

The Denver "T" Ankle-Foot Orthosis: A Unique Orthotic Approach in Selected Hemiplegic Patients

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INTRODUCTION

In many spastic hemiplegic patients with functional equinovarus deformities and ankle instability during ambulation, conventional in-the-shoe ankle foot orthoses (AFO's) when fabricated to provide good mediolateral stability, cause excessive flexion moment at the knee at heel strike, causing knee instability. They also often limit dorsiflexion enough to result in exacerbation of the problem of genu recurvatum at toe-off. On the other hand, if the orthosis is fixed to the shoe externally, stimulation of the ball of the foot will often cause excessive extensor spasticity, resulting in increased energy expenditure and more difficult gait.

The Denver "T" AFO, developed in the Orthotics Laboratory at the Denver Veteran's Administration Medical Center, is a custom-molded orthosis which provides excellent mediolateral stability while allowing relatively free ankle dorsiflexion. It

provides mild to moderate dorsiflexion assist which may be varied according to patient requirements, but does not provide excessive plantar flexion resistance at heel strike. Precise trimming posterior to the metatarsal heads prevents excessive stimulation of extensor spasticity, and the polyethylene material from which it is fabricated is extremely light in weight and flexible, causing the orthosis to be well-accepted by patients.

This orthosis is most effective in those hemiplegic patients who exhibit some toe and ankle dorsiflexion as part of a mass flexion pattern, but who cannot control this dorsiflexion throughout the gait cycle, and who may have equinovarus pattern at stance phase and/or ankle instability. It is also of use in those patients who have some limited dorsiflexion, but lose this as they become fatigued. It has generally not been useful in patients who have no ankle dorsiflexion, and should be used with caution where there is insensate skin.

DESCRIPTION OF TECHNIQUE

Patients are evaluated by the Orthotic Clinic Team, consisting of a Rehabilitation Medicine Physician, Orthotist, and Physical Therapist prior to the prescription of the orthosis. Criteria for trial of this orthosis are as follows: The patient has or has nearly achieved maximal neuromuscular function through optimal rehabilitation. The patient exhibits some ankle dorsiflexion in or out of mass pattern. Skin sensation is not totally absent. Moderate to severe spasticity is not a contraindication to use of this orthosis. If possible, gait is evaluated using a pre-fabricated "T" orthosis of appropriate size.

After marking bony prominence and tendons, a negative mold is made in a sitting position with the knee and ankle at 90° and the foot flat on the floor. A positive mold is poured and a 3/4" pipe with vacuum hole is inserted. Modifications include relief over the malleoli and other bony prominences and extensor tendons. The positive mold is then sealed and prepared for vacuum-forming. A sheet of 3/16" Vitathene® is cut to proper size, heated to approximately 190°C, and vacuum-formed over the mold using approximately 20" Hg negative pressure. Edges are brought together to form a seal in the anterior midline.

After curing at room temperature for 24 hours, trim lines are marked as shown (Figures 1 and 2). Overall height of the orthosis is 2.5" above the superior border of the medial malleolus. The posterior cutout extends from two inches below the top of the orthosis to the apex of the calcaneus, and laterally to 1/2" behind the posterior edges of the malleoli. The anterior trim line extends from the cuff section posterocaudally to the anterior borders of the malleoli, mid-lateral aspect of the foot, and plantar surface posterior to the metatarsal heads. The plantar surface is carefully beveled for comfort and even pressure distribution. The orthosis is finished with a 1 1/2" Velcro® strap and Chafe-keeper (Figure 3). This may be adapted for various upper extrem-

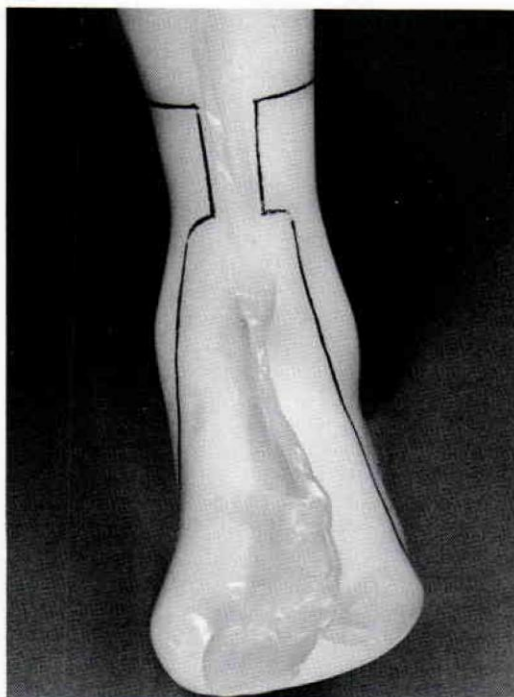


Figure 1. Anterior trim lines.

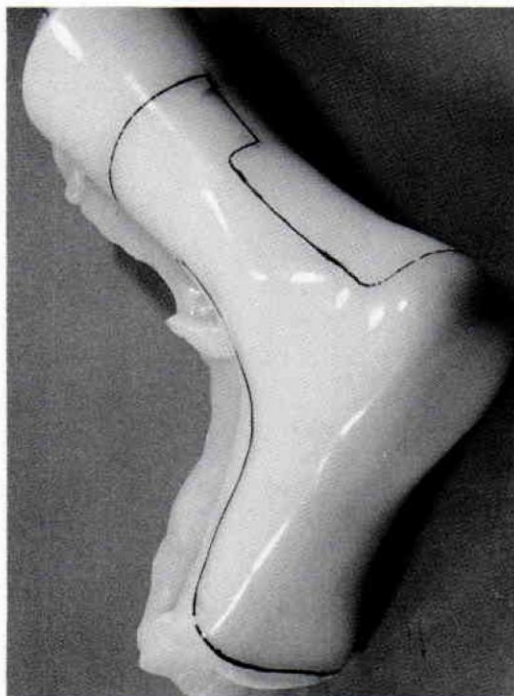


Figure 2. Posterior and lateral trim lines



Figure 3. Finished orthosis.

ity disabilities. The patient will generally require shoes one size wider than his normal width to accommodate the orthosis.

A small to moderate increase in dorsiflexion assist may be achieved by increasing the height of the orthosis and/or increasing the width of the vertical side portion. The posterior cuff, which is usually split (Figure 4) to increase flexibility and ease of donning, may be left solid if more dorsiflexion is needed. In cases of severe spasticity, a Bobath toe spreader has occasionally been used with the Denver "T" AFO with excellent results.

The orthosis is fit over the patient's normal stocking, and checked for adequate relief of pressure over bony prominences and tendons (Figure 5). The patient then wears the orthosis for a short time, after which the orthotist checks for skin problems and makes necessary adjustments. If there is an alteration in skin sensation, the patient is instructed to check the skin at regular intervals and gradually increase wearing time over the first two weeks of use. Telephone followup has been done at

six weeks, three months, and six months, and patients are told to contact the orthotist if they experience any problems with the orthosis.

DISCUSSION

This orthosis was evaluated at the Denver Veterans Administration Medical Center with 17 hemiplegic patients for three to 20 months. Sixteen of the patients were successful users, while one, who had a concomitant nerve injury and insensate foot, discontinued use due to skin breakdown. All patients who had previously used double upright orthoses or polypropylene AFO's found the Denver "T" ankle foot orthosis superior in comfort, convenience, light weight, and stability to their previous orthoses. Clinical gait evaluations showed improvement of gait in all patients evaluated. Formal biomechanical analysis of the orthosis is planned, and application of these principles to other orthotic problems is being explored.

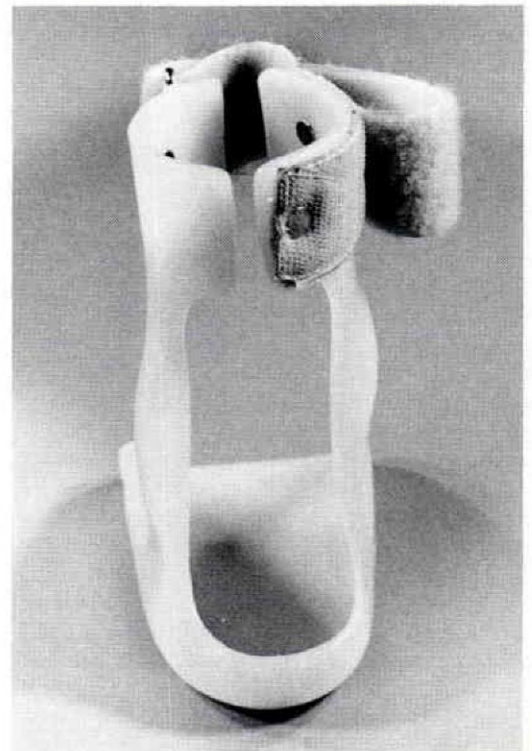


Figure 4. Finished orthosis.

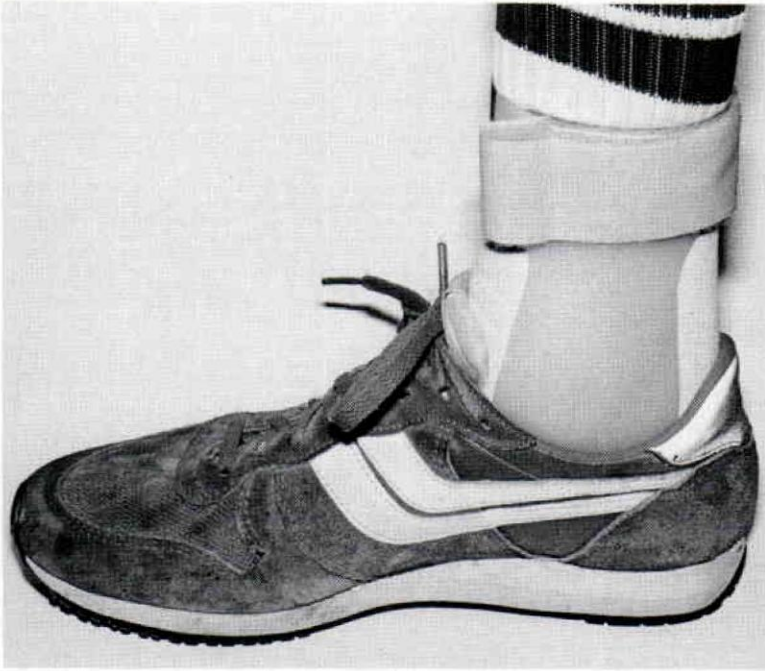


Figure 5. Orthosis is worn over regular stocking inside patient's choice of shoe.

CONCLUSION

The Denver "T" ankle-foot orthosis represents an effective new approach to the problem of functional equinovarus deformity and ankle instability in selected hemiplegic patients. It is designed to make use of neurodevelopmental principles to maximize gait efficiency, and is exceptionally well-accepted by patients.

AUTHOR

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