EMG Basics

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DISCLOSURE

Relevant Financial Relationship(s)
None

Off Label Usage
None
Learning Objectives

1. Describe the steps used during needle EMG examination
2. Identify ways to ensure adequate muscle relaxation
3. Recognize technical methods that can be used to reduce discomfort of needle examination
4. Identify technical factors that could lead to complications during EMG examination
Who is this person?
1) Andre Agassi
2) Roger Federer
3) Rafael Nadal
4) Donald Trump
Who is this person?
1) Andre Agassi
2) Roger Federer
3) Rafael Nadal
4) Donald Trump
Rafael "Rafa" Nadal Parera is a Spanish professional tennis player currently ranked world No. 9, widely regarded as the greatest clay court player in history and has been titled "The King of Clay"
Steps of Performing Needle Exam

1) **Planning the Study**
   - Problem solving approach
   - Clinical evaluation
   - Muscle selection
   - Special precautions

2) **Performing the needle examination**
   - Preparing the patient
   - Needle insertion and movement
   - Pain control

3) **Analysis of electrical activity**
Case

67 year-old woman with right back and leg pain referred by a neurologist for EMG. Per MD’s note: “Patient has predominantly pain in back and shin. Normal strength and reflexes on exam.”

What is the most likely diagnosis?

1. L5 radiculopathy
2. Lumbar plexopathy
3. Sciatic neuropathy
4. Fibular neuropathy
5. I don’t know
The patient is afraid of needles and will only allow you to examine one muscle. Which would you choose?

1. Tensor fascia lata
2. Iliopsoas
3. Vastus medialis
4. Anterior tibialis
5. Medial gastrocnemius
6. I don’t know
Planning the Study
A Problem Solving Approach

Hypothesis Generation:
- Gather data (review records)
- Re-confirm data (own history, exam)
- Define primary hypotheses: L5 radiculopathy
- Define secondary hypotheses and prioritize: #2 sciatic neuropathy, #3 lumbar plexopathy

Hypothesis testing:
Select studies to test “possible” hypotheses (NCS and EMG)
Planning the Study

Selection of Muscles

Examine muscles clearly involved (weak):
  • Define type of pathophysiology: neurogenic vs. myopathic
  • Define active vs. old process
  • Ideally examine mildly-moderately weak muscles

Examine muscles NOT likely involved
  • Narrows localization

Preferable muscle choices
  • Superficial, easily palpated
  • Less painful (FDI > APB, FL > EHL)

Suspected myopathy: limit to one side
Performing the Needle Examination

- Preparing the Patient
- Needle Insertion and Movement
- Minimizing patient discomfort
- Technical issues
Preparing the Patient

- Explain purpose *(Identify disease, distribution and severity)*

- Explain the test
  - Pin insertion, muscle recording,
  - No shock or electricity
  - Sterile needle

- Discomfort will be minimized
  - Very fine needle, pain averages 3 on a scale of 0-10
Needle Insertion and Movement
There are Wrong Ways to Do Things
Needle Insertion and Movement

• Identify and position muscle
  • Palpate muscle borders
  • Support muscle by hand

• Pull skin **taut** & **distal**

• Brace hand on muscle

• Hold needle firmly

• Warn the patient

• “Quick stick”
Needle Movement

- Move smoothly in short steps (0.5 to 1 mm)
- Straight line from insertion through muscle
- Pause 1-2 seconds to listen for slow fibs
Needle Movement

- 3-4 passes of 7-30 steps through muscle (different angles)
- Withdraw from muscle (not skin) between passes
Relaxation During EMG

- Methods to ensure relaxation:
  - Appropriate limb positioning at start
  - Passive limb movement
  - Contraction of antagonist
  - Distraction

- Exceptions:
  - Tongue, anal, respiratory, thoracic PSP
  - Spasticity, rigidity, tremor
  - Children
Reducing the Discomfort of the Needle Examination
How many have had an EMG?

How would you describe the experience?

1) Loved it !!!
2) Pleasant
3) Mildly uncomfortable
4) Very uncomfortable (wouldn’t want another)
5) Worse than childbirth
What patients sometimes tell us . . .

• “My sister had an EMG and said it wasn’t fun!”
• “When I had this test before, I told my doctor I would never have another one”
• “I read the brochure and don’t think that I want to have this done”
• “You are going to do WHAT to me?!!!”
• “I am allergic to needles and went into anaphylactic shock last time I had this!”
Likely to Have Difficulty

- Complains about the pain of the NCS
- Previous painful EMG study
- “I hate needles”
- “I have a high pain threshold”
- Consistent low pain threshold
  - Medical legal, worker’s comp, on disability, fibromyalgia
Likely to Have Difficulty
Minimizing EMG Pain
Patient Preparation

• Thoroughly explain test
• Emphasize that the patient is in control
• Reassure that everyone experiences some discomfort
• Warn about more painful muscles
• Distract with conversation
Minimizing EMG Pain

Which of the following is most likely to reduce the pain of needle EMG?

1) Use monopolar needle rather than concentric
2) Small step needle movements
3) Use surface analgesia prior to needle insertion
4) Move the needle rapidly through the muscle
5) Have the patient repetitively tense and relax the muscle
Which type of needle electrode do you use?

1) Concentric

2) Monopolar
What is the most important factor in your determination of needle electrode?

1) Cost
2) Degree of pain produced by needle type
3) I use what I trained with
4) More stable baseline
# Monopolar vs. Concentric Needle

<table>
<thead>
<tr>
<th></th>
<th>Monopolar</th>
<th>Concentric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>Baseline stability</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>MUP amplitude / duration</td>
<td>Slightly higher</td>
<td>Slightly lower</td>
</tr>
<tr>
<td>Recording surface</td>
<td>Larger</td>
<td>Smaller</td>
</tr>
<tr>
<td>Pickup area</td>
<td>Larger (multidirectional)</td>
<td>Smaller (directional)</td>
</tr>
<tr>
<td>MUP amplitude and duration</td>
<td>Longer /higher</td>
<td>Shorter / lower</td>
</tr>
<tr>
<td>Recorded noise</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>Patient discomfort</td>
<td>??? (Less)</td>
<td>???? (More)</td>
</tr>
</tbody>
</table>
Monopolar vs. Concentric Electrode Pain Comparison

- Pain with needle examination in 48 patients
  - 50-mm **concentric** vs 50-mm **monopolar**
  - **Small** (0.5-1 mm) vs **Larger** steps (0.5-1 cm)

Results: Immediate Pain

• Concentric needle
  • small steps significantly less painful (p < 0.001) than larger steps

• Monopolar needle
  • no difference in pain with step size

• Large steps: monopolar less painful, 0.01

• Small steps: no difference in needles
Minimizing EMG Pain

Needle Handling Techniques

• Needle movements less than one mm
  ✓ Brief insertional bursts

• Straight line movements with pauses

• Smooth, steady movements (no jabs)

• Constant muscle contraction level

• Move away from painful areas (end plates)

• Continuous discussion and feedback
Endplate Activity

- Painful, move away quickly (Turn preamplifier on immediately after needle insertion)
- Hissing and crackling sounds
- Rapid, irregular firing
- Small needle movements - more control
Analgesic Medication

- Minor tranquilizers
- Analgesics - propoxyphene, codeine, etc.
- Conscious sedation
  - Versed given by anesthesiologist
- Surface analgesia
  - Jet injection of Xylocaine
  - Reduces pain of needle insertion through the skin
  - Does not help with pain of needle in muscle
EMLA Cream

- **Eutectic Mixture of Local Anesthetics**
  - Emulsion of lidocaine and prilocaine
- Needs 60 minutes for full effect; apply before NCS
- Doesn’t penetrate thick skin of foot or thenar eminence
Special Considerations and Potential Complications

- Infection precautions
- Coagulopathy
- Obesity
- Cutaneous issues
- Pneumothorax
Infection Precautions

• Universal Precautions for all studies
  • Disposable, sterile electrodes
  • Gloves
  • “Special” precautions - Hepatitis, AIDS

• Cardiac valve disease prophylactic antibiotics not necessary
Anticoagulation

What is the highest INR in which you would comfortably examine the deltoid muscle of a patient on Coumadin?

1) INR 1.5
2) INR 2.0
3) INR 3.0
4) INR 4.0
5) Any INR
6) Will not perform needle EMG on Coumadin
Anticoagulation

• No defined “practice parameter” regarding “safe” level of anticoagulation

• Incidence of complications (controls vs. ASA/clodidogrel vs. warfarin) has been studied

• Decision is individual
  • Most MDs will perform with INR < 3.0
  • Thrombocytopenia less than 30,000

• Hemophilia - consult hematologist
Table 2. Muscles examined.

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Control</th>
<th>ASA/clopidogrel</th>
<th>Coumadin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>100</td>
<td>116</td>
<td>107</td>
</tr>
<tr>
<td>Cervical paraspinals</td>
<td>17</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Thoracic paraspinals</td>
<td>17</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>Lumbar paraspinals</td>
<td>13</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Tibialis posterior</td>
<td>7</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Flexor digitorum longus</td>
<td>10</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>Flexor pollicis longus</td>
<td>25</td>
<td>18</td>
<td>31</td>
</tr>
<tr>
<td>Iliopsoas</td>
<td>11</td>
<td>17</td>
<td>12</td>
</tr>
</tbody>
</table>

ABSTRACT: Introduction: Although needle electromyography (EMG) appears to be a relatively safe procedure based primarily on clinical experience, no evidence-based guidelines exist for EMG procedures in patients taking anticoagulant or antiplatelet medications. We sought to determine whether there is an increased risk of hematoma formation after EMG of potentially high-risk muscles in patients taking anticoagulant or antiplatelet agents. Methods: After undergoing routine EMG, if any of seven predetermined high-risk muscles were tested, study subjects then underwent ultrasound to evaluate for hematoma formation. Results: Patients were divided into three groups based on medication (warfarin, aspirin/clopidogrel, no blood-thinning medication), with at least 100 muscles examined per group. Two small, subclinical hematomas were seen on ultrasound; there was no difference in hematoma risk between groups ($P = 0.43$). Conclusions: Our findings suggest that hematoma formation from standard needle EMG is rare even in high-risk muscles, which have been avoided historically in anticoagulated patients.

Technique in Anticoagulated Patients

• Limit number of muscles
• Limited needle movement
• Avoid deep and higher risk muscles
  • Anterior compartment of leg
  • Muscles neighboring arteries (FPL, Iliopsoas)
  • Paraspinal muscles
• Prolonged, firm pressure
Needle Techniques in Obesity

• Positioning

• Long needles - 75, 90, 120 mm
  • Not to the hub

• Electrical activity
  • Deep palpation

• Caution with difficult muscles
Peri-pleural Muscles

- Trapezius
- Cervical paraspinals
- Rhomboid
- Serratus anterior
- Intercostal & diaphragm

Methods:
- Slow, smooth needle movements
- Listen for short rise time MUPs
- Withdraw when rise time slows
- Listen for respiratory pattern of firing
Needle Technique Summary

• Establish primary and secondary hypotheses
• Plan EMG study approach appropriately
• Take necessary precautions
• Minimize discomfort
• Satisfactory EMG is almost always possible
Questions?