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Prosthetic Management of Partial Foot Amputation (Trans-metatarsal foot) - A Case Study

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ABSTRACT

Background: Partial foot amputees encounter some issues as gait abnormalities due to changes in biomechanics, COG, limb length and propulsion. A specifically designed supramalleolar orthosis was fabricated in order to overcome the problems.
Case description and Method: The supramalleolar orthosis was designed on the basis of patient's condition and complaint. The proximal trim line was extended above the malleoli to ensure medio-lateral stability and rocker bottom was provided for proper push off in terminal stance.
Result: This orthosis provided optimum stability medio-laterally and Push-off was initiated by rocker bottom at the end of stance phase.
Conclusion: This orthosis is an economical and light weight design with proper biomechanical implications.

Key Words: Partial foot orthosis, Supramalleolar orthosis, Mediolateral stability, Terminal stance push off, Partial foot amputee

INTRODUCTION

As per literature, about 2 out of 1000 people are partial foot amputates in industrialized area. Partial foot amputation has a 30-50% complication rate, which is much higher than proximal amputation, so the need for excellent care is paramount[1].

Forefoot amputation is associated with biomechanical deficiencies due to loss of anterior lever arm through disruption of its bony architecture, ligamentous structure and musculature[8]. As the amputation level becomes more proximal (as the length of the residual foot decreases), the gait characteristics will change including reduced sound side step length, decreased velocity, increased energy expenditure and increased vertical load on the sound side. The biomechanical deficiencies like decrease in plantar weight bearing surface, impaired pronation and supination during gait, Loss of active push-off, Weight bearing problems also increases as more of transverse and longitudinal arch structures are disrupted and the normal contours of the foot are destroyed [9,10].

In order to design a proper orthotic management, clinician has to understand the functional differences and considerations for all the levels of partial foot amputation with regard to skeletal anatomy, muscular involvement, and load bearing capability.

The existing designs of orthosis and prosthesis for partial foot amputation are only intended to restore the effective foot length and normalize the gait and function[2]. Whereas, the supramalleolar orthoses is designed to keep the foot in neutral position avoiding deformities which impair

plantarflexion motion and ankle dorsiflexion motion so important in gait mechanics.

METHODOLOGY

Case Report

A 72-year-old man, who had left trans-metatarsal foot amputation in 2006 secondary to Hansen's disease reported to P&O department. Following the amputation, he was undergone rehabilitation procedure. He was provided with MCR footwear until 2017. With the MCR footwear patient was satisfied and life was normal. Patient was able to ambulate inside the house as well as outside. All the daily living activities he was able to perform.

Subject's chief complaint was pain at the distal foot and instability during walking. During evaluation, it was found that over the years contour of the foot changed and hind foot pronation was developed. There were no limitations in joint motion. But scar over bony prominences were found due to use of shoes over years.

Biomechanical deficiencies include reduced plantar weight bearing surface, impair pronation and supination during gait, loss of active push-off are observed. During gait analysis, reduced sound side step length, decreased velocity, increased energy expenditure and increased vertical load on the sound side were observed.

Objective:

The study is aimed to design a supra-malleolar orthosis for trans-metatarsal amputation to provide external support and to control hindfoot pronation.

Design concept –

This is a modified approach of molded supra malleolar orthosis specially designed for transmetatarsal amputation. The orthosis was made by light weight polypropylene plastic and ethaflex was used for lining smooth skin contact between the plastic and the skin. EVA was used for toe filler (Fig 1-a&b).

Fig 1-a: Anterior view b: Medial view of the orthosis

Prior to casting, evaluation was done to determine joint limitations. Mainly pronation of foot and medio-lateral instability of the foot was examined. The materials used in this orthosis are 6mm ethaflex, 6mm polypropylene sheet and 10mm black eva.

The proximal medial and lateral trim line of this design is 5cm superior to the medial and lateral malleoli, 2 cm wide along the calcaneal tuberosity for posterior trimline and the anterior trimline is 6 cm width along the medial and lateral malleoli and just proximal to stump end.

Rocker bottom was created by dividing the sole into 3 equal parts and 1 cm added at the forefoot area. 1 inch from the floor to anterior part of the shoe was marked

and the inclined line was drawn from the marking. According to the inclined line rocker bottom was made. The addition of rocker sole to the shoe can reduce the ground reaction force to act directly onto the cut bone ends. This also further reduces the moment that tends to cause rotation of prosthesis relative to residual foot at end-stance. The rocker sole allows the orthosis for push-off at the terminal stance.

The biomechanical deficiencies of the transmetatarsal foot like, impaired pronation and supination during gait, Loss of active push-off, reduced fore foot weight bearing areas which are observed during evaluation were attended through this supramalleolar orthosis.

RESULT

This design of supramalleolar orthosis delivered optimum stability when got trial with patient. Height accommodation was managed to contralateral footwear according to orthosis height. As the orthosis is built with rocker bottom it allowed push-off in terminal stance phase for normal walking and it was able to control the mediolateral instability and hind foot pronation adequately.

Fig 2: Patient Walking with the orthosis

DISCUSSION

The lisfranc and chopart amputations almost always develop equinus deformity. This causes a painful residual limb when patient walks. It may also cause development of ulcers, since the limb leans on sensitive tissue. Besides causing an abnormal gait pattern it may generate knee hyperextension and in the long run, genu recurvatum.[14]

Dorsiflexion and Plantar flexion are important during second phase of gait. A supramalleolar orthosis allows an appropriate mid-lateral support and avoids equinus better than other designs. It limits the motions by keeping the foot in neutral position, thereby affecting normal walking.

As this orthosis is tried with leprosy patient donning and doffing may be difficult because of trim lines to enhance self-suspension. If the orthosis will be worn by active patients who had amputation due to trauma it would provide more efficient gait pattern (push-off) and mid-lateral stability.

CONCLUSION

This case report shows that the supramalleolar orthosis can be an effective treatment option in tarsometatarsal amputation. The medio-lateral support provided by this orthosis maintains the stability of ankle joint, avoiding malleoli varus and valgus. Because of low cost, light weight and flexibility with all kid of shoes, it will be preferred mainly by lower economic group patients in developing countries.

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