Corrective Lower Limb Bracing for Charcot-Marie-Tooth Disease

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AANEM 2011

Reviewed and accepted by the 2011-2012 Neuromuscular Committee of the American Association of Neuromuscular & Electrodiagnostic Medicine Certified for CME credit 10/2011 – 05/2020
Reviewed 10/2017 by the 2017-2018 Neuromuscular Committee
ORTHOSIS

Is an orthosis a product or a clinical procedure? It is both a clinical service and a product. However, the clinical portion comes first and must be of sound biomechanical correction for the orthosis to work.
Balance loss is the most common complaint CMT patients have when evaluating for AFOs. Balance loss can cause pathological gait to be more exaggerated. With standing balance loss, CMT patients will need to rely on leaning on objects while standing, and touching objects such as walls while walking.
DEFINITION OF AN ANKLE-FOOT ORTHOSIS

Any orthotic device for the lower limb that encloses the ankle and foot and does not extend above the knee, and is intended to prevent a foot from dropping due to inadequate dorsiflexion.
DEFINITION OF A KNEE-ANKLE-FOOT ORTHOSIS

Any orthotic device for the lower limb that extends from above the knee to the ankle and foot.
FACTORS USED TO DETERMINE AND PRESCRIBE A LOWER LIMB ORTHOSIS:

• Age
• Overall strength
• Hand involvement
• Quadriceps strength
• Tibialis anterior strength
• Gastrocnemius strength
• Extent of damage to muscles, tendons, ligaments, bones, joints, and balance
EXAMPLES OF ORTHOSES
PATHOLOGIC GAIT AFFECTING ANKLE AND FOOT

Pathologic gait is when the strength, joint mobility, and coordination for walking represent only a fraction of normal lower-limb potential.

Ankle and Foot

• Inappropriate initial contact
• Low heel strike
• Flat foot contact
• Forefoot contact (toe strike)/footdrop

All of the above contribute to a steppage gait.

We can also observe pathologic gait from an AFO that is not performing properly.

From the Atlas of Orthotics, Biomechanical Principles and Application, American Academy of Orthopaedic Surgeons
PATHOLOGICAL GAIT AFFECTING THE KNEE

• Excessive flexion (used to compensate for balance loss)
• Flexion limited, absent, or excessive
• Hyperextension (most commonly observed with CMT)
• Varum / Valgum

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WHAT ARE THE MOST COMMON SYMPTOMS WITH CMT WHEN EVALUATING FOR BRACING?

- Footdrop
- Pes cavus deformity
- Varus deformities
- Valgus deformities
- Muscle atrophy
- Balance loss
PRIMARY BRACING CORRECTIONS FOR CMT SHOULD ADDRESS THE FOLLOWING:

- Foot drop
- Loss of balance
- Gastrocnemius weakness
- Foot and ankle deformity
- Slow walking speed
What are gait deviations? What do all gait deviations have in common?

They are deviated movements of other muscles and joints of the body to compensate for loss of motor power due to a neuropathy.

Main Goal:

To prevent the toes from hitting or dragging on the ground, which can cause the person to trip or fall.
PRIMARY GAIT COMPENSATIONS WITH CMT

• Bilateral hip hiking-causes a steppage gait
• Lateral trunk bending
• Circumduction

All of these gait deviations are due to weakness of: Tibialis Anterior
MOST COMMON FOOT DEFORMITY

Pes Cavus
OTHER CMT FOOT DEFORMITIES

Varus

Valgus
EFFECTS OF DROP FOOT AND BALANCE LOSS

1. Increases oxygen consumption
2. Overtaxes the existing musculature that is working
3. Early fatigue
4. High risk for tripping and falling
EFFECTS OF UNCORRECTED FOOT DEVIATIONS OR DEFORMITIES

1. Contractures—the achilles tendon becomes shortened from a lack of dorsiflexion
2. Ligamentous laxity—ligaments become overstretched due to improper joint alignment. This causes further instability at the foot and ankle, and creates more balance loss
BRACING CORRECTION TECHNIQUES FOR CMT

- Corrective mold taken properly should incorporate realignment of joint deviations
- Lab modifications or corrections
- Test braces (diagnostics)
  - If necessary
- Corrective brace fabrication
- Final fitting of device
  (including adjustments)
ACHIEVABLE ALIGNMENT CORRECTIONS WITH CMT

Valgus of 29 degrees
Valgus reduced to 3 degrees
WHAT SHOULD CORRECTIVE CMT BRACING CONSIST OF?

Tri-Planar Correction

The patient’s foot and ankle need to be corrected as much as possible in all 3 planes of movement

1. Ankle Joint-or Talocrural Joint movements are:
   - Dorsiflexion
   - Plantarflexion

2. Subtalar Joint movements are:
   - Eversion (pronation)
   - Inversion (supination)
TRI-PLANAR CORRECTION

3. The midtarsal joint (transverse tarsal joint):

   Formed from the:
   Talonavicular and Calcaneocuboid joints.

   Movements = Inversions and eversion-moves in a transverse plane up and down, side to side transverse.
BRACING CORRECTION TECHNIQUES FOR CMT

- Triplanar correction
- Corrected alignment
- Balance restoration
- Prevention of further deformity
- Example of a more functional gait through energy storing mechanics
BALANCE AND BRACING
BASIC PRINCIPLES

1. If the patient cannot stand with balance—they cannot walk with balance.
2. Balance requires a stable foundation—if the foot and ankle are not corrected in the brace’s footplate, balance will be poor.
3. Balance restoration also requires practice, much like learning a new sport.
4. Floor reaction brace design help CMT patients with balance
BENEFITS OF CARBON FIBER

- Maintains shape
- Does not torque (bending motion) against rotational forces
- Can be structured differently in one device
- Can be used for energy storing devices
Energy Storing Brace CHARACTERISTICS

- It is custom made for each CMT patient, out of multiple layers of carbon fiber and a para-aramid synthetic fiber
- Carbon fiber will not twist or bend like plastic
- Carbon fiber is rigid where it should be and will flex and give energy release where we desire it to flex
- It will effectively store energy, and provide significant spring assist.
ACHIEVEMENTS WITH CMT PATIENTS AND ENERGY STORING BRACES

CMT Patient completes Boston Marathon in April 2008