Corrective Lower Limb Bracing for Patients with CMT

Definition of an ankle-foot orthosis (AFO):
Any orthotic device for the lower limb that encloses the ankle and foot, 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, and is intended to control the knee joint in addition to the foot and ankle.

Bracing for adults and children
Dropfoot and balance loss are the most common complaints CMT patients have when evaluating for AFOs. Balance loss can cause pathological gait to be more exaggerated. With balance loss, CMT patients will need to rely on objects to lean against while standing, and to touch objects, such as walls, while walking.

Bracing for children with CMT should consist of all the same clinical evaluations and goals as for adults. One primary difference is consideration for growth. As growth rates cannot be controlled or clinically predicted, it is in the discretion of practitioners as to whether they could build in extra length to the device for potential growth without compromising fit, stability, and function.

Another difference in treating children is that there may be a more intense focus on correction than with adults, to the point of even over-correction, knowing the ongoing progression of deformity that often occurs in CMT patients. Adults can still achieve significant correction in gait, and this should be the goal in orthotic treatment.

Factors used to determine and prescribe a lower limb orthosis:
- Tibialis anterior strength
- Gastrocnemius strength
- Quadriceps strength
- Age
- Overall strength
- Hand involvement
- Extent of damage to muscles, tendons, ligaments, bones, joints and balance.

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, where the legs raise abnormally high to compensate for toe drag.

Thus the main goal of orthotic treatment is to prevent the toes from hitting or dragging on the ground, which can cause the person to trip or fall.

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

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

Gait deviations with cmt
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.

Primary gait compensations with cmt
- Bilateral hip hiking; causes a steppage gait
- Lateral trunk bending
- Circumduction; circular movement of the leg to prevent the toes from dragging on the ground.

All of these gait deviations are due to weakness of the Tibialis Anterior.

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Effects of drop foot and balance loss
:: Increases oxygen consumption
:: Overtaxes the existing musculature that is working
:: Early fatigue
:: High risk for tripping and falling

Effects of uncorrected foot deviations or deformities
:: Contractures—the achilles tendon becomes shortened from a lack of dorsiflexion
:: 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)

Corrective cmt bracing should 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
2. Subtalar Joint
3. The midtarsal joint (transverse tarsal joint)

Types of orthoses:
:: Posterior leaf spring Ankle-foot orthosis (AFO)
:: Solid ankle AFO
:: Floor reaction AFO
:: Jointed AFO
:: Range-of-motion adjustable jointed AFO
:: Energy storing carbon fiber AFO
:: Knee-ankle-foot orthosis (KAFO)
:: Energy storing KAFO
:: Off-the-shelf AFOs (not recommended for CMT patients with moderate or severe deformity, or edema)

Differences between custom and off the shelf orthoses (AFOs)
:: Custom made AFOs are made from a mold of the patient’s leg, in order to fabricate a custom fit device which can address different structural deformities.
:: Off the shelf are not made from molds. They are pre-manufactured, and are typically fit by sizes; small, medium, large, left and right.

Corrective bracing goals for cmt
:: Triplanar correction
:: Corrected alignment
:: Balance restoration
:: Prevention of further deformity
:: 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 can be poor.
3. Balance restoration also requires practice. Physical therapy should be incorporated if needed.
4. Floor reaction brace design helps CMT patients with balance.
5. Energy storing designs can help patients reduce fatigue.

Current materials used in bracing fabrication
1. Thermoplastics
2. Metal
3. Leather
4. Carbon fiber

Benefits of carbon fiber
:: Maintains its shape.
:: Does not torque (bending motion) against rotational forces
:: Can be structured differently in one device
:: Can be used for energy storing devices

It is recommended that CMT patients who experience balance loss, foot/leg pain, or an irregular gait obtain an evaluation by a certified orthotist. Uncorrected gait and balance issues can lead to other complications, including progression of further joint deformity, progression of muscle weakness and fatigue, increased risk for falls, and overall negative impact on quality of daily activities.

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