun (Halifax, United Kingdom), Shwe Tun (Halifax, United Kingdom)

INTRODUCTION: Martin–Gruber anastomosis (MGA) is the most common anomalous innervation. Reported incidence varies from 7.7 to 34%. Methodology differs from cadaveric studies to electrophysiological nature.

OBJECTIVE: To identify the incidence, demography, and types of MGA among our patients. The effect or clinical relevance to those patients was sought.

METHODS: A retrospective study was conducted on patients referred for upper limbs to our department over 4 months. MGA was suspected if: median motor nerve stimulation proximally induced a higher amplitude compound muscle action potential (CMAP), there was an ulnar motor nerve CMAP amplitude drop proximally, median motor nerve conduction velocity was very fast in the forearm, median motor nerve CMAP revealed initial positive deflection with proximal stimulation, or median nerve stimulated proximally revealed initial positive deflection not seen when stimulated at the wrist.

RESULTS: A total of 736 patients (1183 arms) were tested: 66 patients (95 arms) have MGA. Incidence is 8.03/100 arms studied; 43% of MGA cases have CTS (mean age: 51 years, 70% female). Left and right are equally affected; 21 cases are bilateral. Median motor nerve fibers that crossover to the ulnar/first dorsal interosseous is the most common, 81 arms (85%); 14 cases have crossover to the abductor digiti minimi. No other types were seen. None of the cases were clinically affected by the existence of MGA.

SUMMARY/CONCLUSION: Our data revealed an MGA incidence of 8%. Awareness of this condition led us to include more studies on patients referred for upper limbs. A future and larger prospective study is contemplated.

Myat Thura, MBBS, MD
IFCN Award Recipient

155

ULTRASONOGRAPHIC FINDINGS OF ULNAR NERVE INSTABILITY AROUND ELBOW IN FRESH CADAVERS

Dong Hwee Kim (Ansan-si, South Korea), Ki Hoon Kim (Ansan-si, South Korea), Gu Young Kim (Ansan-si, South Korea)

INTRODUCTION: Ulnar nerve instability (UNI) during elbow flexion may be a potential cause of ulnar neuropathy associated with frictional neuritis or increased vulnerability to external compression.

OBJECTIVE: To evaluate the relationship between UNI and snapping of the medial triceps muscle during elbow flexion using ultrasound (US) in fresh cadavers and to confirm UNI via cadaveric dissection.

METHODS: Eighteen elbows of 9 fresh cadavers (3 women, 6 men) were recruited. Dynamic US was performed in 3 positions of the elbow. The horizontal distance from the apex of medial epicondyle (ME) to the margin of ulnar nerve (UN) and medial triceps (TB) muscle (ME_UN and ME_TB, respectively), cross-sectional area, and flattening ratio (FR) were measured. The UNI was classified into 3 types: Type N, no dislocation; Type S, subluxation; Type D, dislocation. Numbers 0, 1, and 2 indicated extension, 90 degree flexion, and full flexion of elbow position, respectively. To confirm UNI, the fresh cadavers were dissected and ulnar nerves were exposed.

RESULTS: In 90 degree elbow position, Type N was found in 18 elbows, and in full flexion, types N and S, 12 and 6 elbows, respectively. In full flexion of the elbow, there was a statistically significant difference in ME_UN1, ME_UN2, ME_TB, FR0, FR1, and FR2 (p<0.005). The UNI was confirmed with cadaveric dissection.

SUMMARY/CONCLUSION: UNI is increased with elbow flexion, which would be related with the snapping of the median triceps muscle. It is important to recognize UNI during elbow flexion as a potential cause of ulnar neuropathy.

Dong Hwee Kim, MD, PhD
IFCN Award Recipient
RADIATION-INDUCED MALIGNANT PERIPHERAL NERVE SHEATH TUMOR INVOLVING THE BRACHIAL PLEXUS
Rocio Vazquez Do Campo (Jacksonville, FL), Elizabeth Mauricio (Jacksonville, FL)

INTRODUCTION: Malignant peripheral nerve sheath tumors (MPNSTs) may develop spontaneously, as a malignant transformation of neurofibroma or schwannoma, or as a late complication of radiotherapy. Only 6% of radiation-induced MPNSTs develop in limb nerves. Brachial plexus involvement is extremely rare.

OBJECTIVE: To present a case of radiation-induced MPNST involving the brachial plexus.

METHODS: A 59-year-old woman with history of Hodgkin’s lymphoma treated with chemotherapy and thoracic radiation 15 years prior presented with a 7-month history of left shoulder pain, progressive left upper limb numbness and weakness, and weight loss.

RESULTS: She had severe weakness and atrophy in upper arm and forearm muscles, absent reflexes and reduced light touch and pinprick sensation diffusely in the left upper limb. Needle EMG showed a severe, patchy left brachial plexopathy with myokymic discharges in forearm muscles. Despite myokymia and due to significant pain and cancer history, neoplasm was suspected. A large, heterogeneously enhancing mass arising from the left brachial plexus extending into the extraforaminal portion of C5-7 nerve roots was found on MRI. Biopsy revealed a high-grade MPNST and fluorodeoxyglucose-positron emission tomography confirmed localized disease. She underwent left forequarter amputation with pre-surgical adjuvant radiotherapy.

SUMMARY/CONCLUSION: Radiation-induced MPNSTs should be considered in patients with radiation exposure presenting with a painful, rapidly enlarging mass arising from peripheral nerve structures in the radiation field. Myokymia does not exclude a neoplastic cause, and biopsy is required to confirm diagnosis. Prognosis is poor unless wide surgical excision can be achieved. In MPNSTs with extensive involvement of the brachial plexus, forequarter amputation provides the best curative treatment option.

Rocio Vazquez Do Campo, MD
Resident and Fellow Member Award Recipient

RETROSPECTIVE REVIEW OF CARPAL TUNNEL SYNDROME AND PROMIS SCORES
David Speach (Rochester, NY), Clifford Everett (Rochester, NY), Adam Michalik (Rochester, NY), Rajeev Patel (Rochester, NY), Judith Baumhauer (Rochester, NY), John Orsini (Rochester, NY), Donna Ferrero (Rochester, NY)

INTRODUCTION: Patient reported outcomes are increasingly important in determining the value of medical care and guiding medical treatment. The Patient Reported Outcome Measurement Information System (PROMIS®) is a recently developed reporting metric used in a number of medical specialties, particularly orthopaedics. Previous studies have indicated that severity of CTS determined by EDX study does not correlate with patient clinical symptoms.

OBJECTIVE: To determine whether the severity of CTS on EDX study correlates with commonly used PROMIS measures of pain, mood, general physical function, and upper limb function.

METHODS: EDX studies from a single university based orthopaedic/rehabilitation practice were reviewed for degree of CTS. PROMIS scores completed at the time of examination were reviewed and compared to the EDX results. Bayesian regression analysis using one way ANOVA was used to determine whether a correlation existed between the severity of CTS and PROMIS scores.

RESULTS: The PROMIS domains of physical function, depression, pain interference and upper extremity function did not correlate with the degree of CTS on EDX study.

CONCLUSION: Similar to other patient reported measures used to gauge the severity of CTS, PROMIS does not appear to correlate with the EDX severity of CTS. Our results suggest that PROMIS scales of pain, mood, general physical function, and upper limb function lack specificity in predicting patient limitations from CTS, or ultimately the outcome of CTS treatment. This suggests that a hand specific outcome measure be used in this patient population.
NEUROPHYSIOLOGY AND RADIOLOGY IN DIAGNOSIS OF THORACIC OUTLET SYNDROME (TOS)
Albina Tretiakova (Kyiv, Ukraine), Lidia Chebotariova (Kyiv, Ukraine), Oksana Haiko (Kyiv, Ukraine), Igor Tretyak (Kyiv, Ukraine), Roman Tretiakov (Kyiv, Ukraine)

INTRODUCTION: Diagnosing thoracic outlet syndrome (TOS) can be difficult because the symptoms and their severity can vary greatly.

OBJECTIVE: To identify criteria for diagnosis and evaluation of pathology of TOS.

METHODS: A retrospective analysis of 55 patients (mean age: 32 years, 65.5% female) was conducted. Clinical evidence of functional vessel “entrapment” in the cervicoaxillary canal was sought, with arm and neck movements aggravating symptoms or obliterating pulse. Tests included sensory and motor nerve conduction velocities (NCVs), needle EMG, ultrasound of vessels and nerve trunks, X-ray of the cervical spine, and MRI of the brachial plexus.

RESULTS: Three variants of symptom predominance were determined: (1) neurogenic 83.6%, (2) venous 9.1%, and (3) arterial 7.3%. Needle EMG determined muscle involvement and pathology. Most sensitive changes on stimulation were in latency and action potential amplitude of the medial brachial cutaneous nerve (56.4%); 43.6% had sensory abnormalities but none on nerve conduction. On X-ray, abnormal relation between clavicle and first rib, enlarged vertebral transverse process, accessory cervical ribs, high first ribs with reduced costoclavicular space were found in only 21.8%. One MRI showed abnormal origins of the brachial plexus. Hypertrophy or abnormal insertion of scalene muscles were observed in 4 cases, narrowing of the costoclavicular space in 3. Ultrasound of the subclavian artery with compression tests showed structural changes in 74.5%; abnormal blood flow was found on color flow mapping.

SUMMARY/CONCLUSION: Needle EMG is often of little value in diagnosing TOS; clinical data with ultrasound and X-ray play a predominant role. Neuroimaging including of brachial plexus helps identify anatomical abnormalities, exclude other diagnoses, and minimize risks of surgical decompression.

Oksana Haiko, MD, PhD
IFCN Award Recipient

Albina Tretiakova, PhD, DSc
IFCN Award Recipient

THE REPRODUCIBILITY OF THE AMPLITUDE OF THE FAR-FIELD POTENTIAL (FFP) OF THE COMPOUND MUSCLE ACTION POTENTIAL (CMAP)
Takashi Chiba (Itabashi-ku, Japan), Chizuko Oishi (Mitaka Shi, Japan), Masahito Kobayashi (Hodogaya-ku, Yokohama, Japan), Mana Higashihara (Itabashi-ku, Japan), Masahiro Sonoo (Itabashi-ku, Japan)

INTRODUCTION: The compound muscle action potential (CMAP) amplitude may be used as a simple surrogate marker of lower motor neuron involvement, although the low reproducibility is a definite limitation of this parameter. Recently, contribution of the far-field potentials (FFPs) to routine CMAPs has been documented, especially in the ulnar and tibial nerve. The FFP is not influenced by the position of the recording electrode, and a higher reproducibility is expected than in routine CMAPs.

OBJECTIVE: To investigate the reproducibility of the amplitude of the FFP of the CMAP.

METHODS: Subjects were 7 healthy volunteers. Routine distal CMAPs and their FFPs were recorded for the tibial and ulnar nerves by 2 examiners. One examiner repeated the examination twice. The coefficient of variance (CV) was calculated for all 3 measured values, as well as to evaluate inter- or intra-examiner variation. CV of different parameters were compared using a one-sample Wilcoxon test.

RESULTS: When 3 values were pooled, the CV of FFP amplitude (5.1±2.9%) was significantly smaller than that of routine CMAP amplitude (10.6±6.1%) for the tibial nerve. There was no significant difference between the 2 parameters for the ulnar nerve (8.0±5.7% versus 10.4±9.4%). The difference for inter- or intra-examiner variation did not reach significance.

CONCLUSION: The FFP amplitude, having a good reproducibility, is promising as a simple tool to evaluate lower motor neuron loss.
160
SHORT TERM OUTCOMES OF PATIENTS WITH GUILLAIN–BARRÉ SYNDROME
Sarah Siddiqui (Karachi, Pakistan), Masood Zaman (Karachi, Pakistan), Tahirah Hasan (Karachi, Pakistan), Adeel Khoja (Karachi, Pakistan), Sara Khan (Karachi, Pakistan)

INTRODUCTION: Guillain–Barré syndrome (GBS) is an acute postinfectious polyradiculoneuropathy affecting 100,000 individuals/year, associated with significant morbidity and persistent functional disability in some patients.

OBJECTIVE: To determine the in-hospital mortality and functional outcome at discharge and at 2 weeks among patients with GBS.

METHODS: Records of 216 patients diagnosed with GBS, admitted during 2011–2015 at the Aga Khan University Hospital, Pakistan were retrospectively reviewed. Primary outcome parameters included in-hospital mortality and functional outcome (as assessed by the Modified Rankin Scale, or MRS) at discharge and at 2 weeks. Logistic regression analysis was performed to assess for factors which affect the outcome of GBS patients who require mechanical ventilation.

RESULTS: Of the 216 patients admitted, in-hospital mortality was 7.8%. At discharge, 44.2% were able to ambulate without assistance (MRS <3) and 69.5% at 2 weeks. In contrast, only 11.3% out of the 53 (24.5%) mechanically ventilated patients had an MRS of <3 at discharge, while 18.8% needed assisted ventilation at home. On univariate analysis, factors negatively influencing the outcome of mechanically ventilated patients were increasing age, longer length of hospital stay, sepsis, autonomic dysfunction, electrolyte imbalance, and pulmonary complications. On multivariate analysis, only increasing age was significant.

SUMMARY/CONCLUSION: Despite advances in treatment modalities and ICU care for patients with GBS, short term outcomes are still far from ideal, especially in the subgroup requiring mechanical ventilation. Careful monitoring and timely management of modifiable risk factors can help improve the outcomes. Patients need to be positively counseled about potential recovery with aggressive rehabilitation.

Sarah Siddiqui, MBBS, FCPS, MRCP
IFCN Award Recipient

161
BILATERAL RADIAL NEUROPATHIES AFTER PUSH-UPS
Stacy Jordan (Lansing, MI), Michael Andary (East Lansing, MI), Michael Slesinski (Brighton, MI)

INTRODUCTION: There are rare cases of bilateral radial neuropathies reported from muscular exertion, but no reported cases resulting from push-ups. One suggested etiology is due to compression by the lateral head of the triceps.

OBJECTIVE: To describe a case of bilateral radial neuropathies sustained after push-ups in an otherwise healthy male.

CASE REPORT: A 27-year-old male presented to the ER after sudden onset numbness and tingling in bilateral arms followed by weakness. Symptoms occurred after approximately 20 minutes of push-ups during his police academy training. Physical examination revealed significant weakness localized to radial-innervated muscles distal to the elbow bilaterally. Additional workup was negative. He was discharged home with wrist braces. He presented for EDX evaluation approximately 3 weeks later. At that time, he noted moderate improvement in his symptoms after participating in physical therapy.

RESULTS: Bilateral upper extremity sensory NCSs of the superficial radial nerve from the wrist and motor NCSs from the elbow to the extensor indicis were normal. We did not stimulate from Erb's point. Needle EMG found fibrillation potentials in bilateral radial-innervated muscles distal to the triceps while other muscles were normal. Polyphasic motor units were found in most denervated muscles. EDX findings were suggestive of bilateral incomplete radial neuropathy proximal to the elbow with axon loss and evidence of reinnervation. There was no other EDX evidence for hereditary neuropathy with liability to pressure palsies.

SUMMARY/CONCLUSION: Push-ups should be considered as a possible mechanism of compressive radial neuropathy.

Stacy Jordan, DO
Resident and Fellow Member Award Recipient
URIC ACID LEVELS CORRELATE WITH INFERIOR SENSORY NERVE FUNCTION IN HEALTHY SUBJECTS
Alon Abraham (Tel Aviv, Israel), Carolina Barnett Tapia (Toronto, Canada), Hans Katzberg (Toronto, Canada), Leif Lovblom (Toronto, Canada), Hans Katzberg (Toronto, Canada), Bruce Perkins (Toronto, Canada), Vera Bril (Toronto, Canada)

INTRODUCTION: High levels of uric acid (UA) are associated with peripheral neuropathies, including diabetic sensorimotor polyneuropathy and chronic inflammatory demyelinating polyneuropathy. Furthermore, UA levels have been found to correlate with both the clinical and electrophysiological severity of diabetic sensorimotor polyneuropathy, mainly with sensory functions.

OBJECTIVE: To explore whether UA levels correlate with nerve function in healthy subjects also.

METHODS: Included were 126 healthy subjects recruited prospectively for another study. We extracted demographic data, body mass index (BMI), blood pressure, Toronto Clinical Neuropathy Score, electrophysiological findings, vibration perception thresholds (VPTs), and laboratory test results including UA, hemoglobin A1c, estimated glomerular filtration rate, and lipid levels.

RESULTS: Mean cohort age was 56±17 years, comprising 56% females. Males had higher UA values compared with females. Univariate beta regression coefficient analysis between UA levels and demographic, clinical, electrophysiological, and laboratory findings showed significant positive correlations with male gender, components of the metabolic syndrome, and VPTs, while an inverse correlation was found with electrophysiological sensory parameters. A multivariate regression model showed positive correlations with BMI, finger VPTs, and triglycerides only.

SUMMARY/CONCLUSION: Higher UA levels correlate with inferior sensory nerve function in healthy subjects, expanding the evidence of the negative impact of UA on peripheral nerves.

A CASE OF FAMILIAL ACUTE INFLAMMATORY DEMYELINATING POLYNEUROPATHY
Gary Gallagher (Ann Arbor, MI), Robert Kobelja (Ann Arbor, MI), Ann Little (Ann Arbor, MI), James Teener (Ann Arbor, MI)

INTRODUCTION: Acute inflammatory demyelinating polyneuropathy (AIDP) is a rare, immune-mediated polyneuropathy with several variants. AIDP typically presents as an acute, monophasic paralytic illness which may be provoked by infection or other triggering event. Pathogenesis is thought to arise from an immune response to an infection which then triggers an autoimmune attack on myelin. The most commonly identified infection is Campylobacter jejuni. AIDP is thought to be a sporadic illness, although there are rare case reports of AIDP presenting in 2 or more family members separated by months or years, or simultaneously in siblings.

OBJECTIVE: To illustrate a case of simultaneous AIDP in a mother and son.

CASE REPORT: A previously healthy 69-year-old woman presented for admission with ascending paresthesias and weakness over 7 days while her previously healthy 35-year-old son presented with numbness and arm weakness progressing to quadriparesis over 1-2 days. Both had been at a family reunion with 20+ other family members but had been the only ones to handle raw buffalo meat while preparing a meal. No other family members developed similar symptoms. Needle EMGs for both demonstrated markedly prolonged F responses, prolonged distal latencies, and conduction block. Cerebrospinal fluid studies demonstrated albuminocytologic dissociation. Despite extensive testing, no infectious source was identified.

SUMMARY/CONCLUSION: There are rare case reports of familial AIDP in siblings. This is the first report, to our knowledge, of simultaneous AIDP in a parent and offspring which may suggest a genetic predisposition in some families to a common trigger.
164
NEUROPATHY ASSOCIATED WITH TS-HDS ANTIBODIES RESPONSIVE TO TREATMENT WITH IVIG
Pantelis Pavlakis (New York, NY), David Fernandez (New York, NY)

INTRODUCTION: Trisulfated disaccharide IdoA2S-GlcNS-6S (TS-HDS) antibodies have been associated with immunoglobulin Mk IgMκ) monoclonal gammopathy of undetermined significance (MGUS) and predominantly sensory axonal, or small-fiber, neuropathy.

OBJECTIVE: To describe a case of neuropathy associated with TS-HDS antibodies and a favorable response to IVIg therapy.

CASE REPORT: A 56-year-old man presented with progressive, non–length-dependent painful paresthesias since age 53. Examination showed normal strength and reflexes and decreased pain, temperature, and vibration sensation in the distal arms and legs. EDX studies showed normal motor and sensory evoked responses in the arms and legs, except for mild median neuropathy at the left wrist, and no abnormal spontaneous activity on needle EMG. Blood tests showed IgGk-MGUS positive TS-HDS antibodies and negative FGFR3, myelin-associated glycoprotein, systemic, and paraneoplastic antibodies. MRIs showed only mild lumbar spine degenerative changes and normal lumbosacral plexus. Skin biopsy showed proximally and distally decreased intraepidermal nerve fiber density. Symptoms were refractory to multiple agents, eventually requiring opiate treatment. After starting IVIg symptoms improved; he no longer required long-acting opiates, and short-acting opiate dose was halved.

SUMMARY/CONCLUSION: We report a case of IVIg-responsive, predominantly small-fiber neuropathy associated with IgGk-MGUS and TS-HDS antibodies. Similar to prior studies, our patient had pure sensory, predominant small-fiber neuropathy. The majority of patients have IgMκ-MGUS; however, our patient had IgGk-MGUS. Although this report is uncontrolled, the marked decrease in opiate requirement after IVIg provides a relatively objective marker of treatment response. Larger-scale, placebo-controlled studies are needed to further validate this observation.

165
BORTEZOMIB INDUCED ACUTE INFLAMMATORY DEMYELINATING POLYNEUROPATHY
Sadie Waheed (Lexington, KY), Saeed Ahmadi (Toronto, Canada), Stephen Ryan (Lexington, KY), Zabeen Mahuwala (Lexington, KY)

INTRODUCTION: Bortezomib has been part of the treatment regimen of multiple myeloma for over a decade. This first-in-class clinically used proteasome inhibitor is known to cause peripheral neuropathy via various cellular mechanisms. This neuropathy can be demyelinating or axonal, with sensory predominant features. However, subacute sensorimotor neuropathy with loss of muscle mass has also been noted.

OBJECTIVE: To report a case of acute onset polyneuropathy (acute inflammatory demyelinating polyneuropathy, or AIDP) after bortezomib treatment.

METHOD: A 70-year-old caucasian male suffering from immunoglobulin A (IgA) multiple myeloma was admitted to the hospital because of frequent falls and difficulty walking. This started 5 days after the third dose of chemotherapy regimen, which included bortezomib, lenalidomide, and dexamethasone. The patient complained of general fatigue after the first dose, and asymmetric weakness in the lower extremities (R>L) after the second dose. On examination, the tone and bulk were normal but there was asymmetric proximal weakness (R>L) with loss of deep tendon reflexes in the lower limb. NCSs confirmed the presence of mixed sensorimotor loss with both demyelinating and axonal neuropathic features. Cerebrospinal fluid analysis revealed albumin-cytogenetic dissociation. The patient was treated with IVIg for 5 days, which resulted in a marked improvement of his symptoms. Followup NCSs at 12 months also showed marked improvement, hence confirming the diagnosis.

CONCLUSION: We report a case of AIDP after bortezomib treatment. The improvement in symptoms after IVIg treatment highlights the importance of diagnosing AIDP in patients with multiple myeloma who are recently exposed to bortezomib.
166

ISOLATED FACIAL DIPLEGIA AS A RARE MANIFESTATION OF GUILLAIN BARRE SYNDROME (GBS)
Ehtesham Khalid (Nashville, TN), Uzoamaka Ugochukwu (Nashville, TN), Bassel Abou-Khalil (Nashville, TN)

INTRODUCTION: Guillain–Barré syndrome (GBS) is classically a monophasic disease, with several variants. Here, we present an atypical case of a second episode of GBS, presenting as isolated facial diplegia.

CASE REPORT: A 27-year-old woman with a history of typical GBS 6 years prior to presentation was assessed after 2 days of facial diplegia. A week after a viral prodrome, she developed symmetric weakness around her mouth that spread to the rest of her face. No other focal symptoms were appreciated. Her examination was notable for severe bilateral upper and lower facial weakness. There were no other cranial nerve, motor, or sensory abnormalities. Her muscle stretch reflexes were 2+ throughout. Cerebrospinal fluid studies were notable for protein of 377 mg/dL and 15 nucleated cells/ml (lymphocytes and monocytes on cytology). Needle EMG showed mild demyelination changes in her arm and reduced recruitment in the face. Treatment with IV immunoglobulin led to significant improvement of facial weakness. However, she subsequently developed progressive weakness in her extremities. She was re-evaluated 17 days after discharge, and examination showed almost normal facial strength, but mild-to-moderate generalized extremity weakness and areflexia. Repeat needle EMG showed progression of her sensorimotor polyneuropathy. She was re-admitted for plasma exchange.

SUMMARY/CONCLUSION: Isolated facial diplegia is an uncommon manifestation of GBS, reported only in 1% of cases. Approximately 45% of patients have additional limb findings including hyporeflexia, which was not initially present in our patient but was subsequently noted. GBS should be an important consideration in patients presenting with bifacial lower motor neuron weakness.

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167

DEVASTATING ISCHEMIC MONOMELIC NEUROPATHY AFTER PLASTIC ZIP TIE HANDCUFFS; A MESSAGE TO SECURITY AGENCIES.
Ahmad Wali (Quetta, Pakistan)

INTRODUCTION: Ischemic monomelic neuropathy (IMN) is well known following compartment syndrome, casts, or tourniquet use. One of the devastating forms is increasingly reported after tying hands of suspects/accused persons with plastic zip handcuffs by security agencies. This is especially increasing in countries who are war torn or coping with terrorism.

OBJECTIVE: To increase awareness among physicians and security agencies to recognize IMN early, take measures to prevent this rapidly developing neuropathy, and discourage the use of plastic handcuffs in arresting suspects and correctional places.

METHODS: This is a case of a 22-year-old male arrested by security agency as a suspect. His hands were tied with plastic zip handcuffs for 36 hours continuously. The patient developed numbness of the bilateral upper limbs within a few minutes and weakness within 2 hours. Upon cutting the zip tie he was unable to flex his forearms and move his hand muscles properly. He had decreased pin prick in his distal forearm and hand dermatomes. Power in finger flexion and abduction was 2/5, while forearm flexion was 3/5 and extension 4/5.

RESULTS: Needle EMG/NCSs revealed asymmetric low motor amplitudes of bilateral musculocutaneous, median, ulnar, and radial nerves. The sensory nerves were nonrecordable. Needle EMG revealed active denervation potentials and rapid firing rate motor potentials.

SUMMARY/CONCLUSION: Plastic zip type handcuffs produce rapid and severe IMN as compared to other means of handcuffs. This leads to devastating axonal loss in hours and results in a handicap condition for the patients. There is dire need to strongly discourage this type of tie by security agencies.

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CHILDHOOD-ONSET HEREDITARY SPASTIC PARAPLEGIA
Mary McClanahan (Brookhaven, GA), Sumit Verma (Atlanta, GA)

INTRODUCTION: Hereditary spastic paraplegias (HSPs) are rare genetic gait disorders, characterized by progressive lower extremity spasticity and weakness due to corticospinal tract neuronal degeneration. English-language literature on childhood-onset HSP is limited.

OBJECTIVE: To study clinical, electrophysiological, and genetic profiles in pediatric HSP.

METHOD: This was a retrospective chart review of genetically-confirmed HSP children evaluated at a tertiary-care children’s hospital from 2013-2017, including history, pedigree analysis, neuromuscular examination, needle EMG/NCSs, neuroimaging, genetic testing, comorbidities, and treatment.

RESULTS: Ten children (7 boys, 3 girls; mean age at diagnosis: 12.1 years, range: 6-19) were included. All had gait difficulty, with spasticity and weakness in 3, weakness in 3, and spasticity in 4. Pedigree analysis was unrevealing, although 2 sibling pairs were identified. Needle EMG/NCSs performed in 9 subjects were abnormal in 7, with predominantly sensorimotor axonal polyneuropathy. MRI brain/spine were unremarkable, except cerebellar atrophy in 1. Genetic mutations were found in SPG11 (2, siblings), SPAST (2, siblings), KIF1A (2), KIF5A (1), ZFYVE26 (1), REEP1 (1), and SPG7 (1). Mean disease duration from symptom onset to genetic confirmation was 5.6 years. Eight subjects were functionally ambulatory at diagnosis. Comorbidities included seizures (20%), dysarthria (40%), ataxia (50%), cognitive impairment (60%), attention difficulty (40%), hearing impairment (20%), autism (20%), and neuromuscular scoliosis (30%). Treatment included oral baclofen in 60%, gabapentin in 30%, and consideration for intrathecal baclofen pump in 1 subject.

SUMMARY/CONCLUSION: In our cohort, all HSPs presented with gait abnormality, majority demonstrating axonal polyneuropathy, neurocognitive deficits, and normal neuroimaging, with varying patterns of weakness and spasticity. Further multicenter studies are needed to characterize the clinical–electrophysiological profile of pediatric HSPs.

Mary McClanahan, MD
Resident and Fellow Member Award Recipient

MAGNESIUM IN PAINFUL DIABETIC PERIPHERAL NEUROPATHY: THE HINES VA EXPERIENCE
Jasvinder Chawla (Hines, IL), Geeta Verma (Hines, IL), Kalea Colletta (Hines, IL), Sanjay Singh (Hines, IL), James Welsh (Hines, IL)

INTRODUCTION: Several disorders lead to peripheral nerve damage and chronic neuropathic pain. Analgesics can help but patients can continue to have pain, develop side effects, or cannot afford their medications. Magnesium antagonizes the N-methyl-D-aspartate (NMDA) receptor that is central to neuropathic pain and reduces mechanical hyperalgesia and allodynia from peripheral nerve damage in animal models. In diabetics, magnesium supplementation improves neuropathic pain. Given that magnesium may be a low-cost effective therapy with minimal side effects, we assessed oral magnesium in neuropathic pain at higher doses to compensate for poor absorption of magnesium and longer duration of treatment, because magnesium repletion is slow.

OBJECTIVE: To assess efficacy of oral magnesium in neuropathic pain.

METHODS: Patients with small fiber neuropathy resulting in neuropathic pain (n=31; 29 men) were found to have been treated with magnesium oxide; 27 were given 840 mg MgO orally twice daily and 2 given 1680 mg in the morning and 840 mg in the evening.

RESULTS: At 3 months, 27 patients had improvement in the Visual Analogue Scale for pain by 3-6 points (from 9-10/10 to 4-6/10) though 2 patients experienced no differences. Starting dose of 840 mg magnesium oxide twice daily improved pain scores by at least 30%.

SUMMARY/CONCLUSION: Daily oral magnesium is effective in controlling neuropathic pain in patients with small fiber neuropathy. Magnesium supplementation is also reported effective for migraine and postoperative pain. Our findings further support consideration of oral magnesium as a primary or adjunctive therapy for neuropathic pain. Clinical trials with magnesium at higher doses, for longer durations, and using more bioavailable forms are warranted.
SUCCESSFUL HYDRODISSECTION AND CORTICOSTEROID INJECTION AS A TREATMENT FOR MEDIAN NEUROPATHY AT THE ELBOW SECONDARY TO A LIGAMENT OF STRUTHERS
John Norbury (Greenville, NC), John Norbury (Greenville, NC)

INTRODUCTION: Median neuropathy at the elbow can be a challenging diagnosis and there are few nonsurgical treatments.

OBJECTIVE: To successfully diagnose and treat a median neuropathy at the elbow with nonsurgical measures.

METHODS: A 26-year-old caucasian female presented with a 2 out of 10 pain score in the elbow with tingling and numbness in the hand and fingers. Strength was intact, and sensation was reduced throughout the right arm. EDX evaluation revealed no abnormalities in the median nerve. A plain film of the humerus revealed a supracondylar spur. Neuromuscular ultrasound revealed increased hypoechogenicity and cross-sectional area compared to the contralateral side directly proximal to a ligament of Struthers. She underwent a hydrodissection of the median nerve and corticosteroid injection with 4 cc of 1% lidocaine and 1 cc of 6 mg/cc betamethasone, which was performed under ultrasound guidance without complication.

RESULTS: At 3 weeks followup, the patient reported 40% improvement in symptoms and complete resolution of her numbness and tingling. Her disabilities of the arm, shoulder, and hand score decreased from 30.8 to 10.8.

SUMMARY/CONCLUSION: Ultrasound can be a helpful adjuvant to EDX studies when there is nerve swelling but no axon loss in focal neuropathies. Hydrodissection and injection may be a nonsurgical treatment for median nerve entrapment at the ligament of Struthers and can also be of assistance in confirming the diagnosis when the clinical and EDX picture is not clear. More research is needed to determine the efficacy of this procedure.

HYPERTRIGLYCERIDEMIA AND SMALL FIBER NEUROPATHY: COINCIDENCE OR CAUSATIVE?
Jasvinder Chawla (Hines, IL), Piotr Tekiela (Hines, IL), Kalea Colletta (Hines, IL), Paz Martinez (Hines, IL), Sanjay Singh (Hines, IL), Welsh James (Hines, IL)

INTRODUCTION: Small fiber neuropathy (SFN) is a common complaint that drives many patients to seek medical attention but is a challenge for neurologists to diagnose as it can be missed on routine needle EMG/Nerve conduction studies. Although diabetes is the most common cause for SFN, other less well studied etiologies include hypertriglyceridemia. Smaller studies have shown that hypertriglyceridemia causes mild axonal polyneuropathy which is often subclinical and can be overshadowed by symptoms of diabetes.

OBJECTIVE: To assess improvements in SFN in patients treated with statins for hypertriglyceridemia.

METHODS: Among the 126 patients identified with neuropathic pain, 46 had hypertriglyceridemia. Only 9 were identified with normal needle EMG/nerve conduction studies but abnormal quantitative sudomotor axon reflex test results consistent with SFN. These 9 patients were started on a statin by their primary care physician, and their lipid profile was checked at 4-6 weeks followup.

RESULTS: All 9 patients showed gradual but complete improvement of their neuropathic pain after effective treatment of their triglyceride levels. The range of triglyceride lowering was from 93% to 217% based upon their baseline values.

SUMMARY/CONCLUSION: SFN with its numerous etiologies remains a challenging disease, and many patients are limited to symptomatic treatment due to lack of understanding of mechanisms. Our case series presents a group of patients with complete relief of symptoms by treatment of hypertriglyceridemia with conventional statins. Whether improvements were related to reversal of metabolic dysfunction of neurons or other mechanisms is unclear. Given that hypertriglyceridemia is potentially a treatable condition with statins or dietary improvements and may reverse neuropathic pain secondary to SFN, assessing and treating hypertriglyceridemia is an important part of the clinical workup in patients with neuropathy.
**OPIOID-RELATED BRACHIAL PLEXOPATHY: A CASE SERIES**

Mathieu Cuchanski (Danville, PA), Jose David Avila (Danville, PA)

**INTRODUCTION:** Heroin overdose is associated with multiple neurologic complications. Non-traumatic brachial plexopathy has rarely been reported and is typically accompanied by rhabdomyolysis. Only 1 previous case of brachial plexopathy following methadone overdose has been published.

**OBJECTIVE:** To describe 2 patients with brachial plexopathy after opioid overdose.

**CASE REPORTS:** (1) A 36-year-old man presented with left arm and bilateral leg weakness after a heroin overdose. Brain and cervical MRI were normal. Creatine kinase (CK) was >22,000 U/L (normal <200). Examination performed 3 weeks later demonstrated atrophy of the left supraspinatus, deltoid, and biceps brachii, severe proximal limb weakness, absent biceps and brachioradialis reflexes, and sensory loss in the C5-6 dermatomes, suggesting an upper trunk plexopathy. The patient was lost to followup and EDX studies were not completed. (2) A 28-year-old man with a history of heroin abuse was found unresponsive after overdosing on methadone and quetiapine. Brain MRI showed changes indicative of hypoxic injury. CK was 9932 U/L. He noted right arm weakness and numbness upon waking. Examination performed 3 weeks later disclosed proximal and distal right arm weakness, particularly of wrist and finger extension, and left hand weakness. EDX study demonstrated a right upper trunk brachial plexopathy, predominantly affecting the infraspinatus, biceps brachii, and brachioradialis, and a left ulnar mononeuropathy at the elbow.

**SUMMARY/CONCLUSION:** Acute non-traumatic brachial plexopathy is a rare complication of opioid overdose. The mechanism may involve direct toxicity and/or immune factors. Opioid-related brachial plexopathy may become more prevalent in the current opiate epidemic.

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Resident and Fellow Member Award Recipient

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**WORSENING CHRONIC INFLAMMATORY DEMYELINATING POLYNEUROPATHY AFTER PEMBRILIZUMAB TREATMENT OF METASTATIC MELANOMA: A CASE REPORT**


**INTRODUCTION:** Management of chronic inflammatory demyelinating polyneuropathy (CIDP) associated with cancer remains a therapeutic challenge. Pembrolizumab is a humanized monoclonal antibody that targets PD-1 receptor and is indicated for certain types of cancers including metastatic melanoma. Treatment with immunotherapy such as pembrolizumab can result in severe and potentially life-threatening neuromuscular complications.

**OBJECTIVE:** To report a case of severe CIDP weakness in a patient with metastatic melanoma treated with pembrolizumab.

**CASE REPORT:** A 64-year-old man with CIDP presented with progressive proximal leg weakness. Cerebrospinal fluid (CSF) protein was abnormally elevated at 310 mg/dL. Other CSF and laboratory studies were normal, including creatine kinase. He was given full dose IV immunoglobulin (IVIg) with significant improvement. CT of the chest demonstrated multiple lung nodules, whose biopsy revealed metastatic melanoma with unknown primary site. Serum paraneoplastic panel was negative including antiganglioside antibody. Pembrolizumab biweekly treatments were initiated, with rapid deterioration of his CIDP weakness to near-complete quadriparesis without respiratory or bulbar compromise. Full dose IVIg infusions were continued and timed so as not to diminish pembrolizumab benefit for melanoma. For 2 months, melanoma immunotherapy had to be withheld due to severe and worsening CIDP weakness. Serial CT scans showed resolution of metastatic process. Since cancer remission, pembrolizumab was discontinued. The patient has continued to improve with full dose IVIg every 3 weeks.

**SUMMARY/CONCLUSION:** Our case demonstrates the need for proactive and interdisciplinary management of neuromuscular weakness from CIDP in patients with concurrent malignancy treated with new immunotherapies, some of which are associated with considerable neurotoxic effect.
OBINUTUZUMAB (GAZYVA), A POTENT ANTI-B CELL AGENT, IN THE TREATMENT OF RITUXIMAB-UNRESPONSIVE IGM ANTI-MYELIN-ASSOCIATED GLYCOPROTEIN (MAG)-MEDIATED-NEUROPATHY
Goran Rakocevic (Philadelphia, PA), Ubaldo Martinez-Outschoorn (Philadelphia, PA), Marinos Dalakas (Philadelphia, PA)

INTRODUCTION: Approximately 40% of patients with immunoglobulin M (IgM) anti-myelin-associated glycoprotein (MAG) neuropathy respond to rituximab, an anti-CD20 B cell depleting drug. Obinutuzumab is a humanized monoclonal antibody against CD20 that exerts greater than rituximab antibody-dependent cellular cytotoxicity and phagocytosis and greater direct B-cell killing. Obinutuzumab, approved for chronic lymphocytic leukemia (CLL), might be more effective in refractory anti-MAG neuropathy.

OBJECTIVE: To describe clinical and serological response to obinutuzumab in 2 patients with anti-MAG-IgM neuropathy who continued to worsen despite initial treatment with IV immunoglobulin (IVIg) and multiple courses of rituximab.

METHODS: Two patients, 69 and 64 years old, with benign IgM demyelinating sensorimotor neuropathy and high-titer anti-MAG antibodies, had progressive disease of 7-12 years. One never responded to 1 full-course of rituximab, while the other had mild early improvement and stabilization but then continued to worsen despite repeated infusions. Upon obinutuzumab introduction, both patients had bilateral foot drop requiring assistance for ambulation, sensory ataxia, persisting IgM spikes, elevated total IgM levels, and high anti-MAG titers. Obinutuzumab was administered over 6 months per standard CLL protocol.

RESULTS: No clinical improvement was observed in either, leading to drug discontinuation after 6 months. The IgM levels however normalized in both patients (from a mean of 420 mg/dl to <200 mg/dl) and the MAG antibody titers decreased, while the IgM spike persisted.

SUMMARY/CONCLUSION: Obinutuzumab, administered for 6 months, did not improve 2 patients with advanced anti-MAG neuropathy unresponsive to rituximab, but lowered the IgM level and the anti-MAG antibody titers.

NERVE CONDUCTION STUDIES VERSUS ULTRASONOGRAPHY FOR ASSESSMENT OF ULNAR NEUROPATHY AT THE ELBOW
Hala Elhabashy (Cairo, Egypt), Reem Elhadidy (Cairo, Egypt), Sandra Ahmed (Cairo, Egypt), Reda Abdelrazek (Ismailia, Egypt)

INTRODUCTION: Ulnar neuropathy at the elbow (UNE) is the second most common entrapment neuropathy. Diagnosis and localization of UNE is not always easy to establish. Mixed NCSs allow direct measure of nerve conduction without the additional variable of the neuromuscular junction. Ultrasonography is an evolving tool in evaluation of entrapment neuropathies.

OBJECTIVE: To investigate normative values of mixed NCSs of the ulnar nerve at the elbow and to assess the role of ultrasonography in diagnosing and localizing UNE.

METHODS: A case control study was carried on 47 clinically affected and 80 clinically non-affected ulnar nerves. All were subjected to routine and mixed NCSs of the ulnar nerve and ultrasonographic examination to measure the cross-sectional area (CSA) of the ulnar nerve at 5 levels: 5 cm proximal to the sulcus; 2.5 cm proximal to the sulcus; at the level of the sulcus; 2.5 cm distal to the sulcus, and 5 cm distal to the sulcus. Plus, distal and proximal ratios were calculated.

RESULTS: The cutoff value of mixed nerve conduction velocity (NCV) for the across elbow segment was ≤49 m/s. The cutoff value of the maximum CSA of the ulnar nerve found at 2.5 cm distal to the sulcus was >10.5 mm2. The sensitivity of routine NCSs, mixed NCSs, and ultrasound in diagnosing UNE measured versus clinical diagnosis were 70.2, 78.7, and 82.9%, respectively.

SUMMARY/CONCLUSION: Mixed NCSs are easily performed and reproducible studies which can be added to routine NCSs for ulnar neuropathy at the elbow. NCSs and ultrasound are complementary in the diagnosis of UNE.

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IFCN Award Recipient
**176**

**COMPARISON OF THE RECRUITMENT OF THE SOLEUS F WAVE TO M WAVE, EVIDENCE FROM AN EXPERIMENTAL ACUTE ISCHEMIA**  
*Bethany Calabrese (Syracuse, NY), Fang Liu (Syracuse, NY), Robert Weber (Syracuse, NY), Yu Zhu (Syracuse, NY)*

**INTRODUCTION:** Effects of compression/ischemia in our studies on H reflexes have shown dissociation in changes of M and H waves. Early recruited M waves, representing the largest motor fibers, were blocked immediately upon ischemia, whereas H waves, representing smaller motor fibers as defined by Henneman's size principle, were unchanged. F waves are elicited by antidromic depolarization of alpha motor neurons.

**OBJECTIVE:** To compare effects of compression/ischemia on M and F waves to M and H wave changes with compression/ischemia in H reflex testing to determine which population of motor units F waves represent.

**METHODS:** Five tibial nerve F waves were studied in 4 adults with stimulation at the popliteal fossa and recording from the soleus. A blood pressure cuff induced compression/ischemia at the calf. Recordings were taken before compression/ischemia and at 2 minutes of compression/ischemia. M wave latency and amplitude, F wave latencies, and F wave persistence were recorded.

**RESULTS:** Immediately upon compression/ischemia, there was a slight decrease in M wave amplitude. At 2 minutes of compression/ischemia, M wave amplitude decreased by 10-20% with slightly increased latency. F wave latencies and persistence after 2 minutes of compression/ischemia were similar to their baseline values.

**SUMMARY/CONCLUSION:** The F wave represents motor fibers that are less sensitive to compression/ischemia when compared to earliest recruited motor fibers of the M wave, as evidenced by change in amplitude of the M wave without significant change in F wave at 2 minutes of compression/ischemia.

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Resident and Fellow Member Award Recipient

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**177**

**A CASE OF FULMINANT ACUTE MOTOR SENSORY AXONAL NEUROPATHY (AMSAN) MIMICKING BRAIN DEATH WITH ATYPICAL RECOVERY**  
*Noushin Jazebi (Galveston, TX), Neel Patel (Galveston, TX), Alok Dabi (Galveston, TX)*

**INTRODUCTION:** Guillain–Barré syndrome (GBS) is an acute inflammatory polyneuropathy with various classifications based on clinical and electrophysiological findings that include acute inflammatory demyelinating polyradiculoneuropathy, acute motor axonal neuropathy (AMAN), and acute motor–sensory axonal neuropathy (AMSAN). Very rarely fulminant forms of GBS present as acute onset tetraparesis and areflexia with absent brainstem reflexes, simulating brain death.

**OBJECTIVE:** To investigate potential clinical manifestations, diagnostic methods, and longterm prognosis of fulminant GBS/AMSAN.

**CASE REPORT:** Here, we describe the case of a patient with a rapidly progressive fulminant AMSAN, who required intubation and mechanical ventilation within the first 24 hours, with loss of all brainstem reflexes by day 6, mimicking brain death, followed by unique course of recovery. In addition to broad serum and cerebrospinal fluid testing and MRI neuroimaging, needle EMG/NCSs were performed. Brain death was excluded using continuous electroencephalogram. Initial EDX study indicated severe axonal polyneuropathy with features of acquired demyelination and absent F waves, temporal dispersion, and conduction block. Repeat needle EMG demonstrated no evidence of active denervation. There was reduced insertional activity in left frontalis and orbicularis oculi. There were no NCS responses from the left upper and lower extremities.

**SUMMARY/CONCLUSION:** The natural course of fulminant AMAN and other GBS forms is largely unknown given there are only a few other reports of severe GBS mimicking brain death. This case underlines the importance of recognizing fulminant AMSAN, through electrophysiological study, as a mimicker of clinical brain death. The course of recovery was atypical in our case, by regaining head and neck movement and appropriate responding, while still having absent brainstem reflexes.
A CASE OF TRANSTRETIN FAMILIAL AMYLOID POLYNEUROPATHY PATIENT WITH THE MONONEUROPATHY MULTIPLEX
Zeliha Matur (İstanbul, Turkey), Şahin Avcı (İstanbul, Turkey), Onur Akan (İstanbul, Turkey), Burcu Altunrende (İstanbul, Turkey), Oya Uyguner (İstanbul, Turkey)

INTRODUCTION: Transthyretin familial amyloid polyneuropathy (TTR-FAP) is typically present with sensorimotor and autonomic polyneuropathy.

OBJECTIVE: To report an atypical TTR-FAP case with mononeuropathy multiplex.

CASE REPORT: A 67-year-old woman presented with asymmetric painful numbness and weakness in her legs and hands. One year before admission, her complaints started as stabbing pain and numbness in her right leg under the knee. Symptoms slowly progressed and passed to her left leg 7 months ago and her hands 4 months ago. She had balance and hearing loss, fatigue, loss of appetite and weight loss, and diarrhea over 1 year. Neurological examination revealed asymmetric muscle weakness and atrophy predominantly at the distal parts of the lower extremities, decreased/lost deep tendon reflexes, long stocking and glove style sensory disturbances, commonly decreased vibration senses dominant in the right toe, deteriorated position sense in the right toe, and a positive Romberg test. Needle EMG findings were compatible with asymmetric axonal polyneuropathy affecting sensory and motor nerve fibers predominantly at the lower extremities and autonomic dysfunction. Axonal loss was seen in the sural nerve biopsy; vasculitis findings and amyloid deposits were absent. Lip biopsy did not show lymphocyte or amyloid infiltration. Genetic analysis revealed a missense pGlu109Gln mutation in the TTR gene.

CONCLUSION: The presence of autonomic findings and the absence of evidence of vasculitis in nerve biopsy suggest the possibility of FAP in our patient, although clinical findings are not typical. It should be kept in mind in the differential diagnosis of the progressive course of axonal polyneuropathies starting at an adult age.

ATYPICAL PRESENTATION OF GUILLAIN BARRE SYNDROME: CASE REPORT
Javier Arias-Suarez (Bogota, Colombia), Jorge Diaz-Ruiz (Bogota, Colombia)

INTRODUCTION: Guillain–Barré syndrome (GBS) is the most common acute inflammatory polyneuropathy. It has multiple forms of presentation that may include sensory and motor symptoms of axial, appendicular, and/or bulbar location.

CASE REPORT: A 45-year-old male patient with no history of neurological disease, consulted for 8 days with nasal voice, dysphagia, and nasal regurgitation for fluids, mild dysarthria. Later, paresthesias presented in his hands along with a sensation of heaviness in the extremities. Two weeks before he had an episode of pharyngitis. Physical examination upon admission showed velopalatine dysfunction, nasal voice, diminished reflex, hypesthesia in the hands and feet, and normal strength and gait. No evidence of ophthalmoplegia or ataxia. Cerebral spinal fluid showed albuminous cytological dissociation (proteins 65/leukocytes 0). Needle EMG was compatible with sensorimotor demyelinating polyneuropathy. Treatment was started with IV immunoglobulin. After the second dose the patient presented with facial diplegia, loss of taste, and increased heart rate with increased arterial blood pressure, suggesting dysautonomia, which should be monitored in the ICU. At the end of the treatment there was an adequate response with improvement of initial symptoms, with persisting bilateral facial paralysis.

CONCLUSIONS: GBS has defined presentation forms with higher incidence. However, there is a spectrum of symptoms that do not fit completely in these or, as in this case, have unusual or subtle manifestations that make it necessary to consider atypical presentations as an etiological option and refine the diagnostic processes.
EXTENDING THE CLINICAL SPECTRUM OF DEJERINE SOTTAS SYNDROME: A NEW FAMILY WITH COGNITIVE IMPAIRMENT AND HEARING LOSS CARRYING TREMBLER MUTATION
Soumya Bouchachi (Newark, NJ), Hael Abdulrazeq (Newark, NJ), Howard Sander (New York, NY), Nizar Souayah (Newark, NJ)

INTRODUCTION: Dejerine–Sottas syndrome is a severe hereditary neuropathy with heterogeneous genetic transmission. Both autosomal dominant and autosomal recessive inheritance patterns have been described. Only 1 human case of a mother and son with Dejerine–Sottas syndrome carrying the mutation gly150asp in the PMP22 gene has been previously reported, in 1997. This exact mutation is found in the Trembler mouse used to study Charcot–Marie–Tooth (CMT) disease.

OBJECTIVE: To report a new Dejerine–Sottas phenotype in a family carrying the Trembler mouse mutation.

CASE REPORT: A 43-year-old woman presented with gross ataxia which started in her childhood. She stopped walking at age 10 and has been wheelchair-bound since adolescence. Neurological examination revealed profound sensory ataxia and hearing loss as well as mild cognitive impairment. NCSs revealed severe sensorimotor neuropathy. Genetic testing results showed she was heterozygous for point mutation gly150asp in the PMP22 gene. Her 20-year-old son has a similar phenotype and was carrying the same mutation. He is currently using crutches for ambulation.

SUMMARY/CONCLUSION: In addition to severe peripheral neuropathy, both the mother and son were found to have cognitive impairment and hearing loss. It is worth noting that neither the cognitive impairment nor the hearing loss were reported in the 1997 case. White matter lesions have been observed in the Trembler mouse model of CMT. This report extends the clinical spectrum of Dejerine–Sottas syndrome to involve the central nervous system and cranial nerves.

PREVALENCE OF ULNAR NERVE DISLOCATION PRIOR TO 90° OF ELBOW FLEXION AND SUBSEQUENT ELECTRODIAGNOSTIC IMPLICATIONS
Berdale Colorado (St. Louis, MO), Michael Bonnette (St. Louis, MO), Michael Sookochoff (St. Louis, MO), Seth Katzen (St. Louis, MO)

INTRODUCTION: The ulnar motor NCS is commonly performed at 90 degrees of elbow flexion to better correlate surface skin measurement and true nerve length. However, this assumes that the ulnar nerve is located in the epicondylar groove. Ulnar nerve dislocation occurring prior to 90 degrees of elbow flexion would impact distance measurements and subsequent nerve conduction velocity (NCV) values.

OBJECTIVE: To determine the prevalence of patients with ulnar nerve dislocation prior to 90 degrees of elbow flexion and determine effects on NCV across the elbow.

METHODS: A retrospective study was conducted on consecutive patients between August 2014 and August 2017 who underwent needle EMG/NCSs of the upper extremity in conjunction with nerve ultrasound. Data were collected regarding the presence of ulnar nerve subluxation/dislocation. For patients demonstrating dislocation prior to 90 degrees flexion, ulnar motor NCV across the elbow at 90 degrees flexion was compared with NCV at a position of elbow flexion prior to dislocation.

RESULTS: Of the 290 patients included, 48 (16.6%) were found to have ulnar nerve subluxation/dislocation on ultrasound. Of those, 20 (41.7%) had subluxation, and 28 (58.3%) had dislocation. Among patients with dislocation, 8 (28.6%) dislocated prior to 90 degrees of elbow flexion. In these patients, NCV across the elbow was slower by an average of 8±4 m/s when the elbow was placed in a position of elbow flexion prior to dislocation compared to the standard 90 degrees of elbow flexion.

SUMMARY/CONCLUSION: Ulnar nerve dislocation prior to 90 degrees of elbow flexion may overestimate NCV across the elbow when NCS is performed in a 90 degrees flexed position. Identifying ulnar nerve dislocation may reduce false–negatives when electrodiagnostically assessing for ulnar neuropathy at the elbow.
A CASE OF NERVE RECOVERY AFTER ALCOHOL CESSATION
Collin Grant (Columbus, OH), William Pease (Columbus, OH), Monal Desai (Columbus, OH)

INTRODUCTION: Of all the negative effects of excessive alcohol consumption, neuropathy is one of the most prevalent. The exact incidence is unclear, however studies using clinical and EDX evaluations suggest 25-66% of chronic alcoholics have some degree of neuropathy. It is unclear whether nerve recovery occurs after ceasing alcohol intake. In this report, we describe a case of EDX evidence that suggest ongoing denervation and reinnervation occurring simultaneously in a woman who reports 3 years of sobriety.

CASE REPORT: A middle aged woman presented to the outpatient clinic with tingling and numbness in her legs and fingers, as well as weakness in her legs and arms that began about 6 months ago. She had no history of trauma, diabetes, or thyroid issues. She does have a long history of alcoholism, but had been abstinent for 3 years. On physical examination, lower limb strength was normal other than slight weakness in the extensor hallucis longus bilaterally (4/5), and the upper limb was only weak in the bilateral abductor pollicis brevis (4/5). She was numb to light touch to the knees bilaterally. EDX examination showed abnormal needle EMG/NCSs, specifically a severe chronic distal predominant sensorimotor axonal peripheral neuropathy, with signs of reinnervation proximally and ongoing denervation more distally. These findings are most consistent with alcohol-related neuropathy, and the pattern suggests that some nerve regeneration has occurred.

CONCLUSION: Alcoholic neuropathy is an extremely prevalent and debilitating condition. This case demonstrates how EDX is an important tool in not only diagnosing the condition, but also in determining the severity and whether reinnervation is occurring.

NEUROMUSCULAR ULTRASOUND FOR DIAGNOSIS OF IATROGENIC RADIAL NERVE INJURY
Sarada Sakamuri (Palo Alto, CA), Thomas Wilson (Palo Alto, CA)

INTRODUCTION: Intraoperative radial nerve injury is an unusual complication of surgical repair of humerus shaft fractures. This iatrogenic injury can be misdiagnosed as a nerve palsy from the initial trauma. EDX studies cannot distinguish between iatrogenic and traumatic axonal injuries. In this context, neuromuscular ultrasound (NMUS) may help identify the etiology and guide treatment decisions.

OBJECTIVE: To demonstrate the value of NMUS in the workup of radial neuropathy after complex humeral trauma.

CASE REPORT: A 27-year-old woman was struck by a vehicle and suffered multiple major orthopedic traumas, including a comminuted right humeral midshaft fracture treated with open repair. She later noted severe right wrist and finger drop but, due to concussion, was unsure whether weakness began pre- or postoperatively. Neurological evaluation after 7 months revealed dense weakness and numbness in the right radial distribution. Needle EMG and NCSs revealed absent radial motor and sensory responses and no voluntary motor unit activity in the radial distribution distal to the triceps. NMUS of the nerve at the spiral groove demonstrated hypoechoic features and multiple metallic structures interrupting its course. Surgical exploration revealed direct impingement of the radial nerve by a cortical plate and screw, prompting immediate nerve graft repair.

SUMMARY/CONCLUSION: Radial nerve injuries due to impingement by orthopedic hardware may be erroneously attributed to the initial bony trauma, leading to a missed opportunity for early intervention. NMUS can identify help identify an intraoperative iatrogenic injury that may require nerve exploration and repair.
BRACHIAL PLEXOPATHY AFTER INFLUENZA VACCINATION IN ADULTS IN THE USA: A REPORT FROM THE CDC/FDA VACCINE ADVERSE EVENT REPORTING SYSTEM (1990-2017)
Nirav Sanghani (Newark, NJ), Shreya Shah (Boston, MA), Rajanigandhi Hanumanthu (Newark, NJ), Nizar Souayah (Newark, NJ)

INTRODUCTION: There are isolated reports of brachial plexopathy after influenza vaccination.

OBJECTIVE: To determine the rate and characteristics of brachial plexopathy after influenza vaccination in adults in the United States.

METHODS: Data from Vaccine Adverse Event Reporting System (VAERS) from 1990-2017 were used, and brachial plexopathy cases were classified as definite or possible. Definite cases had both clinical evidence and positive needle EMG/NCSs. Cases without neurophysiologic testing were classified as possible.

RESULTS: Data revealed 160 reported cases (75 men, 84 women, 1 unknown; mean age: 51.10±14.26 years, range: 18-81) of brachial plexopathy (84 definite, 76 possible). The reported rate of new post vaccination brachial plexopathy was 6/year. Onset after age 65 was found in 21%. Onset was within 2 weeks in 78% of cases, 3-6 weeks in 10.8%, and more than 6 weeks in 5% (average time of onset was 9.76±18.68 days). Hospitalization was required for 6.3%, and 17% experienced permanent disability. The average onset and distribution of brachial plexopathy after vaccination was significantly different from both non-plexopathy events after vaccination (9.76 versus 5.01 days, p<0.0001; 45% within 48 hours versus 77.23%, p<0.0001) and Guillain–Barré syndrome after vaccination (9.76 versus 21.74, p<0.0001; 45% within 48 hours versus 11%, p<0.0001).

SUMMARY/CONCLUSION: Although the reporting rate of post influenza vaccination plexopathy is within the range expected in the general population, the unbalanced distribution in the first 6 weeks post vaccination suggests that the association may not be entirely coincidental. Continuous active monitoring of post vaccination plexopathy is recommended.

Nirav Sanghani, MD, DM
Resident and Fellow Member Award Recipient

IMMUNOTHERAPY RESPONSIVE INTESTINAL PSEUDO-OBSTRUCTION IN THYMOMA AND MYASTHENIA GRAVIS: A CASE STUDY
Chelsea Zale (Cincinnati, OH), Hani Kushlaf (Cincinnati, OH)

INTRODUCTION: Intestinal pseudo-obstruction is becoming more recognized as a clinical syndrome in patients with thymoma and myasthenia gravis (MG). Due to limited case reports, clinical outcome and management of these patients have yet to be established. We report a patient who had resolution of the intestinal pseudo-obstruction after thymectomy, steroids, IV immunoglobulin (IVIg), and plasma exchange (PE).

OBJECTIVE: To describe clinical characteristics, course, and management of a patient who developed intestinal pseudo-obstruction in the setting of thymomatous MG.

CASE REPORT: A 44-year-old male presented with 3 weeks of left ptosis, mild intermittent diplopia, and difficulty with mastication. A week after the onset of myasthenia symptoms, he developed nausea/vomiting, and abdominal pain/distention. Anti-acetylcholine receptor and striational antibodies were positive. Computed tomography of the chest showed a heterogeneous anterior mediastinal mass consistent with thymoma. He was started on pyridostigmine with marked improvement of myasthenia symptoms but his gastrointestinal symptoms continued to progress over a month to the point of inability to tolerate oral/tube feeding and obstipation. He was started on parenteral nutrition and given 2 g/kg IVIg over 5 days. Afterwards, he underwent thymectomy, and the pathology was diagnostic of thymoma type B2/B3. This was followed by PE every other day for 5 treatments, then weekly thereafter. He was also given IV Solu-Medrol® with a switch to oral prednisone once he was able. His gastrointestinal symptoms improved gradually, with complete resolution in 3.5 months.

SUMMARY/CONCLUSION: Intestinal pseudo-obstruction in patients with thymomatous MG may respond to immunotherapy and thymectomy with complete resolution of symptoms.

Chelsea Zale, DO
Resident and Fellow Member Award Recipient
HIGH PREVALENCE OF OSTEOPOROSIS AND OSTEOPENIA IN ADULT MYASTHENIA GRAVIS PATIENTS: A PILOT STUDY FROM AN ACADEMIC INSTITUTION IN CENTRAL PENNSYLVANIA

Nadia Bowling (Hershey, PA), Sankar Bandyopadhyay (Hershey, PA)

INTRODUCTION: Osteoporosis (OP) and osteopenia are largely underdiagnosed conditions. Scattered reports of prevalence of OP in patients with neurological disorders have been published. A mouse model study of OP has shown progressive trabecular bone loss with progression of neuromuscular conditions. Such data for OP and osteopenia for adult myasthenia patients in the United States are lacking.

OBJECTIVE: To study the prevalence of OP and osteopenia in patients with myasthenia gravis seen in an academic neuromuscular clinic in central Pennsylvania.

METHODS: In this institutional review board-approved retrospective study, 33 consecutive adult patients (18 women, 15 men) with myasthenia gravis, diagnosed by serology or single fiber EMG, after random scheduling, had baseline bone mineral density (BMD) tests performed from the lumbar spine and femoral neck at the onset of diagnosis.

RESULTS: Five patients had OP (15%); 12 had osteopenia (36%), and 16 had normal BMD testing (49%). The majority (51%) had an abnormal test: 7/15 men (47%) and 10/18 women (55%). Results were statistically significant.

SUMMARY/CONCLUSION: This study showed a surprisingly high prevalence of OP and osteopenia in patients with myasthenia gravis, independent of any known longterm similar effects of prednisone therapy. Large multicenter studies are worth contemplating as this can turn out to be an undiagnosed pandemic. OP can result in plummeted quality of life, pain, and fractures, which are potentially preventable if accurate and holistic diagnoses are made in a timely way.

PLASMAPHERESIS VERSUS INTRAVENOUS IMMUNOGLOBULIN VERSUS STEROIDS IN THE TREATMENT OF MYASTHENIA GRAVIS CRISIS. A NEW YORK STATE PLANNING AND RESEARCH COOPERATION SYSTEM DATABASE ANALYSIS (1998-2014)

Shuja Sheikh (Wharton, NJ), Janaki Patel (Newark, NJ), Hael Abdulrazeq (Newark, NJ), Abu Nasar (Newark, NJ), Nizar Souayah (Newark, NJ)

INTRODUCTION: Plasma exchange (PE), IV immunoglobulin (IVIg), and corticosteroids have been used for the treatment of myasthenia gravis (MG) crisis.

OBJECTIVE: To investigate the use of IVIg, corticosteroids, and PE in the treatment of MG crisis.

METHODS: We used New York Statewide Planning and Research Cooperation System database for the 1998-2014 period. Data were analyzed using IBM PSPP software.

RESULTS: Treatment was given to 969 patients with MG crisis, of which 51.7% received IVIg, 43% PE, and 5% steroids. More patients treated with PE were diagnosed with respiratory failure as compared to IVIg treated patients (23% versus 13%, p<0.001). PE treated patients also required more mechanical ventilation (>96 hours) and tracheostomy as compared to IVIg treated patients (20% versus 5%; and 7% versus 2% respectively, p<0.007). The average length of stay in the PE group was significantly higher than the IVIg and steroids groups (11 days versus 5 days versus 6 days, respectively, p<0.001). The average charges were significantly higher in the PE group compared to those treated with IVIg or steroids ($114,400 versus $84,200 versus $61,500, respectively, p<0.001). There was no significant increase in mortality in PE treated patients as compared to IVIg or steroids.

SUMMARY/CONCLUSION: The average length of stay and hospitalization charges of MG crisis patients were significantly higher in patients treated with PE compared to those treated with IVIg and steroids. Work is in progress to investigate influence of comorbid conditions on therapeutic intervention efficacy.

Shuja Sheikh, MD
Resident and Fellow Member Award Recipient
DISPOSITION OF PATIENTS DIAGNOSED WITH MYASTHENIA GRAVIS CRISIS, A NEW YORK STATE PLANNING AND RESEARCH COOPERATION SYSTEM DATABASE ANALYSIS (1998-2014)
Shuja Sheikh (Wharton, NJ), Janaki Patel (Newark, NJ), Hael Abdulrazeq (Newark, NJ), Abu Nasar (Newark, NJ), Nizar Souayah (Newark, NJ)

INTRODUCTION: Plasma exchange (PE), IV immunoglobulin (IVIg), and corticosteroids have been used for the treatment of myasthenia gravis (MG) crisis.

OBJECTIVE: To investigate the relationship between the type of therapeutic intervention and disposition of patients diagnosed with MG crisis.

METHODS: We utilized data from the New York Statewide Planning and Research Cooperation System database between 1998 and 2014. Data were analyzed using IBM PSSP software.

RESULTS: Treatment was given to 969 patients with MG crisis, of which 51.7% received IVIg, 43% PE, and 5% steroids. Significantly more patients treated with PE were discharged to a skilled nursing facility/short term hospital when compared to IVIg (43% versus 28%, p<0.001) or died/hospice-home (6% versus 4%, p<0.001). Home discharge was significantly higher in the group treated with IVIg compared to the groups treated with PE and steroids (69% versus 52% versus 55%, respectively, p<0.001). Discharge to a skilled nursing or short-term hospital was lower in IVIg treated patients as compared to PE and steroids (28% versus 43% versus 43%, respectively, p<0.001). Death or hospice-home discharge was not significantly higher in PE treated patients as compared to IVIg and steroids (6% versus 4% versus 2%, respectively, p=0.268).

SUMMARY/CONCLUSION: Discharge to home was significantly higher in patients diagnosed with MG crisis treated with IVIg relative to those treated with PE and steroids.

Shuja Sheikh, MD
Resident and Fellow Member Award Recipient

MYASTHENIA GRAVIS THERAPEUTIC INTERVENTION CHARGES COMPARISON. A NEW YORK STATE PLANNING AND RESEARCH COOPERATION SYSTEM DATABASE ANALYSIS (1998-2014)
Janaki Patel (Newark, NJ), Shuja Sheikh (Newark, NJ), Hael Abdulrazeq (Newark, NJ), Abu Nasar (Newark, NJ), Nizar Souayah (Newark, NJ)

INTRODUCTION: Plasma exchange (PE), IV immunoglobulin (IVIg), and corticosteroids have been used for the treatment of myasthenia gravis (MG) crisis.

OBJECTIVE: To investigate the charges of IVIg, steroids, and PE in myasthenia gravis (MG) crisis treatment.

METHODS: We utilized data from the New York Statewide Planning and Research Cooperation System database between 1998-2014. Data were analyzed using IBM PSSP software.

RESULTS: Treatment was given to 969 patients over the age of 18 with MG crisis, of which 51.7% received IVIg, 43% PE, and 5% steroids. There was a significant difference in average total charge in mechanically ventilated as compared to non-mechanically ventilated patients in the PE, IVIg, and steroid treated groups ($208,297 versus $67,287, $178,715 versus $68,710, and $124,639 versus $47,888, respectively, p<0.05). In non-mechanically ventilated patients, the average total charges of both IVIg and PE were significantly greater when compared to steroids ($68,710 and $67,287 versus $47,888, respectively, p<0.001). In non-mechanically ventilated patients greater than 65 years old, the average total charge of IVIg and PE is significantly greater than that of steroids ($78,751 and $78,202 versus $38,735, respectively, p<0.001).

SUMMARY/CONCLUSION: Hospitalization charges of MG crisis depend on disease severity and treatment modality with the highest charges observed in the subgroup of those mechanically ventilated and treated with PE.
CO-OCCURRENCE OF SERONEGATIVE MYASTHENIA GRAVIS AND COMMON VARIABLE IMMUNODEFICIENCY DISEASE—BOTH AN OPPORTUNITY FOR PROPER DIAGNOSIS AND A CHALLENGE FOR THERAPY

George Small (Pittsburgh, PA)

INTRODUCTION: Seronegative myasthenia gravis (MG) is a problematic disease state for both the treating clinician and patient. It creates dilemmas regarding misdiagnosis and overtreatment, and is the subject of studies searching for other pathogenic antibodies targeting the neuromuscular junction and endplate. Of the purported 40,000-50,000 myasthenia patients in the United States, 3000-5000 may be seronegative by commonly available commercial assays. Our neuromuscular clinic has further identified 2 patients with seronegative, generalized MG, electrophysiologically verified, along with common variable immunodeficiency disorder (CVID). Such an immune-impaired condition complicated by a neuromuscular junction disorder presents opportunities and challenges in developing proper therapeutic planning.

OBJECTIVE: To highlight the rare concurrence of an autoimmune neuromuscular disease with an immunodeficiency state, complicating therapeutic decision making, particularly in the seronegative MG state.

CASE REPORTS: Both patients maintain independent ambulation, normal consistency diets, and improvement in diplopia, ptosis, and respiratory function, 1 with pyridostigmine and IV immunoglobulin (IVIg) therapy, the other with IVIg, rituximab, and plasma exchange. MG diagnosis was delayed in both individuals because of their lack of specific MG antibodies, and their physicians’ initial skepticism.

SUMMARY/CONCLUSION: Both patients came to adequate therapy because of their own persistence in ensuring a complete workup for MG, despite their seronegative states. MG prevalence is likely higher than reported, particularly in CVID, which occurs with other autoimmune conditions that are seronegative due to the immunopathology of CVID itself, where antibody production is impaired.

NEUROMUSCULAR TRANSMISSION DEFECTS IN MYOPATHIES: RARE BUT WORTH SEARCHING FOR?

Behzad Elahi (Rochester, MN), Ruple Laughlin (Rochester, MN), William Litchy (Rochester, MN), Margherita Milone (Rochester, MN), Teerin Liewluck (Rochester, MN)

INTRODUCTION: Decrement of motor responses with repetitive nerve stimulation (RNS) is a cornerstone of the diagnosis of neuromuscular junction disorders. Recently, decrement was reported in a few hereditary muscle disease patients, who responded favorably to pharmacological augmentation of neuromuscular transmission.

OBJECTIVE: To determine the frequency of decrement in a cohort of myopathy patients.

METHODS: We reviewed all patients seen in our electrophysiology laboratory referred for myopathy who also underwent RNS from January 1, 2007, to May 31, 2017. We included all patients with decrement (>10%) and either pathological or molecular diagnosis of myopathies.

RESULTS: We identified 258 patients with a pathological or molecular diagnosis of myopathies who underwent RNS. Among this group, 5 patients had abnormal decrement, including 2 patients with biopsy-proven congenital myopathies (1 centronuclear myopathy, 62% decrement, with a single truncated TTN gene variant and 1 multiminicore disease, 16% decrement, with 2 RAPSN variants), 2 patients with combined inflammatory myopathy and hydroxychloroquine-associated myopathy (both, 18% decrement), and 1 distal myopathy patient (34% decrement) with a single truncated TTN variant. The patients with centronuclear and multiminicore pathology responded to pyridostigmine or a combination of pyridostigmine and albuterol, respectively; both tested negative for acetylcholine receptor antibodies. The distal myopathy patient failed to respond to pyridostigmine. No patient with an acquired myopathy received pharmacological treatment.

CONCLUSION: Despite the rare occurrence of decrement in myopathy, its presence may indicate treatment responsiveness and urge consideration of pharmacological intervention.

Behzad Elahi, MD, PhD
Resident and Fellow Member Award Recipient
ECULIZUMAB SHOWS CONSISTENT IMPROVEMENT ACROSS QUANTITATIVE MYASTHENIA GRAVIS TEST MUSCLE GROUPS
Renato Mantegazza (Milan, Italy), Kenji Fujita (New Haven, CT), Fanny O’Brien (New Haven, CT), James Howard, Jr. (Chapel Hill, NC)

INTRODUCTION: The physician-reported quantitative myasthenia gravis (QMG) test was a key efficacy measure in the 26-week, phase 3, randomized, double-blind, placebo-controlled REGAIN study of patients with anti-acetylcholine receptor antibody-positive myasthenia gravis (gMG). Ocular and generalized weakness have previously shown different degrees of response to various therapies, including prednisone and IV immunoglobulin therapy/plasma exchange. However, using the patient-derived MG activities of daily living (MG-ADL) scale during REGAIN, eculizumab treatment showed a consistent trend toward rapid and sustained improvement across all 4 domains (bulbar, respiratory, limb, and ocular).

OBJECTIVE: To evaluate the effect of eculizumab on different muscle groups during REGAIN using the QMG test.

METHODS: Changes in QMG domain scores from baseline to week 26 were determined for patients whose QMG scores were abnormal at baseline. Repeated-measures analyses of QMG scores were performed for bulbar (swallowing and speech), respiratory (forced vital capacity), gross motor (limb and axial motor items), and ocular (ocular and facial muscles) domains.

RESULTS: Eculizumab-treated patients showed improvements in all QMG domain scores from baseline to week 26. Rapid, sustained improvements were demonstrated across all 4 QMG domains, with a trend towards significant differences between eculizumab and placebo at week 26 (bulbar, p=0.0628; respiratory, p=0.0682; gross motor, p=0.0114; ocular, p=0.0017). The safety profile of eculizumab was consistent with previous reports.

SUMMARY/CONCLUSION: Unlike other therapies, eculizumab demonstrated a consistent clinical response across all muscle groups measured using the QMG. This was in agreement with previously reported MG-ADL findings with eculizumab. (NCT01997229)
MINIMAL MANIFESTATIONS WITH ECULIZUMAB IN MYASTHENIA GRAVIS
Renato Mantegazza (Milan, Italy), Gil Wolfe (Buffalo, NY), Srikanth Muppidi (Stanford, CA), Heinz Wiendl (Minster, Germany), Kenji Fujita (New Haven, CT), Fanny O’Brien (New Haven, CT), James Howard, Jr. (Chapel Hill, NC)

INTRODUCTION: Patients with anti-acetylcholine receptor antibody-positive (AChR+) refractory generalized myasthenia gravis (gMG) continue to experience significant unresolved morbidities and increased risk of exacerbations and hospitalizations, after treatment with multiple therapies.

OBJECTIVE: To determine whether eculizumab would help these patients achieve minimal manifestations as evaluated by the MG Foundation of America Post-intervention Status (PIS).

METHODS: Patients with AChR+ refractory gMG were enrolled in the 26-week, phase 3, randomized, double-blind, placebo-controlled REGAIN study of the efficacy and safety of eculizumab. Those who completed REGAIN could participate in the open-label extension study. PIS, including achievement of minimal manifestations, was assessed at REGAIN weeks 4, 12, and 26 and open-label study week 26 and reported using descriptive statistics.

RESULTS: At REGAIN week 26, 34/56 eculizumab-treated patients (61%) had a PIS status of improved and 14 (25%) achieved minimal manifestations; 25/59 placebo-treated patients (42%) had a PIS of improved, with 8 (14%) achieving minimal manifestations. Improvements from REGAIN baseline to open-label study week 26 (September 2016 cutoff) were similar for the placebo/eculizumab and eculizumab/eculizumab groups. A PIS of improved was achieved by 75/104 (72%) patients (eculizumab/eculizumab, 35/48 [73%]; placebo/eculizumab, 40/56 [71%]). Minimal manifestations was achieved by 48/104 (46%) patients (eculizumab/eculizumab, 21/48 [44%]; placebo/eculizumab, 27/56 [48%]). The longterm safety profile of eculizumab was consistent with previous reports.

SUMMARY/CONCLUSION: Eculizumab treatment was associated with a higher proportion of patients achieving minimal manifestations compared with placebo. By open-label study week 26, similar proportions of patients in the eculizumab/eculizumab and placebo/eculizumab groups had achieved minimal manifestations. (NCT01997229, NCT02301624)

ECULIZUMAB REDUCES MYASTHENIA GRAVIS EXACERBATION RATES
Saiju Jacob (Birmingham, United Kingdom), Jeffrey Guptill (Durham, NC), Andreas Meisel (Berlin, Germany), Kenji Fujita (New Haven, CT), Kaushik Patra (New Haven, CT), James Howard, Jr. (Chapel Hill, NC)

INTRODUCTION: Patients with anti-acetylcholine receptor antibody-positive (AChR+) refractory generalized myasthenia gravis (gMG) experience exacerbations that can lead to hospitalizations. In AChR+ gMG, complement activation and formation of membrane attack complex/terminal complement complex are central to neuromuscular junction pathology and chronic disease morbidity. Eculizumab uniquely targets and inhibits terminal complement activation.

OBJECTIVE: To evaluate the effect of eculizumab on exacerbation rates in patients with AChR+ refractory gMG.

METHODS: Eculizumab efficacy and safety in AChR+ refractory gMG patients were assessed in the 26-week, phase 3, randomized, double-blind, placebo-controlled REGAIN study. Patients who completed REGAIN could enter the open-label extension. Exacerbations were defined as all events of clinical worsening/deterioration, MG crises, or requirement for rescue therapy. Occurrences of exacerbations/MG crises before REGAIN were as defined in patient records. Exacerbation rates adjusted for patient years were estimated for the year before study entry (REGAIN, n=125), during REGAIN (placebo, n=63), and during REGAIN and the open-label study (all eculizumab exposure combined; n=123 [56/62 eculizumab- and 61/63 placebo-treated patients entered the extension]). Event rates were compared using a Poisson regression model.

RESULTS: There was a 56% relative reduction in exacerbation rates with eculizumab compared with placebo (p=0.0409), and a 66% relative reduction compared with the year before REGAIN entry (p=0.0008). The eculizumab longterm safety profile was consistent with that previously reported.

SUMMARY/CONCLUSION: Eculizumab reduced exacerbation rates in patients with AChR+ refractory gMG, suggesting that elevated complement activation may contribute to the ongoing risk of exacerbations in this population. (NCT01997229, NCT02301624)
IS MYASTHENIA GRAVIS ASSOCIATED WITH VACCINATION: A REPORT FROM THE CDC/FDA VACCINE ADVERSE EVENT REPORTING SYSTEM (1990-2017)

Nirav Sanghani (Newark, NJ), Nizar Souayah (Newark, NJ), Rajanigandhi Hanumanthu (Newark, NJ), Shreya Shah (Newark, NJ)

INTRODUCTION: There are isolated case reports of myasthenia gravis (MG) occurring after vaccination.

OBJECTIVE: To determine the rate and characteristics of MG after vaccination in adults in the United States.

METHODS: Adult MG cases ascertained from the Vaccine Adverse Event Reporting System from 1990 to 2017 were classified into definite or possible according to strict criteria.

RESULTS: There were 71 MG cases (36 men, 34 women, 1 unknown; mean age: 49.0±18.9 years, range: 18-84) reported (definite 57, possible 14). The reported rate of new post-vaccination MG was 2.1/1,00,000/year; 73.6% of definite cases were newly diagnosed as MG after vaccination. The onset was within 6 weeks of vaccination in 77% (55) with an average onset at 10.0±10.7 days. Most commonly associated vaccines were influenza (36%) followed by hepatitis B (24%). Hospitalization was required by 25% of definite MG patients who experienced myasthenia crisis. Crisis was the presenting feature in 31% of newly diagnosed MG. The onset of myasthenia symptoms after vaccination was significantly different from non-MG events (15.8±21.9 versus 7.5±18.6 days, p<0.005) and similar to onset of Guillain–Barré syndrome after vaccination (15.8±21.9 versus 15.6±14.1 days, p 0.95).

SUMMARY/CONCLUSION: Although the results suggest that the reporting rate of post-vaccination MG overlaps with its incidence in the general population, the occurrence of most cases within 6 weeks after vaccination indicates that some cases could have been triggered by vaccination. The presentation with myasthenic crisis was more common than reported by most of the studies (31% versus 20%). These findings warrant continuous and careful analysis and monitoring for MG after vaccination.

Nirav Sanghani, MD, DM
Resident and Fellow Member Award Recipient

OVERLAP OF MYASTHENIA GRAVIS AND MYOSITIS IS A COMMON ETIOLOGY OF NEUROMUSCULAR WEAKNESS ASSOCIATED WITH IMMUNE CHECKPOINT INHIBITOR THERAPY IN A MULTICENTER RETROSPECTIVE STUDY OF 15 PATIENTS

Amanda Guidon (Boston, MA), Shruti Raja (Durham, NC), Divyanshu Dubey (Boston, MA), Nathan Clement (Boston, MA), Kerry Reynolds (Boston, MA), Jeffrey Guptill (Durham, NC), William David (Boston, MA)

INTRODUCTION: Immune-related myasthenia gravis (irMG) and myositis (irMyositis) are rare complications of immune checkpoint inhibitor (ICI) therapy. The phenotypic range is emerging.

OBJECTIVE: To describe the spectrum of irMG and irMyositis.

METHODS/RESULTS: This retrospective analysis (2014-2018) included the clinical, EDX, laboratory, and histopathological features of 15 patients (median age: 69 years, range: 32-81). ICIs included antibodies (Abs) to cytotoxic T-lymphocyte-associated protein 4, programmed cell death 1, and its ligand. Median ICI doses prior to developing toxicity was 2 (range: 1-23). Definite overlap irMG/irMyositis (6) was most common, followed by irMyositis (4), irMG (2), probable overlap (2), and probable irMyositis (1). Dyspnea (10) and/or dysphagia (8) were common presenting symptoms; examination frequently revealed ocular (11) and proximal limb weakness (10). Acetylcholine receptor Abs were rare (4). Peak creatine kinase was >400 IU/L in 10 patients. Repetitive nerve stimulation was abnormal in 3/4, single fiber EMG in 6/9. EDX diagnosis was myopathic (2), neuromuscular transmission disorder (NMTD) (3), mixed myopathic/ NMTD (6), and normal (3). Inflammatory features characterized 4/5 muscle biopsies. Nine had myocarditis/ arrhythmias. All but 1 received ≥1 of the following: pyridostigmine, corticosteroids, IV immunoglobulin, plasma exchange, or rituximab. Neuromuscular symptoms improved in 12/14, completely in 6. irMyasthenia/irMyositis contributed to 3/5 deaths.

SUMMARY/CONCLUSION: Weakness with dysphagia or dyspnea in ICI-exposed patients should prompt consideration of irMG/irMyositis, which commonly overlap. Since individual tests may be normal, diagnosis requires a high index of suspicion and synthesis of all data. Jitter studies or muscle biopsy may be required for accurate diagnosis and to allow for prompt treatment.
GENDER DIFFERENCE IN PREDNISONE ADVERSE EFFECTS: FROM THE RANDOMIZED TRIAL OF THYMECTOMY IN MYASTHENIA GRAVIS DATABASE
Ikjae Lee (Birmingham, Alabama), Henry Kaminski (Washington, DC), Tarrant McPherson (Birmingham, AL), Hui-Chien Kuo (Birmingham, AL), Gary Cutter (Birmingham, AL)

INTRODUCTION: Prednisone is a first line immunosuppressive treatment for myasthenia gravis (MG) and the adverse effects are common. Gender difference in prednisone adverse effects among MG patients has not been systematically evaluated.

OBJECTIVE: To compare the frequency and intolerability of prednisone associated adverse effects by examining the Randomized Trial of Thymectomy in Myasthenia Gravis (MGTX) database.

METHODS: Basic demographic information and treatment associated symptoms (TASs) were extracted from the MGTX database. The frequency and the distress level of the 28 individual TASs were calculated and compared between men and women.

RESULTS: A total of 123 participants—65 (49 women) in the thymectomy plus prednisone (TPP) group and 58 (39 women) in the prednisone alone (PA) group—have completed 1829 TAS reports. Women were younger than men (33.0 years versus 39.1 years, p=0.009). Followup TAS report numbers were comparable between men and women (15.0 versus 14.8). Time-weighted average alternate-day prednisone doses were comparable between men and women in both groups. TASs were more common and commonly distressing for women compared to men (95% versus 88%, 89% versus 81%, respectively, p<0.0001). Back pain, changed appearance, headache, moon face, and palpitation were more commonly reported and more distressing for women. Fatigue and poor vision were more commonly reported and distressing for men, while increased appetite was more commonly reported in men but more distressing for women.

CONCLUSION: TASs are common in MG patients treated with prednisone, more frequent and distressing for women. Our results may assist in counseling patients receiving chronic corticosteroid therapy.

PEDIATRIC MYASTHENIA GRAVIS AFTER VACCINATION IN THE UNITED STATES: A REPORT FROM THE CDC/FDA VACCINE ADVERSE EVENT REPORTING SYSTEM (1990-2017)
Nirav Sanghani (Newark, NJ), Rajanigandhi Hanumanthu (Newark, NJ), Shreya Shah (Newark, NJ), Nizar Souayah (Newark, NJ)

INTRODUCTION: Pediatric myasthenia gravis (PMG) triggered by infections have been reported. The occurrence or exacerbation of PMG after vaccination has not been studied.

OBJECTIVE: To determine rate and characteristics of PMG after vaccination in the United States.

METHODS: Data from Vaccine Adverse Event Reporting System (VAERS) during 1990-2017 were used. PMG cases for those younger than 18 were classified into definite or possible according to strict criteria. Congenital myasthenia syndromes were excluded.

RESULTS: A total of 33 cases of PMG (8 boys, 24 girls, 1 unknown; mean age: 9.59±5.41 years, range: 2.4 months-18 years) were reported (definite 20, possible 13). The reporting rate of PMG after vaccination was 1.2/1,00,000 per year; 94% of patients were newly diagnosed with PMG after vaccination. The onset was within 6 weeks of vaccination in 45% of cases (86% of them within 2 weeks). Most common associated vaccines were human papillomavirus (45.5%) followed by hepatitis A/B (27.3%). Myasthenia crisis occurred in 24.3%; crisis was the presenting feature in 22.5% of newly diagnosed PMG. The presentation was ocular in 34.3% and generalized in rest.

SUMMARY/CONCLUSION: Although the reporting rate of PMG after vaccination is in the range expected in the general population, the unbalanced distribution of cases in the first 6 weeks after vaccination suggests that some cases could have been triggered by vaccination and warrants continuous monitoring of PMG after vaccination.

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Resident and Fellow Member Award Recipient
201
PREDNISONE ADVERSE EFFECTS ARE COMMON AND ASSOCIATED WITH UNWILLINGNESS TO ACCEPT A DOSE INCREASE: SURVEY RESULT FROM MYASTHENIA GRAVIS FOUNDATION OF AMERICA REGISTRY
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INTRODUCTION: Prednisone is a first-line immunosuppressive treatment for myasthenia gravis (MG). Short and longterm adverse effects of corticosteroids are a limiting factor in the treatment of MG.

METHOD: The MG patient registry is a patient-driven, nationwide database with patients aged ≥18 years who were diagnosed with MG and live in the United States. Custom designed “prednisone-steroid use and MG” survey was sent out to MG registry participants as part of semiannual followup. Data were collected and analyzed for frequency.

RESULTS: Of the 398 MG participants who completed the survey (173 men, 225 women), 298 reported current (174) or past (288) prednisone intake. Current prednisone dosage varied 0.5-75 mg (median 10 mg, interquartile range [IQR] 7-20); dosing frequency was daily in 132 (76%) and every other day in 31 (18%). Peak prednisone dose was commonly between 20-60 mg (median 50 mg, IQR 25-60); however, doses over 60 mg daily was reported in 59 (20%). Prednisone adverse effects were reported more commonly in women (95% versus 81%, p<0.0001). Women reported more intolerable adverse effects (77% versus 50%, p<0.00001) and less willingness to accept a dose increase (26% versus 44%, p=0.03) compared to men.

CONCLUSION: Prednisone is commonly used in the treatment of MG, with highly variable dosages and dosing frequencies reflecting the absence of a standard guideline. Intolerable adverse effects were more commonly reported among women and was associated with unwillingness to accept a dose increase. Consensus guidelines and their validation are required to guide prednisone treatment for MG.

202
TIMING OF DECREMENTAL RESPONSE IN RNS
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INTRODUCTION: An evaluation up to 6 minutes during repetitive nerve stimulation (RNS) is suggested to detect a maximal decrement at 2-4 minutes postexercise for myasthenia gravis (MG) diagnosis. However, there are no studies that analyze if shorter timing would be sufficient to detect a decrement >10%.

OBJECTIVE: To evaluate if RNS up to 2 minutes postexercise is sufficient to detect a significant decrement response. In addition, we evaluated sensitivities and specificities using different decrement cutoff values for RNS.

METHODS: A retrospective chart review of patients referred for evaluation of symptoms suggestive of MG between January 2013 to September 2017 were identified from a neuromuscular database at the University of Kansas Medical Center using the medically unexplained symptoms and ICD-10 codes. Patients were divided in MG and control groups. Clinical, demographic, laboratory, and EDX information were obtained. Frequencies and percentages were used to represent gender, clinical, serologic, and EDX information. T-test and chi-square tests were used to compare numerical and categorical variables.

RESULTS: A total of 76 MG patients and 100 control subjects were identified. Decrement >10% was detected in 95% of MG patients with abnormal RNS within 2 minutes postexercise. Specificities of >95% accepting cutoff of >9% for facial and accessory nerves and >7% for ulnar nerve were observed in our study accompanied by an increase of sensitivities at these points.

SUMMARY/CONCLUSION: RNS up to 2 minutes postexercise might be sufficient to detect a significant decrement in MG patients. Additionally, a cutoff value of <10% might be acceptable for facial, ulnar, and accessory RNS for MG diagnosis.
RESPONSE TO ECUЛИZУMAB IN MYASTHENIA GRAVIS PATIENTS RECENTLY TREATED WITH CHRONIC IVIG
Saiju Jacob (Birmingham, Alabama), Hiroyuki Murai (Narita, Japan), Kimiaki Utsugisawa (Hanamaki, Japan), Richard Nowak (New Haven, CT), Heinz Wiendl (Münster, Germany), Kenji Fujita (New Haven, CT), Fanny O’Brien (New Haven, CT), James Howard, Jr. (Chapel Hill, NC)

INTRODUCTION: Chronic IV immunoglobulin (IVIg) may be used to treat patients with refractory myasthenia gravis (MG). The phase 3, randomized, double-blind, placebo-controlled REGAIN study evaluated the efficacy and safety of eculizumab in patients with anti-acetylcholine receptor antibody-positive refractory generalized MG.

OBJECTIVE: To investigate response to eculizumab compared with placebo in patients who received chronic IVIg before REGAIN entry.

METHODS: IVIg treatment was not permitted during REGAIN, except as rescue therapy, and patients previously treated with IVIg underwent a 4-week washout period before randomization. Patients were included in this subgroup analysis if they had received chronic IVIg 4 or more times in 1 year, with at least 1 dose occurring during the 6 months before REGAIN. Exacerbations and changes in MG status were assessed.

RESULTS: Of the 18 patients (eculizumab 9, placebo 9), 4 experienced exacerbations (1 received eculizumab, 3 received placebo). Clinically relevant improvements were numerically larger for eculizumab-treated patients than for placebo, respectively (mean change, standard deviation: MG activities of daily living score [MG-ADL], −5.3 [4.0] versus −2.1 [2.8]; quantitative MG score [QMG], −4.1 [6.1] versus −1.3 [3.5]). More patients who received eculizumab (7/9) had a clinically meaningful response (by ≥3 points for MG-ADL and/or ≥5 points for QMG) versus placebo (3/9). The eculizumab safety profile was consistent with previous reports. An open-label extension of REGAIN is ongoing; interim data (December 2017) will also be presented.

SUMMARY/CONCLUSION: With eculizumab treatment, there was a trend toward meaningful clinical improvements and fewer exacerbations, compared with placebo, in patients who previously received chronic IVIg. (NCT01997229, NCT02301624)

3,4 DIAMINOPYRIDINE IMPROVES DOK-7 CONGENITAL MYASTHENIC SYNDROME WEAKNESS: CLINICAL EXPERIENCE IN TWO PATIENTS

INTRODUCTION: Autosomal recessive DOK7 congenital myasthenic syndrome (CMS) has variable onset and severity with progressive course of limb-girdle pattern of weakness with ambulatory and respiratory difficulties. Ventilatory failure may occur by the third decade. Albuterol employed orally is commonly utilized for respiratory insufficiency. Patients with DOK7 deficiency may benefit from 3,4-diaminopyridine (3,4-DAP) up to 1 mg/kg/day.

OBJECTIVE: To describe treatment challenges in DOK7 CMS and clinical response to 3,4-DAP in 2 siblings with progressive worsening of muscle weakness including respiratory insufficiency.

METHODS: Two siblings, a brother and a sister, 45 and 41 years old, respectively, developed exercise intolerance and ambulatory difficulty during childhood. The sister had more severe phenotype with delayed motor milestones and axial muscle weakness requiring extensive spinal fusion as a teenager. Both patients’ symptoms worsened with acetylcholinesterase inhibitors.

RESULTS: Both were diagnosed genetically with DOK7 CMS as teenagers, and placed on oral albuterol 4 mg 3/day with benefit. During her pregnancy, she went into myasthenic crisis requiring intubation and feeding tube placement. Both patients are presently ambulatory without assistance. The brother has been dependent on bilevel positive airway pressure, while the sister is not using it, although indicated. Introduction of 3,4-DAP 60-80 mg/day has provided a burst of energy and sustained improvement of stamina and respiratory status for both patients (pre-3,4-DAP forced vital capacity (FVC) <40% to post-3,4-DAP FVC 50% of predicted normal value).

SUMMARY/CONCLUSION: 3,4-DAP can be effective in stabilizing and potentially improving DOK7 CMS symptoms.
**206**

**MEDIAN NERVE REPETITIVE SIMULATION IN MYASTHENIA GRAVIS**

*Tiffany Lee (Brecksville, OH), Yuebing Li (Cleveland, OH)*

**INTRODUCTION:** Studies suggest that repetitive nerve stimulation (RNS) of distal nerves (commonly ulnar) appears less sensitive than proximal nerves (commonly spinal accessory [SA] or facial nerves) in myasthenia gravis (MG) patients. In our laboratory, median nerve is routinely studied in RNS.

**OBJECTIVE:** To compare the yield of median RNS to that of SA and facial nerves. To determine if RNS findings in the median nerve is influenced by the occurrence of carpal tunnel syndrome (CTS).

**METHODS/RESULTS:** Of 448 patients in this retrospective analysis who received RNS during 2010-2016, 110 carried MG diagnosis. Abnormal RNS (decrement >10% in 1 nerve) was seen in 33/93 median, 33/97 SA, and 48/97 facial nerves. Among 62 MG patients with abnormal RNS, abnormalities were seen in 33/54 median, 33/55 SA, and 48/58 facial nerves. RNS of median and SA nerves were both performed in 52 of these 62 MG patients, with abnormalities seen in both nerves in 20 median nerve alone in 10, and SA nerve alone in 7. More significant decrement (defined >5% difference in maximal decrement between nerves) was seen in the median nerve in 19 and the SA nerve in 11 patients. Six of 33 patients with abnormal median RNS had EDX evidence of CTS similar to the incidence in patients with normal median nerve RNS study (30/324, p=0.10).

**SUMMARY/CONCLUSION:** Diagnostic yield of median RNS is comparable and complementary to that of SA. Notwithstanding a lack of direct comparison, our data suggest that median RNS may be of better yield to ulnar based on previously published data. No significant association exists between the occurrence of CTS and abnormal median RNS. As median RNS is easier to perform it should be commonly used in MG patients.

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**205**

**LRP4-POSITIVE MYASTHENIA GRAVIS WITH CONCOMITANT AXIAL MYOPATHY**

*Iva Breskova (Washington, DC), Mohammad Abu Rub (Washington, DC), Henry Kaminski (Washington, DC), Perry Richardson (Washington, DC)*

**INTRODUCTION:** Double seronegative myasthenia gravis (MG) with antibodies to low-density lipoprotein receptor-related protein 4 (LRP4) is a newly recognized entity, with a variable frequency. The clinical features are usually those of ocular or mild generalized MG.

**OBJECTIVE:** To describe an unusual case of double seronegative MG with anti-LRP4 antibodies and concomitant axial myopathy.

**CASE REPORT:** A 63-year-old woman with Crohn's disease on maintenance steroid therapy started experiencing fatigable ptosis 9 months prior to presentation and was subsequently diagnosed with LRP4-antibody positive MG. She responded favorably to cholinesterase inhibitor therapy and steroids. After she had a Crohn's disease flare she developed significant neck extensor weakness, with minimal improvement to symptomatic or immunomodulatory therapies. Her examination showed fatigable ptosis with bilateral facial weakness, along with neck extensor more than deltoid and biceps muscle weakness with moderate wasting. Neck MRI showed atrophy of the posterior paraspinal muscles and the majority of neck muscles with sparing of facial muscles. Needle EMG was notable for an abundance of myopathic motor unit potentials most severe in the cervical paraspinals but also the arm and shoulder muscles, without active denervation changes. The patient refused muscle biopsy.

**SUMMARY/CONCLUSION:** MG with dropped head not responsive to conventional therapies has been rarely reported, and so far only in cases of seropositive MG. This is the first case of documented myopathy in LRP4-positive MG and raises the question of whether axial myopathy is a separate underestimated clinical entity or a variant of MG.
TAKOTSUBO CARDIOMYOPATHY AS A COMPLICATION OF JUVENILE MYASTHENIA GRAVIS EXACERBATION
Hoda Abdel-Hamid (Pittsburgh, PA), Matthew Ginsberg (Pittsburgh, PA)

INTRODUCTION: Myasthenia gravis (MG) is an autoimmune disease affecting the skeletal muscle neuromuscular junction. Takotsubo cardiomyopathy has rarely been reported during exacerbations in older patients, many with preexisting cardiovascular risk factors.

OBJECTIVE: To illustrate cardiac complication in association with juvenile MG.

CASE REPORT: We report a case of Takotsubo cardiomyopathy in a 19-year-old otherwise healthy female with history of acetylcholine receptor antibody positive MG. The patient presented with an acute crisis manifesting with progressive weakness and shortness of breath requiring an ICU admission. During her course she developed cardiac arrhythmias and decreased cardiac function. She was diagnosed with Takotsubo cardiomyopathy, required temporary inotropic support, and improved over several days.

SUMMARY/CONCLUSION: MG is a rare disease and even more rare in the pediatric population. Takotsubo cardiomyopathy is posited to be caused by a surge of catecholamines in response to physical and emotional stress. It has been reported previously in adults in MG crisis. This case illustrates that it may be seen even in young, otherwise healthy patients during MG exacerbation.
RESULTS FROM THE MGTX EXTENSION STUDY OF THYMECTOMY IN MYASTHENIA GRAVIS

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INTRODUCTION: The Thymectomy Trial in Non-Thymomatous MG Patients Receiving Prednisone (MGTX), a randomized, rater-blinded study, demonstrated that extended transternal thymectomy combined with a standardized prednisone protocol was superior to prednisone alone in improving clinical status at 3 years.

OBJECTIVE: An extension study continued to follow MGTX subjects up to 5 years to ascertain longer-term effects of thymectomy.

METHODS: The MGTX Extension Study employed the same prednisone protocol and outcome assessments used in the main trial. MGTX enrolled patients with generalized non-thymomatous myasthenia gravis (MG), age 18-65 years with disease duration <5 years, MGFA Clinical Classification Class 2 to 4, and elevated acetylcholine receptor antibodies. The primary outcomes were the time-weighted average of the Quantitative MG (QMG) score and the time-weighted average alternate-day prednisone dose.

RESULTS: Of 111 subjects who completed the MGTX trial, 68 entered the extension study; 55 completed the 60-month assessment. Initial treatment assignment did not predict whether patients entered the extension study. At 5 years, patients who underwent thymectomy continued to demonstrate improved clinical status based on time-weighted average QMG (5.47±3.87 vs. 9.34±5.08; p<0.001) and lower average alternate-day prednisone requirements (25 mg±21 mg vs. 48±29 mg; p<0.001). The proportion of patients requiring azathioprine (20% vs. 58%; p<0.001) or intravenous immunoglobulin (9% vs. 33%; 95% CI 6.2-43.3%; p=0.01), and hospitalization for MG exacerbation (6% vs. 30%; p=0.01) were lower in the thymectomy group.

SUMMARY/CONCLUSION: After 5 years, thymectomy continues to benefit generalized non-thymomatous MG patients. These benefits include a more favorable disease status, decreased medication requirements including corticosteroids, and fewer hospitalizations for disease exacerbations.


OBJECTIVE: To evaluate the therapeutic impact of thymectomy in MuSK-MG.

METHODS: Data from a multi-center, retrospective blinded review of rituximab in MuSK-MG were analyzed (Hehir, Neurology, 2016). The primary endpoint was a Myasthenia Gravis Foundation of America (MGFA) Post-Intervention Status (PIS) score of MM or better. Secondary outcomes included: prednisone dose, other immunosuppressant medications, intravenous immunoglobulin (IVIG) or plasma exchange (PLEX) treatment, and the Myasthenia Gravis Status and Treatment Intensity (MGSTI).

Results: Baseline characteristics were similar between thymectomy (n=26) and non-thymectomy (n=29) groups, including treatment with rituximab (42% vs. 45%). Median follow-up was >3 years. At last visit: (1) 35% of thymectomy subjects reached the primary endpoint compared to 55% of non-thymectomy subjects (p=0.17); and (2) 69% of thymectomy subjects were taking prednisone compared to 41% of non-thymectomy subjects (p=0.058) (median dose 10mg/day vs. 0mg/day, p=0.04). After controlling for rituximab, baseline prednisone, and final IVIG/PLEX treatment, thymectomy was not associated with greater likelihood of favorable clinical outcome, but broad confidence intervals cannot exclude therapeutic effect (OR 0.43, 95% CI 0.13-1.48, p=0.18).

SUMMARY/CONCLUSION: Thymectomy was not associated with additional clinical improvement in this multi-center cohort of MuSK-MG patients.
DIETARY MODIFICATIONS AND EFFECT ON MYASTHENIA GRAVIS

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INTRODUCTION: Myasthenia gravis (MG) is defined as a chronic autoimmune neuromuscular disease in which antibodies inhibit the appropriate biological processes to cause muscular contraction, resulting in weakness. Recent research in multiple sclerosis (MS) suggests certain dietary changes have decreased the severity of MS symptoms (Kathryn C. Fitzgerald, Neurology, 2018). Perhaps these results could translate to other autoimmune diseases.

OBJECTIVE: The objective of this study was to determine if patients adhered to an anti-inflammatory diet, there would be a reduction in the severity of their MG symptoms.

METHODS: This is a prospective cohort study. Acetylcholine receptor antibody positive patients were selected from the Neuromuscular Clinic at Spectrum Hospital in Grand Rapids, Michigan. These patients were provided a single survey asking about their symptoms, medications, supplements, and dietary modifications. A detailed chart review was then conducted to determine classification of MG, verification of self-reported medications, disease interventions, and MG-QOL-15.

SUMMARY/CONCLUSION: Preliminary results demonstrate a group of MG patients who developed type II diabetes mellitus (DM), either from prednisone use or secondary to lifestyle choices. Following diagnosis with DM, these patients made dietary modifications such as reducing sugar intake and calorie counting. Consequently, avoiding sugar is a component of an anti-inflammatory diet; however, the diet modification was not for MG rather DM. MG symptom changes were difficult for most patients to interpret surrounding DM dietary management. Further research is required to determine if there is a significant connection between DM and MG disease severity.
HIGH PREVALENCE OF OSTEOPOROSIS AND OSTEOPENIA IN ADULT MYASTHENIA GRAVIS PATIENTS - A PILOT STUDY FROM AN ACADEMIC INSTITUTION IN CENTRAL PENNSYLVANIA

INTRODUCTION: Osteoporosis (OP) and Osteopenia are largely under-diagnosed conditions. Scattered reports of prevalence of osteoporosis in patients with neurological disorders have been published. A mouse model study of osteoporosis has shown progressive trabecular bone loss with progression of neuromuscular conditions. Such data for OP and Osteopenia for patients seen in adult Myasthenia patients in the US, are lacking.

OBJECTIVE: To study prevalence of OP and Osteopenia for patients with Myasthenia gravis seen in an academic neuromuscular clinic in central Pennsylvania.

Methods: In this IRB approved retrospective study, thirty three consecutive adult patients with Myasthenia gravis, diagnosed by serology or SFEMG, after random scheduling, had baseline bone mineral density (BMD) test done from L spine and femur-necks at the onset of diagnosis. Eighteen were women and fifteen, men.

RESULTS: Five patients had Osteoporosis (15%); twelve had Osteopenia (36%), and sixteen five had normal (49%) BMD testing. Majority (51%) had an abnormal test. 7 out of 15 men (47%) and 10 out of 18 women (55%) had abnormal testing. Results were statistically significant.

SUMMARY/CONCLUSION: This study showed a surprising high prevalence of Osteoporosis and Osteopenia in patients with myasthenia gravis, independent of any known long term similar effects of prednisone therapy. Large multicenter studies are worth contemplating as this can turn out to be an undiagnosed pandemic. Plummeted quality of life, pain, and fractures can result from osteoporosis, which are potentially preventable if accurate and holistic diagnoses are made in a timely way.

RAPID AND SUSTAINED IMPROVEMENT WITH ECULIZUMAB IN ANTI-ACHR ANTIBODY MYASTHENIA GRAVIS

INTRODUCTION: Eculizumab is a humanized monoclonal antibody that binds complement protein C5. The response time to eculizumab in generalized myasthenia gravis (gMG) appears to be 4 weeks from the phase 3 REGAIN trial. Objective: To report the clinical presentation and the rapid sustained improvement with eculizumab in a patient with AchR antibody gMG.

CASE REPORT: A 68-year-old man with bulbar predominant non-thymomatous AchR antibody gMG diagnosed in 1/2013 was started on pyridostigmine. Prednisone 20 mg/day was started in 5/2013 following thymectomy in 2/2013. Higher doses of prednisone caused excessive bruising. IVIG was used to treat two exacerbations with shortness of breath, dysarthria, and inability to swallow in 2015 and was continued following the second exacerbation every 3 weeks. He had right leg DVT in 2016 and bilateral leg DVTs and pulmonary embolism with a negative thrombophilia profile in 12/2017. He continued to have bulbar symptoms, neck weakness, and arm weakness close to the next dose of IVIG (i.e., 3 weeks). Azathioprine 50 mg BID was started in 12/2017. MG-ADL score was 6 upon presentation to our clinic. At the initial visit, we stopped IVIG, increased azathioprine to 150 mg daily and started eculizumab. 5 weeks later, MG-ADL score was 0 after receiving three doses of eculizumab and we tapered prednisone. 9 weeks after the initial visit, MG-ADL score remained 0 after receiving six doses of eculizumab and we stopped prednisone.

SUMMARY/CONCLUSION: Based on this case report, eculizumab produces a rapid and sustained improvement after only three doses in gMG.
SWOLLEN TONGUE: A UNIQUE PRESENTATION OF MYASTHENIA GRAVIS
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INTRODUCTION: Isolated oropharyngeal involvement on presentation of myasthenia gravis is uncommon. Bulbar weakness usually manifests as dysarthria, hypophonia, and/or dysphagia.

OBJECTIVE: We report two unusual cases of MG where subjective tongue swelling was 1) the initial presenting symptom and 2) an initial sign of myasthenic exacerbation.

Methods: Report of two patients.

RESULTS: CASE 1: 74 year old woman who initially noted "tongue swelling." She was treated by her primary physician and otolaryngologist with high-dose steroids for presumed angioedema. She was transferred to our neurology ICU for worsening ptosis, weakness of eye closure, and dysphagia. MG was suspected and later confirmed by EDX and AChR antibody titers. Symptoms improved with IVIg.

CASE 2: 68 year old man with previous ocular symptoms of seropositive MG, treated with low-dose steroids for five years, developed dysphagia. Days after undergoing laminectomy, he noted isolated "tongue swelling," attributed to lisinopril. He was treated for presumed angioedema with high-dose steroids, but developed progressive ptosis, diplopia, dysarthria, and significant dysphagia. Further examination revealed weakness of the tongue, eye closure, jaw closure, and proximal extremities. He received IVIg with marked improvement.

SUMMARY/CONCLUSION: A careful history and neurologic exam are important in evaluating a complaint of "swollen tongue," as it may indicate tongue weakness due to MG. High-dose steroids given for presumed angioedema could cause worsening of myasthenic weakness.

RA101495, A SUBCUTANEOUSLY-ADMINISTERED PEPTIDE INHIBITOR OF COMPLEMENT COMPONENT C5 FOR THE TREATMENT OF MYASTHENIA GRAVIS: PHASE 2 DESIGN
J Howard Jr. (Chapel Hill), H Kaminski (Washington, DC), R Nowak (New Haven, CT), G Wolfe (Buffalo, NY), M Benatar (Miami, FL), R Far (Cambridge, MA), P Duda (Cambridge, MA)

Complement component C5 (C5) is a validated therapeutic target in patients with acetylcholine receptor (AChR) antibody positive generalized myasthenia gravis (gMG). RA101495 binds to C5 and inhibits its cleavage into C5a and C5b, thereby inhibiting the formation of the terminal complement complex (C5b-9), and potentially reducing neuromuscular junction damage resulting from classical complement pathway activation in MG.

The ongoing randomized, double-blind placebo-controlled multicenter Phase 2 clinical trial in gMG evaluates two daily doses (0.1 mg/kg and 0.3 mg/kg) of RA101495 self-administered subcutaneously (SC) over 12 weeks. After completing the trial, participants will have the option to receive RA101495 in a study extension.

The purpose of this trial is to evaluate the safety, tolerability, and efficacy of RA101495 in patients with gMG. Key entry criteria include: anti-AChR antibody positive gMG with an MGFA Class of II-IVa and a Quantitative Myasthenia Gravis (QMG) Score ≥ 12 at baseline. Patients are not required to have failed prior immunosuppressant therapy, but treatment with immunoglobulins or plasma exchange within the preceding 4 weeks, and thymectomy within 6 months of enrollment are disallowed. Vaccination against Neisseria meningitidis is required per standard of care. The primary endpoint is the change in QMG from baseline to Week 12.

RA101495, if determined to be safe and effective, has the potential to provide a more convenient and accessible treatment option for patients with MG.
DISEASE BURDEN AND TREATMENT HISTORY IN THE MYASTHENIA GRAVIS FOUNDATION OF AMERICA (MGFA) PATIENT REGISTRY

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The MGFA Registry was initiated in 2013 with the goal to improve understanding of care and disease impact on persons living with myasthenia gravis (MG). We investigated how disease severity, as measured by MG activities of daily living (MG-ADL) and MG quality of life (MG-QOL15) scales, is associated with MG-specific treatment history in this large cohort.

Our cross-sectional analysis included all available records as of 7/2017 with MG diagnosis of at least 1 year and with data on MG-ADL or MG-QOL15 scores at entry into the Registry. Characteristics (n=1140) were: Mean age: 54.6 years; 66.2% female; 80.4% Caucasian; median MG-ADL: 6 (0-21); median MG-QOL15: 21 (0-60). 23% and 6% were positive for anti-AChR and anti-MuSK antibodies, respectively, however >70% and >90% marked 'unknown' or 'no response' for anti-AChR and anti-MuSK antibodies indicating that they did not know or were not made aware of these clinical markers.

MG specific treatment was reported as follows: 71% pyridostigmine; 42% corticosteroids; 24% mycophenolate mofetil; 19% azathioprine; 19% intravenous immunoglobulin (IVlg); and 4% plasma exchange. Prior therapies included corticosteroids (36 %); IVlg (28%); and plasma exchange (26%). Few patients (<5-10%) reported ever receiving other treatments: cyclosporine; tacrolimus; methotrexate; cyclophosphamide; or rituximab. 40% had undergone thymectomy.

Patient registries offer information often unavailable in medical records but may be less complete and not entirely representative of the entire population. However, we will show that MG continues to negatively impact the health-related quality of life of many patients despite symptomatic and immunosuppressive treatment.

OVERLAP SYNDROME OF MYASTHENIA GRAVIS AND MYOSITIS IS A COMMON ETIOLOGY OF NEUROMUSCULAR WEAKNESS ASSOCIATED WITH IMMUNE CHECKPOINT INHIBITORS IN A MULTICENTER RETROSPECTIVE STUDY OF 15 PATIENTS

A Guidon (Boston, MA), S Raja (Durham, NC), D Dubey (Boston, MA), N Clement (Boston, MA), K Reynolds (Boston, MA), J Guptill, (Durham, NC), W David (Boston, MA)

INTRODUCTION: Immune-related myasthenia gravis (irMG) and myositis (irMyositis) are rare complications of immune checkpoint inhibitor (ICI) therapy. The phenotypic range is emerging.

OBJECTIVE: To describe the spectrum of irMG and irMyositis.


RESULTS: Median age was 69 years (32-81). ICIs included antibodies (Abs) to cytotoxic T-lymphocyte-associated protein 4, programmed cell death 1 and its ligand. Median ICI doses prior to developing toxicity was 2 (range 1-23). Definite overlap irMG/irMyositis (6) was most common, followed by irMyositis (4), irMG (2), probable overlap (2) and probable irMyositis (1). Dyspnea (10/15) and/or dysphagia (8/15) were common presenting symptoms; examination frequently revealed ocular (11/15) and proximal limb weakness (10/15). Acetylcholine receptor Abs were rare (4/15). Peak creatine kinase was > 400 IU/L in 10/15 patients (mean 1775.4, range 43-4883). Repetitive nerve stimulation was abnormal in 3/14, single fiber EMG in 6/9. EDX diagnosis was myopathic (2), neuromuscular transmission disorder (NMID) (3), mixed myopathic/NMID (6) and normal (3). Inflammatory features characterized 4/5 muscle biopsies. Nine patients had myocarditis/arrhythmias. 14/15 received ≥1 of the following: pyridostigmine, corticosteroids, IVlg, plasma exchange or Rituximab. Neuromuscular symptoms improved in 12/14, completely in 6. irMyasthenia/irMyositis contributed to 3/5 deaths.

SUMMARY/CONCLUSION: Weakness with dysphagia or dyspnea in ICI-exposed patients should prompt consideration of irMG/irMyositis, which commonly overlap. Since individual tests may be normal, diagnosis requires a high index of suspicion and synthesis of all data. Jitter studies or muscle biopsy may be required for accurate diagnosis and to allow for prompt treatment.
REVERSAL OF LONG-TERM RESPIRATORY FAILURE IN A MU SK-POSITIVE MYASTHENIA GRAVIS PATIENT UTILIZING DUAL DIAPHRAGMATIC PACEMAKER

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BACKGROUND: Myasthenia gravis (MG) can cause respiratory failure in crisis, requiring mechanical ventilation. Causes of diaphragmatic dysfunction in MG are difficult to diagnose as there may be other causes such as ventilator-induced diaphragmatic dysfunction (VIDD). We present a case of reversible respiratory failure due to proposed VIDD in a MuSK-positive myasthenic utilizing dual diaphragmatic pacemaker (DDP). DDPs are not well described in MG.

Case Description: 64-year-old female with ptosis, bifacial and right arm weakness, and gait instability was diagnosed with MuSK-positive MG in January 2014. In April, she developed worsening dyspnea and was admitted for crisis. She was readmitted in May for worsening dyspnea and progressive weakness, intubated, and discharged with tracheostomy due to inability to wean from ventilator. Her myasthenic symptoms continued to improve with cyclophosphamide and later rituximab, but she still was unable to wean from the ventilator. Phrenic nerve conduction studies demonstrated low responses bilaterally suggesting either phrenic neuropathies or diaphragmatic atrophy. August 2015 received placement of DDP. February 2016, she was off of ventilator. January 2018, she was no longer using DDP. MG symptoms never returned on mycophenolate and weaning doses of prednisone.

CONCLUSION: Isolated chronic respiratory deficit would be atypical in MG. In this case, it is thought the cause of diaphragmatic dysfunction was secondary to VIDD or less likely bilateral phrenic neuropathy as her other myasthenic symptoms resolved while her diaphragm function didn’t. DDP may be a viable treatment option for VIDD in patients with MG or other neuromuscular disorders.

MYASTERIX: A PHASE 1B CLINICAL TRIAL OF CV-MG01, ACETYLCOLINE RECEPTOR MIMETIC PEPTIDES, THERAPEUTIC VACCINE CANDIDATE FOR MYASTHENIA GRAVIS

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INTRODUCTION: CV-MG01 is an orphan drug developed to be a disease specific immunologic treatment of myasthenia gravis (MG). It contains a peptide complementary to hydrophilic and hydrophobic properties of the main immunogenic region of the acetylcholine receptor and a peptide complementary to a dominant T-cell epitope. It aims to generate anti-idiotypic antibodies against the pathogenic acetylcholine receptor antibodies (AChR Abs) and antibodies against disease specific T-cell receptors. Objective: to assess the safety, immunogenicity and to explore the efficacy of 3 subcutaneous injections of CV-MG01 in MG patients with AChR Abs.

METHODS: a first in human, double blind, single center, and placebo controlled clinical trial on myasthenia patients with safety and immunogenicity as primary endpoints and efficacy as a secondary endpoint, using descriptive statistics and inferential statistical analysis (NCT02609022).

RESULTS: Twenty-four patients completed the trial. Six of them received placebo, six a low dose of CV-MG01 and twelve a high dose. No serious adverse events or other safety issues were noted. Most adverse events were local and of mild severity whatever treatment group. Immunogenicity was present in half of the patients but low. AChR Abs remained unchanged. Several patients improved during the trial but no statistically significant difference was found between placebo, low dose and high dose.

SUMMARY/CONCLUSION: CV-MG01 can be administered safely to MG patients. Clinical efficacy could not be demonstrated at this stage, possibly due to small sample size, low disease severity at inclusion, and low immunogenicity.
EFFECT OF THYMECTOMY IN ELDERLY NON-THYMOMATOUS GENERALIZED MYASTHENIA GRAVIS PATIENTS
S Kim, (Seoul, Korea), Y Choi (Seoul, Korea), S Kim (Seoul, Korea), H Shin (Seoul, Korea)

INTRODUCTION: It is unclear whether the thymectomy is beneficial in elderly non-thymomatous myasthenia gravis (MG) patients, as these patients are less likely to have thymic hyperplasia and more likely to have surgical complications.

Objective: We compared the clinical course between the elderly non-thymomatous MG patients who underwent thymectomy and those who only had medical treatment.

METHODS: We included the patients with MG who visited Severance Hospital between January 2000 and May 2018 and retrospectively reviewed medical records. The patients with 1) generalized MG, 2) thymectomy at age ≥50 and 3) positive acetylcholine receptor antibody were included. The patients with 1) pathologically proven thymoma, 2) concomitant neurological disorders and 3) follow-up duration less than 12 months were excluded. We compared the rate of clinical remission with the elderly MG patients who only had medical treatment.

RESULTS: A total of 34 elderly MG patients who underwent thymectomy were included. Of these patients, 18 (62.9%) had thymic hyperplasia, 9 (26.5%) had normal thymus and 7 (20.6%) had involuted or atrophic thymus. We compared the rate of clinical remission with 91 elderly MG patients who only had medical treatment. The cumulative incidence of pharmacologic remission (p=0.003) and complete stable remission (p=0.002) were significantly higher among thymectomy group than among non-thymectomy group. Cox regression analysis revealed that thymectomy group had a 3.329-fold (95% confidence interval 1.617-6.853) increased chance of pharmacologic remission compared to non-thymectomy group after adjusting for sex, age at onset and disease severity.

SUMMARY/CONCLUSION: Thymectomy could have beneficial effect in elderly non-thymomatous generalized MG patients.

LAMBERT-EATON SYNDROME POSITIVE FOR P/Q-TYPE VOLTAGE GATED CALCIUM CHANNEL ANTIBODY
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INTRODUCTION: P/Q type voltage-gated calcium channels antibody can occur in peripheral serum of patients with Lambert-Eaton syndrome.

OBJECTIVE: To analyze the clinical and electrophysiological characteristics of Lambert-Eaton syndrome patients with positive P/Q-VGCCs antibodies.

METHODS: We retrospectively analyzed the data of 23 patients with Lambert-Eaton syndrome diagnosed in Peking Union Medical College Hospital from June 2016 to January 2018, and applied Radioimmune-precipitation assay to measure the serum levels of VGCC antibodies in 21 of them.

RESULTS: In 20/23 cases with complete medical information, 17 cases had a mode of weakness onset accounting for 85%. 11 patients with autonomic nerve failure and 3 with unsteady gait. Pyridostigmine was effective in 15/20 cases, and oral glucocorticoid was effective in 13/20 cases. For 4 patients who aggravated repeatedly, IVIg and azathioprine are effective. At the time of diagnosis, 11/20 tumors were found. VGCC antibodies were detected in 21/23 patients,15 were positive. The median antibody titer was 282.42 pmol/L. There is no significant relationship between tumor and antibody OR=1, CI (0.10-9.22). A shorter course (10 months) had a correlation with antibody positivity OR=2.80, CI (1.38-5.65). Antibody positivity appears to correlate weakly with autonomic symptoms OR=1.85, CI (1.12-3.07).

SUMMARY/CONCLUSION: Lambert-Eaton syndrome needs to be guarded against patients with an onset of asthenia in the lower extremities, fatigue intolerance, without ptosis. VGCC antibodies are helpful in the diagnosis. Pyridostigmine and glucocorticoid may perform well in patients after diagnosis, IVIg and azathioprine may be effective in cases of repeated aggravation. For patients who are initially diagnosed with undefined tumors, tumor markers should be reviewed every 3-6 months during follow-up.
HIGHLY PURIFIED STAPHYLOCOCCAL PROTEIN A DECREASES DISEASE ACTIVITY IN THE MOUSE MODEL OF MYASTHENIA GRAVIS

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INTRODUCTION: The experimental autoimmune myasthenia gravis (EAMG) mouse model produces the antibody response to acetylcholine receptor (AChR) with similarities to the human condition. Protein A can bind immunoglobulin and reduce function of the antibody.

OBJECTIVE: We have used the EAMG mouse to assess the therapeutic potential of highly purified Staphylococcus aureus Protein A (PRTX-100) to ablate weakness.

Methods: We immunized thirty-two mice to AChR in Complete Freund's adjuvant and boosted on day 28 and 56. Prior to the second booster, the animals were stratified by weight and separated into four treatment groups; saline (volume equivalent), IVIg (1g/kg), PRTX-100 (250mcg/kg), and the diluent for PRTX-100 (volume equivalent). Treatments were given as intraperitoneal injections every 48 hours for a total of six injections. Health score, weight and grip strengths were taken throughout the experimental study. AChR-specific IgG, membrane attack complex (MAC) and AChR content at the neuromuscular junction were analyzed.

RESULTS: The weights did not vary between groups. Health scores and grip strengths showed significant improvement in the animals treated with IVIg or PRTX-100 compared to animals given saline or the diluent. The assessment of the AChR-specific IgG showed a significant decrease in the IVIg treated animals compared to the other groups. However, a decrease in the membrane attack complex and the preservation of AChR at the NMJ were significantly improved in the IVIg as well as the PRTX-100 group compared to the animals given saline or diluent.

SUMMARY/CONCLUSION: The efficacy of PRTX-100 is comparable to IVIg in an EAMG mouse model.

ISO LATING AND INVESTIGATING RARE AUTOANTIBODY-PRODUCING B CELLS IN MYASTHENIA GRAVIS

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INTRODUCTION: Myasthenia gravis (MG) patients can harbor pathogenic autoantibodies to muscle-specific tyrosine kinase (MuSK). The autoantibodies disrupt the interaction between MuSK and other postsynaptic proteins. Substantial aspects of the molecular and cellular immunopathology of MuSK MG remain unclear. The isolation of the rare human B cells that produce pathogenic autoantibodies is challenging, but their value in advancing the understanding of immunopathology is exceptional.

OBJECTIVE: To gain insight into the details of MuSK MG immunopathology, we sought to directly isolate MuSK autoantibody-producing B cells.

Methods: We developed a novel florescent MuSK antigen to isolate MG patient-derived B cell populations that express MuSK autoantibodies. Human recombinant MuSK monoclonal autoantibodies (mAbs) were then produced from these cells for the investigation.

RESULTS: A large set (n=65) of unique mAbs was isolated; a select group were characterized. The mAbs bound specifically to MuSK in a live cell-based assay. Many of these mAbs belong to the expected IgG4 subclass but interestingly some use other IgG subclasses that mediate effector functions that differ from IgG4. The location of the epitopes recognized by the mAbs are not restricted to the Ig-like domain-1 of MuSK. Many of the mAbs effectively interrupted agrin-induced clustering of the acetylcholine receptor, indicating their pathogenic capacity.

SUMMARY/CONCLUSION: This study describes a novel reagent for isolation of MuSK autoantibody-producing cells. Human recombinant MuSK mAbs recapitulate key pathologic features of MuSK MG. This reagent has value in furthering our understanding of MuSK MG immunopathology and has potential for use as a clinically-relevant biomarker.
CYCLOPHOSPHAMIDE AS A RESCUE AGENT IN MYASTHENIC CRISIS
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INTRODUCTION: Myasthenic crisis (MC), a complication of Myastenia Gravis (MG), is defined as respiratory compromise that may require intubation and mechanical ventilation.

OBJECTIVE: Although there is little evidence-based medicine to guide MC treatment intravenous immunoglobulin (IVIG), and plasmapheresis are considered first-line agents.

METHODS: We present a case of a middle-aged Vietnamese man who did not respond to these standard interventions, although he responded well to induction and maintenance therapy with Cyclophosphamide.

RESULTS: The patient was able to be weaned off all medications including Cyclophosphamide. He remains in remission

SUMMARY/CONCLUSION: Cyclophosphamide should be considered as a rescue treatment for refractory MC.

BASELINE DECREMENT IN PATIENTS WITH MILD MYASTHENIA GRAVIS PREDICTS IMMUNOMODULATION TREATMENT
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INTRODUCTION: Electrophysiological evaluation in myasthenia gravis (MG) extends beyond the ability to diagnose impaired neuromuscular transmission, and is correlated with disease severity.

OBJECTIVE: In this study, we aimed to explore whether higher degrees of baseline electrophysiological abnormalities are associated with a higher prevalence of more aggressive treatment.

METHODS: We performed a retrospective chart review of 134 MG patients attending the neuromuscular clinic from June 2012 to December 2015, and included 87 patients who had follow-up evaluations. We compared clinical characteristics and treatment regimens during the follow-up period between patients with high jitter (>100 µs) and decrement (>10%) and patients with low jitter and decrement found at the baseline visit, and determined the odds ratio for receiving treatment in the whole cohort, and in patients with mild and moderate to severe disease.

RESULTS: MG patients who had more marked electrophysiological abnormalities at baseline had more severe myasthenic features, and were more frequently treated with intravenous immunoglobulins and/or plasma exchange (odds ratio 2.9-7.7) at the follow-up period. In patients with mild disease, immunomodulatory treatment was associated with high decrement (odds ratio 6.7-21.5), but not with high jitter.

DISCUSSION: More severely abnormal electrophysiology in MG patients predicts the need for immunomodulation. In patients with mild MG, only high decrement is associated with immunomodulation.

SUMMARY/CONCLUSION: More severely abnormal electrophysiology in MG patients predicts the need for immunomodulation. In patients with mild MG, only high decrement is associated with immunomodulation.
CO-OCCURENCE OF MULTIPLE SCLEROSIS AND MYASTHENIA GRAVIS
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INTRODUCTION/OBJECTIVES: Autoimmune mechanisms are implicated in both myasthenia gravis (MG) and multiple sclerosis (MS) with peripheral and central nervous systems as respective targets. We review available evidence assessing co-existence of MS and MG.

METHODS: Case report and literature review
Results: A 54 y/o male with RRMS, diagnosed at age 35, treated with glatiramer acetate for 15 years, until he self-discontinued 3 years prior to presentation. When he recently complained of worsening lower extremity weakness and diplopia over 2 months, his glatiramer acetate was restarted. Brain and spine MRI demonstrated no evidence of active disease. Four weeks later, he developed pneumonia with respiratory failure requiring intubation. After antibiotic treatment and empiric high dose steroids, the patient became weaker, failing extubation trials. Patient underwent EMG, and autoimmune evaluations, revealing acetylcholine receptor antibody seropositive MG, with normal thymus imaging. A Pubmed search for “myasthenia gravis and multiple sclerosis”, yielded 24 articles describing 37 patients. Most patients were females (33), the majority with mild course of both diseases, with no specific order of disease appearance, and only one patient with myasthenic crisis. One case series suggested that combination of these two diseases occurred more frequently than was expected by random association.

SUMMARY/CONCLUSION: Both MG and MS could be part of a “multiple autoimmune syndrome” or could share genetic predisposition to autoimmunity. Dysregulation of T regulatory cells have been linked to pathogenesis of both diseases. Further studies are warranted to assess whether similar pathways of humoral and cell mediated immunity could occur in the pathogenesis of MS and MG.

PRIMARY CNS LYMPHOMA ASSOCIATED WITH MYCOPHENOLATE USE IN MYASTHENIA GRAVIS
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INTRODUCTION: Mycophenolate has been associated with the development of Primary CNS Lymphoma (PCNSL) when used for renal transplant and lupus patients. Such an association has only been reported twice before in the setting of Myasthenia Gravis (MG).

OBJECTIVE: To highlight an uncommon complication associated with chronic mycophenolate use in a patient with MG.

METHODS: A 76 year old MG patient presented with 10 days of increasing weakness, poor balance and alien limb phenomena. Examination showed right sided hemiparesis and dysmetria. Central etiologies including infection, neoplasm, and subacute stroke were considered.

RESULTS: Magnetic resonance imaging (MRI) brain showed multiple ring enhancing lesions. Computed tomography of the chest, abdomen and pelvis was negative for malignancy. Serology for HIV, Borrelia burgdorferi, West Nile, VDRL, varicella and cytomegalovirus serology was negative. Serum toxoplasmosis IgG titers were positive. Empirical treatment of toxoplasmosis was completed without clinical improvement. Repeat MRI brain demonstrated enlarging left parietal lobe lesion with vasogenic edema. Cerebrospinal fluid showed lymphocytic predominance with positive Epstein Barr virus (EBV) DNA PCR. Brain biopsy confirmed high grade B-cell non-Hodgkin lymphoma. Treatment with dexamethasone, methotrexate and rituximab was initiated.

SUMMARY/CONCLUSION: This report underlines the importance of maintaining vigilance when treating patients with immunosuppressants. Though PCNSL is not commonly associated with mycophenolate use, high index of suspicion should be maintained as timely treatment initiation is critical. As recommended for post-transplant patients, EBV viral load screening prior to initiating immunosuppressive treatment and continued EBV viral load surveillance through treatment may be beneficial in identifying patients at high risk for developing lymphoproliferative disease.
LONG-TERM EFFECTIVENESS AND SAFETY OF ECULIZUMAB IN GENERALIZED MYASTHENIA GRAVIS: BEYOND MG-ADL AND QMG
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INTRODUCTION: In the 6-month, double-blind, placebo-controlled REGAIN study, the terminal complement inhibitor eculizumab was effective and well tolerated in patients with AChR+ generalized MG who were symptomatic despite treatment with immunosuppressants.

OBJECTIVE: To evaluate the long-term effectiveness and safety of eculizumab in an open-label extension of REGAIN.

METHODS: 117 patients who completed REGAIN (eculizumab, n=56; placebo, n=61) were enrolled in the open-label extension study and received eculizumab (4-week blind induction then 1200 mg every 2 weeks). MGFA Minimal Manifestations status, and occurrence of disease exacerbations and MG-related hospitalizations were recorded throughout the study, together with MG-ADL, QMG, MGC, MG-QoL15 and safety assessments.

RESULTS: After 1 year of open-label eculizumab, over half of patients (56/102) achieved MGFA Minimal Manifestations status or better. Furthermore, eculizumab during REGAIN and the open-label study combined was associated with reductions of 74% in exacerbation rate and 83% in MG-related hospitalizations (both p<0.0001) versus the pre-study year. Clinically meaningful improvements in activities of daily living (MG-ADL), muscle strength (QMG), functional ability (MGC) and quality of life (MG-QoL15) previously reported for 1 year of open-label eculizumab were sustained through 3 years. Patients who received placebo during REGAIN experienced rapid, sustained improvements with open-label eculizumab (mean change in MG-ADL total score, −3.8 [p<0.0001] from eculizumab start to year 2.5). The long-term tolerability of eculizumab was consistent with its known safety profile from over 10 years of clinical use in other indications.

SUMMARY/CONCLUSION: These results demonstrate the long-term benefits of eculizumab in previously difficult-to-treat patients and support its sustained effectiveness and tolerability. (NCT01997229, NCT02301624).

RELIEVING THE BURDEN OF MYASTHENIA GRAVIS: ECULIZUMAB REDUCES EXACERBATION, HOSPITALIZATION AND RESCUE THERAPY RATES
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INTRODUCTION: Patients with anti-acetylcholine receptor positive (AChR+) generalized myasthenia gravis (MG) who do not respond to conventional therapies experience greater disease burden than those who do respond. This is partly due to increased risk for disease exacerbations, which are often accompanied by a need for rescue therapy and hospitalization, and results in significant healthcare resource utilization. The terminal complement inhibitor eculizumab is well tolerated and associated with clinically meaningful benefits in these patients.

OBJECTIVE: To evaluate the effect of long-term eculizumab on MG exacerbation rates, hospitalizations and rescue therapy use in REGAIN and its open-label extension.

Methods: Exacerbations were defined as clinical worsening/deterioration, MG crises or requirement for rescue therapy. Pre-study exacerbations and hospitalizations were defined by verified patient records. Event rates adjusted for patient-years were calculated for all patients in the pre-study year, placebo-treated patients during the 6-month, double-blind study, and eculizumab-treated patients during the double-blind study and open-label extension (median eculizumab exposure, 27.5 months [range, 22 days–42.8 months]); rates were compared using a Poisson regression model.

RESULTS: Eculizumab was associated with a 65% reduction in exacerbation rate (p=0.0057), a 71% reduction in hospitalizations (p=0.0316) and a 66% reduction in rescue therapy use (p=0.0072) versus placebo. Compared with the pre-study year, eculizumab was associated with reductions of 74% in exacerbation rate and 83% in hospitalizations (both p<0.0001).

SUMMARY/CONCLUSION: Long-term eculizumab is associated with reduced disease burden and healthcare resource utilization, demonstrating that previously published improvements in clinical endpoints lead to additional meaningful outcomes for patients with AChR+ generalized MG. (NCT01997229, NCT02301624).
A CASE OF PARANEOPLASTIC DEMYELINATING POLYNEUROPATHY ASSOCIATING LAMBERT EATON MYASTHENIC SYNDROME
A El-Zohiery (Cairo, Egypt), N Gadallah (Cairo, Egypt)

INTRODUCTION: Lambert-Eaton myasthenic syndrome (LEMS) is an autoimmune disease, occurring sporadically or as a paraneoplastic syndrome. Peripheral neuropathy is commonly accompanied by cancer but demyelinating neuropathies are not commonly reported.

OBJECTIVE: To report demyelinating polyneuropathy associating LEMS in a case of oropharyngeal carcinoma

Methods: A 68 years old heavy smoker patient presented with rapidly progressive quadriaparesis for 3 months. Initial examination showed distal paraparesis with impaired vibration sense in the lower extremities. Progressively, proximal and distal tetraparesis was revealed. Finally, proximal weakness worsened with fatigue, anorexia and asthenia unveiling. ESR was high but tumor markers were free. CT chest and abdomen were free. Patient was referred for electromyography

RESULTS: Bilateral peripheral upper and lower limb nerves showed low compound muscle action potential (CMAP) amplitudes, delayed distal motor latencies (DMLs) and slowing of the conduction velocities. Left ulnar and right posterior Tibial nerves showed proximal conduction block. F wave studies showed delayed latencies and lack of persistence while left ulnar F response was unobtainable. Sensory study was within average for upper limbs nerves but sural nerves action potentials were unobtainable. Needle EMG showed early recruitment, myopathic pattern with no denervation potentials. Repetitive nerve stimulation test showed: decremental response at low rate (45% at 3 Hz) and marked incremental responses at high-rate (720% at 50 Hz). PET scan was demanded discovering a highly suspicious mass at the oropharynx. Biopsy revealed squamous cell carcinoma.

SUMMARY/CONCLUSION: Superimposed demyelinating polyneuropathy may alter the presentation of LEMS and delay the diagnosis of malignancy.

SUBCUTANEOUS IMMUNOGLOBULIN IN MYASTHENIA GRAVIS: A NORTH AMERICAN OPEN LABEL STUDY
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INTRODUCTION: In routine care, subcutaneous (SC) immunoglobulin Ig might be easier to administer than IVIg.

OBJECTIVE: We recently completed a North American study investigating efficacy and safety of SCIg treatment in myasthenia gravis (MG) patients. We present herein the primary outcome analyses.

METHODS: This multi-center open label investigator-initiated study had 2 components: IVIg Screening Phase (ISP; Weeks -10 to -1) followed by Experimental Treatment Phase (ETP; Weeks 0 to 12). We hypothesized that more than 65% of the patients entering the ETP would have stable QMG score (primary outcome) at Week 12. We recruited 23 patients in the ISP and 22 entered the ETP. 12/22 (54.5%) were females and 20 (91%) non-hispanic with mean age 52.7 years ±16.2. We had complete ETP QMG data for 19/22; one subject withdrew from ISP owing to worsened condition and two subjects withdrew before Week 4 (needle dislike). The main statistical analysis was conducted for n=20 subjects using a one-sided test of proportions at the 5% significance level. Sensitivity analyses were conducted using a cohort of n=22 subjects using 'best-case' and 'worst-case' imputation scenarios for the primary outcome.

RESULTS: 17/20 subjects (85%; 95% CI: 0.69 – 1.00) were treatment “successes” (p=0.03). Sensitivity analyses using the ‘best-case’ imputation resulted in 19/22 (86.4%; 95% CI: 0.72 – 1.00) declared as treatment success (p=0.018). Sensitivity analyses using the ‘worst-case’ imputation resulted in 17/22 (77.3%; 95% CI: 0.60 – 0.95) declared as treatment success (p=0.114).

SUMMARY/CONCLUSION: Most MG patients who were doing well on IVIg maintained their stability for another 12 weeks once transitioned to SCIg.
THE RISK OF SERIOUS INFECTIONS AND FRACTURES IN MYASTHENIA GRAVIS
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INTRODUCTION: Most patients with myasthenia gravis (MG) require chronic immunotherapy, placing them at risk of infections and fractures. This is of particular concern in the elderly.

OBJECTIVE: To determine the rates of serious infections and fractures in a cohort of MG patients compared to age- and sex-matched general population comparators.

METHODS: A retrospective population-based cohort study, identifying newly-diagnosed MG patients through administrative databases in Ontario, Canada between 2000 and 2016. Crude overall and sex-specific rates of infections and fractures, as well as hazard ratios, were calculated.

RESULTS: A total of 3,823 MG patients and 15,292 healthy comparators were included. MG patients were more likely to have multiple comorbidities, including diabetes, hypertension and osteoporosis. The overall infection rate was double in the myasthenia group compared to controls (72.58 infections per 1000 patient years vs. 35.02, p<0.01; hazard ratio 1.33, 95% CI 1.24-1.42). Respiratory infections, sepsis, herpes zoster, post-operative infections, and osteomyelitis were more common in the MG group. There was no increase in the overall rate of fractures between the groups (MG 8.71 fractures per 1000 patient years vs. 7.98 in the control group).

SUMMARY/CONCLUSION: These are the first data to analyze the risk of infections in a large cohort of MG patients. In our cohort, MG patients had more comorbidities than age- and gender-matched comparators. MG patients were more likely to develop several types of infections, but were not more likely to have major limb fractures than a control cohort. Possible reasons for these findings are discussed.

MUSK MYASTHENIA GRAVIS IS ASSOCIATED WITH AN IMBALANCE IN TFH17 CELL SUBSETS
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INTRODUCTION: Patients with acetylcholine receptor antibody myasthenia gravis (MG) exhibit a higher frequency of circulating and thymus T follicular helper (Tfh) cells and produce IL-21, the hallmark cytokine for Tfh cells. Objective: To characterize subsets and function of Tfh cells in muscle specific kinase antibody MG (MuSK-MG) using high dimensional polychromatic flow cytometry immune profiling.

METHODS: Peripheral mononuclear cells (PBMCs) from 33 MuSK-MG patients and 22 control subjects were stained with fluorochrome-conjugated antibodies associated with Tfh cell phenotypes. We acquired cells on a BD LSRII flow cytometer. To assess Tfh cell's role in promoting antibody production, CD4+CXCR5+ Tfh cells and naïve B cells were sorted from MuSK-MG patients and controls, and co-cultured for 5 days in the presence of anti-CD3/anti-CD28 stimulation. We measured IgG concentration by ELISA.

RESULTS: The overall frequency of Tfh cells was not significantly different between MusK-MG patients and control subjects. However, detailed analysis revealed a significant increase in the Tfh17 (CXCR3-CCR6+) subset (p<0.01). MuSK-MG patients demonstrated a higher capacity to produce IL-17, IL-21, and IFN-γ along with an increase in the ratio of Tfh to T-follicular regulatory cells (p<0.01). Furthermore, Tfh cells isolated from MuSK-MG patients induced higher concentrations of IgG compared with control subjects (p<0.05).

SUMMARY/CONCLUSION: Our data demonstrate that autoantibody production in MuSK-MG patients is not due to an increase in the frequency of total Tfh cells, but rather an imbalance in the distribution of Tfh17 cells, the subset of Tfh cells that is most efficient in facilitating antibody production by B cells.
RETROSPECTIVE ANALYSIS OF OUTCOMES AND SAFETY AFTER RITUXIMAB USE FOR MYASTHENIA GRAVIS IN PATIENTS ≥ 65 YEARS OLD
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INTRODUCTION: Rituximab is an option to treat myasthenia gravis (MG) refractory to other therapies. Some data suggest younger age is a predictor of response. However, most reported rituximab-treated patients are under age 65. Comorbidities in older patients may preclude other immunotherapies, increase the risk of side effects, and necessitate a lower prednisone dose.

OBJECTIVE: To assess the efficacy and tolerability of rituximab in older patients with MG.

METHODS: Retrospective analysis of all patients from 3 centers first treated with rituximab for MG after age 65.

RESULTS: Fourteen patients (5 women, 9 men; 9 acetylcholine receptor antibody (ab) positive, 3 muscle-specific tyrosine kinase ab positive, and 2 double seronegative) were treated with rituximab. Mean age at rituximab induction was 73.8 ± 7.4 years and median disease duration 36.5 months. Thirteen patients had been treated with prednisone, most with additional immunotherapies. MGFA Post-Intervention Status was “Improved” or better in 7/10 (70%) patients six months after rituximab and 6/6 (100%) patients at 12 months. Median prednisone dose was significantly lower at 6 (12.5 mg/day, p=0.008) and 12 months (5 mg/day, p=0.028) compared to baseline (20 mg/day). Five patients received 1-6 additional courses. In 60 infusions, 5 infusion reactions occurred; all patients completed the infusions. Five patients had serious adverse events. No patients stopped rituximab due to side effects. Three patients died during follow-up.

SUMMARY/CONCLUSION: Most of our MG patients over age 65 improved with rituximab. Although adverse events were common, most were considered unrelated to rituximab and none led to drug discontinuation.

HEPATITIS B VIRUS REACTIVATION IN HEPATITIS B SURFACE ANTIGEN-POSITIVE MYASTHENIA GRAVIS PATIENTS WITH CORTICOSTEROID THERAPY
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INTRODUCTION: Hepatitis B virus reactivation (HBVr) is associated with long-term corticosteroid treatment. However, this phenomenon is poorly understood in myasthenia gravis (MG) patients.

OBJECTIVE: To investigate the relationship between HBVr in MG patients who were tested positive for antibody against hepatitis B core antigen (anti-HBc) and corticosteroid regimen.

METHODS: Twenty-five MG patients who were positive for anti-HBc were analyzed retrospectively.

RESULTS: 20 hepatitis B surface antigen (HBsAg)-positive patients and four HBsAg-negative patients underwent corticosteroid therapy with or without pre-antiviral therapy, one patient only received symptomatic treatment. The incidence of HBVr in HBsAg-positive patients receiving corticosteroid treatment without pre-antiviral therapy was significantly higher than in those undergoing pre-antiviral therapy (10/13, 76.9% vs 0/7, 0%; P=0.003). Thirteen HBsAg-positive patients who did not receive antiviral therapy in advance were administered with relatively high doses (76.9% patients were prescribed high doses) of corticosteroid treatments for a mean duration of 15.0 months; 53.8% of these patients underwent decremental courses of corticosteroid. According to HBVr risk classification, all high-risk patients, and 25% of patients who were at moderate risk, developed HBVr. Of the HBsAg-negative patients, one developed HBVr without pre-antiviral therapy (33.3%).

SUMMARY: HBsAg-positive MG patients receiving long-term and relatively high doses of corticosteroid treatments had a high risk of HBVr. Usage of pre-antiviral medications may prevent the occurrence of HBVr. HBVr risk assessment, the detection of serological status for hepatic viruses and liver function, along with antiviral prophylaxis, should therefore be considered before treating MG patients with corticosteroids, particularly those who are HBsAg-positive.
COGNITIVE PERFORMANCE IN BRAZILIAN PATIENTS WITH MYASTHENIA GRAVIS

INTRODUCTION: Although, the current literature does not present strong evidences about cognitive impairment in individuals with Myasthenia Gravis (MG), this is a frequent complaint among patients.

OBJECTIVE: To describe the cognitive profile of patients with MG.

METHODS: This is a cross-sectional descriptive study. The patients were recruited in the Neuromuscular outpatient clinics of a reference Hospital in Porto Alegre/Brazil. A standardized battery of instruments was utilized for assessing the cognitive profile (executive functions, memory and verbal fluency), MG quality of life questionnaire (MGQOL) and the MG Composite (MGC) as a clinical scale was applied.

RESULTS: Twenty eight patients was assessment, to be 75% (n=21) females, with a mean age of 48.64 (± 19.0) years, a mean education period of 9.18 (± 4.16) years and a mean disease time of 13.73 (± 10.17) years. Regarding the cognitive profile the percentage of patients with altered scores in each cognitive test was 39.3% (n=11) in MMSE, 75.0% (n=21) MOCA, 14.3% (n=4) in phonological verbal fluency. Concerning memory tests, 53.6% (n=15) in immediate memory, 35.7% (n=10) in short-term retention and 63.0% (n=17) in long-term retention. Just five patients had all cognitive tests with normal scores. In MGQOL it was observed a mean of 15.39 (±14.43) points (maximum score 30 – poor QoL) and in MGC a mean of 10.48 (±7.04) points (maximum score 50 – severe disease).

CONCLUSION: We observed a high percentage of individuals with cognitive impairment in executive functions and memory (immediate and retention) in this sample, even patients presented low scores at MGC and MGQOL.

CLINICAL CHARACTERISTICS OF JUVENILE MYASTHENIA GRAVIS IN SOUTHERN CHINA
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INTRODUCTION: Myasthenia gravis (MG) with onset in childhood or adolescence is termed juvenile myasthenia gravis (JMG). JMG and adult MG have many different manifestations. The characteristics and long-term outcome of patients with JMG is not thoroughly reported.

OBJECTIVE: To describe the clinical profile, clinical outcomes and factors that may affect the outcome of juvenile myasthenia gravis (JMG) patients in southern China.

METHODS: We reviewed information relating to JMG patients treated and evaluated at the First Affiliated Hospital, Sun Yat-sen University, between 1998 and 2015.

RESULTS: Overall, 77.4% patients showed initial symptoms in the prepubertal period. 306 patients showed only ocular symptoms at onset. 61 ocular myasthenia gravis (OMG) patients (61/306, 19.9%) had developed generalized myasthenia gravis (GMG). Anti-acetylcholine receptor antibodies (AChR-Ab) titer was an independent risk factor for generalization. 3.4% experienced spontaneous remission. Low-dose oral prednisone (0.25 mg/kg) was administered when symptoms did not significantly improve after pyridostigmine treatment. Optimal outcome was achieved in 59.6% of patients. Specifically, 18.3% attained complete stable remission, 3.7% attained pharmaceutical remission, and 37.6% attained minimal manifestation. In total, 21.5% attained CSR, a significantly higher proportion than the GMG patients (8.6%, P = 0.009). Moreover, 67.2% of patients with duration <2 years showed significant clinical improvement compared with 46.3% of those with duration >2 years (P < 0.001).

SUMMARY: There was a low frequency of cases positive for AChR-Ab in the Chinese population. AChR-Ab titer was revealed as an independent risk factor for generalization. Low doses of prednisone treated JMG effectively with few side effects.
CLINICAL OUTCOME AND PREDICTIVE FACTORS OF POSTOPERATIVE MYASTHENIC CRISIS

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INTRODUCTION: 10%–20% of MG patients suffer from thymoma and about 30% of thymoma patients have thymoma-associated MG (TAMG). Thymectomy is always prescribed for TAMG patients and has an important role in controlling symptoms of MG, but postoperative myasthenic crisis (POMC) may still occur in these patients. No data exist in describing the factors closely related to POMC in TAMG.

OBJECTIVE: To explore the clinical outcome and predictors of postoperative myasthenic crisis (POMC) in TAMG.

METHODS: 173 TAMG patients undergoing thymectomy from January 2000 to March 2013 were retrospectively reviewed. Variables affecting the occurrence of POMC were evaluated by binary logistic regression analysis.

RESULTS: Fifty-one patients experienced POMC. Univariate analysis revealed that events significantly associated with increased risk of POMC include symptom duration before operation >2.75 months, preoperative bulbar symptoms, incomplete resection, operation time >122.5 minutes and advanced stages (stage III or IV). Multivariate logistic regression analysis showed that preoperative bulbar symptoms (OR = 3.207 [1.413–7.278]; P = 0.005) and incomplete resection (OR = 4.182 [1.332–13.135]; P = 0.014) were independent risk factors for POMC. Twenty-eight patients died during the follow-up. The log-rank test revealed survival for patients with POMC was significantly worse than that for patients without POMC.

SUMMARY: The factors for developing POMC in TAMG patients include the preoperative bulbar symptoms and incomplete resection of thymoma. Moreover, the patients with POMC had a worse prognosis compared with patients without POMC. Our study highlights the need of appropriate preoperative management of TAMG patients to prevent the occurrence of POMC.

IMBALANCE OF TWO MAIN CIRCULATING DENDRITIC CELL SUBSETS IN PATIENTS WITH MYASTHENIA GRAVIS

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INTRODUCTION: Although it is well documented that circulating dendritic cells (DCs) have specialized features in many kinds of physiological and pathological condition of human, there is still lack reports about the features of DCs in the peripheral blood of myasthenia gravis (MG) patients.

OBJECTIVE: We aimed to investigate the quantitative and component features of DCs and their implication in MG.

METHODS: We collected peripheral blood from different kinds of MG patients and recorded their clinical characteristics. Using flow cytometry, we distinguished circulating DC subsets [plasmacytoid DCs (pDCs) and myeloid DCs (mDCs)] and enumerated their densities in peripheral blood.

RESULTS: Absolute numbers of circulating pDCs were significantly decreased in naïve MG patients compared with healthy controls, resulting in a markedly lower ratio of pDCs/mDCs (percentage). Thus, there was an imbalance in the proportions of different circulating DC subsets. We did not find clustered pDCs in the hyperplastic thymus of MG patients. The clinical status of MG patients was improved after drug treatment, together with an increased ratio of pDCs/mDCs. In a longitudinal follow-up, we observed that circulating mDCs were significantly reduced after 1 month of therapy with a steroid and immunosuppressant, resulting in recovery of the pDC/mDC ratio.

SUMMARY: The ratio of circulating DC subsets might reflect the balance between the autoimmune response and immune tolerance of a patient, and ratio changes during treatment could be a promising marker to predict the efficacy of a specific drug used for MG patients.