Effects of modified foot orthoses on vertical ground reaction force and pain in patient with unilateral plantar fasciitis- A case report

POLY GHOSH

ABSTRACT

**Background:** Plantar fasciitis is associated with alteration of vertical ground reaction forces and pain that needs to be treated by using foot orthoses.

**Objectives:** The purpose of the case study is to find out the effect of modified foot orthoses on vertical ground reaction force and quantify the force with and without orthoses.

**Materials and methods:** A female subject with unilateral plantar fasciitis in left foot was included in the study. Subject had been provided with modified foot orthosis. Pain was evaluated by using visual analogue scale and vertical ground reaction force was measured by Computer Dyanography Ultraflex Gait Analyser. All measures were acquired before the fabrication of Modified foot orthosis as a baseline data and after that modified foot orthoses was fabricated. Patient was discharged with the orthoses and after 12 weeks of follow up pain and vertical ground reaction force was measured.

**Results:** There was significant improvement in pain as well as ground reaction force by using modified foot orthosis. Vertical ground reaction forces measured during taking baseline data which was different from right foot at loading response, midstance and terminal stance. Follow up data was taken at 12 weeks after use of the orthosis. Pain ratings during baseline was 7.3 and 12 weeks of follow up pain was reduced by 3.8 measured by Visual analog scale.(VAS)

**Conclusion:** Modified foot orthosis significantly reduces pain experienced during walking and normalizes the vertical ground reaction force in patient with unilateral plantar fasciitis.

**Keywords:** Plantar Fasciitis, Modified Foot Orthosis, Vertical Ground Reaction Force, Visual Analogue Scale, Computer Dyanography Ultraflex gait analyser.

DOI: 10.5455/ijhrs.000000116
2 and other factors that causes plantar fasciitis are training error, excessive weight, age related degenerative changes, occupations requiring prolonged standing or ambulation those falling into this category include teachers, construction workers, cooks, nurses, military personnel, and athletes training for long distance running events, and shoes with poor cushioning. In the presence of these risk factors, excessive tensile forces may cause micro-tears in the plantar fascia.\(^3\)

Orthoses are a commonly advocated therapy for plantar fasciitis.\(^4\) Arch support, heel pad, prefabricated night splint and foot orthosis are commonly prescribed orthosis for plantar fasciitis.\(^5\) Foot orthosis are mostly used in the conservative treatment of plantar fasciitis.\(^6\) Foot orthosis are also believed to optimize biomechanical loading of the foot, more specifically to decrease excessive pronation, off-load the plantar fascia at its origin, and recreate the shape of the heel pad.\(^7\) Foot orthosis includes temporary foot orthosis, custom made functional foot orthosis and UCBL.\(^8\) The rigid foot orthosis plays an important role in torque curve caused by transverse rotation of the lower extremity during stance phase of gait and showed a near to normal force pattern.\(^9\) It has been reported that Custom foot orthosis causes reduction of pain as well as disability rating 66% and 75% respectively.\(^10\) Plantar fasciitis causes alteration of mechanical load and vertical ground reaction force (VGRF) during gait between symptomatic and asymptomatic limb.\(^11\) Biomechanical changes mainly occur in alteration of ground reaction forces, which may cause other associated pathological condition. Orthotic solution for plantar fasciitis is mostly heel cushion, which only provides cushioning effect for the reduction of symptoms, but does not correct any biomechanical causes. Aim of this case study is to find out the effect of modified foot orthosis on vertical ground reaction force and quantify the force with and without orthosis. To reduce the pain and normalization of vertical ground reaction force patient was given a modified foot orthosis made out of polypropylene and Eva thane with heel post.
Background: –

Mrs. Laxmi Mukherjee, 48 years old lady who suffered from pain at left heel from June, 2014. Her body weight was 48 kg and height was 1.53 m. Her chief complaint was morning pain and unable to bear weight on left foot, but after sometimes she can take the weight on left foot. Again the pain started during doing daily activities. She came to NIOH and was diagnosed as plantar fasciitis with calcaneal spur. Then she was started to take medicine. But after continuing medicine pain was resumed but again when she stopped taking medicine pain started. Assessment had been done. Patient was a housewife and she used to cook in prolonged standing position. To confirm the plantar fasciitis, Windlass test was carried out and it was positive, pain was at medial calcaneal tuberosity of left foot. Xray finding showed a calcaneum spur at left heel. Navicular drop test was negative.

Method:-

The patient was reported to OPD of NIOH and patient was diagnosed as a unilateral plantar fasciitis with calcaneum spur at left foot. After that doctor had sent her to prosthetics and orthotics department. Patient was evaluated properly to confirm plantar fasciitis and prescribed a modified foot orthosis. Then baseline data for pain and vertical GRF was taken with subject wearing shoes only for the both feet i.e. asymptomatic and symptomatic feet by Computer dyanography Ultraflex gait analyser.

Measurement and casting was taken for the fabrication of modified foot orthosis. Casting was taken in prone position with the patient lying on plinth in the figure four position. The casing technique used for the fabrication of orthosis was slipper cast technique with the subtalar joint in neutral position.
FIG: - 1 Casting procedure.

Positive cast was modified and at the time of modification, trimline of the orthosis were decided. Anterior trimline of the orthosis was extended 1cm proximal to the first metatarsophalangeal joint at the medial side and 0.5 cm proximal to the fifth metatarsophalangeal joint on the lateral side. Posterior trimline of the orthosis was extended 12-14mm above the ground at the heel cup region and this trimline extended posteromedially up to sustentaculum tali. Medial and lateral trimline were extended from the heel cup and joined to the anterior border of the orthosis.

Soft insert was fabricated with 3mm Evathene. To provide relief for calcaneus spur Evathene was scooped out at spur area. Heel post was attached at heel area of the soft insert to maintain the subtalar neutral. Then orthoses was molded with 4mm polypropylene sheet. Material used in the fabrication of the orthosis was as per body. The final check out of foot orthosis was performed, donning and doffing training given and patient discharged with the orthosis. Subject was advised to wear the orthosis with shoe as much as possible during walking, standing and others activity, at least 8hrs per day. Some care and maintenance of the orthosis was advised like clean the orthosis with mild soap water regularly, remove the orthosis from the shoe when orthosis is not being used. Subject was instructed to contact in the OPD in case she faces any problem with the use of the orthosis.

Follow up data with orthosis was taken after 12 weeks regular use of orthosis. This follow up data was taken for the both symptomatic and asymptomatic feet with the subject wearing modified foot orthosis within the shoe in the symptomatic limb and only shoe in the asymptomatic limb. Vertical ground reaction force was measured through Computer dyanography ultraflex gait analyser and pain was assessed by visual analog scale. The orthosis function effectively and a great improvement was seen in Vertical ground reaction force and pain.

Procedure of measuring Vertical ground reaction force distribution:

Vertical ground reaction force distribution was measured by Computer Dyanography gait analyser (Infrotronics Medical Industrial Engineering). Computer dyanography Ultraflex gait analyser system consists of microcontroller (Ultraflex unit with memory stick), a pair of CDG shoe with 8 foot sensors in each CDG shoe and cable attached with microcontroller to foot sensor. The foot sensors data was digitally acquired at a sampling frequency of 100 Hz and stored in Memory stick of Ultraflex unit. The Ultraflex is a portable battery operated microcontroller unit storage facilities for offline analysis. Subject was asked to wear shoes and then made to wrap the microcontroller called Ultraflex unit around the waist and a pair of CDG shoes with foot sensors of appropriate size were put below the shoes to collect the data. The data of subject
was collected in gait lab of National Institute for the Orthopedically Handicapped, Kolkata, India. Before recording the data subject was made to walk with the instrument for 10 meters to get acquainted with the instrument. After that subject was asked to walk for 20 sec on level ground surface at self-selected speed. Three data were taken and 30sec rest period was given between each data and mean of the three data was taken as a final data. Baseline data of symptomatic and asymptomatic foot was taken with the subject wearing shoe only according to the above mentioned procedure. Follow up data was taken with the subject wearing shoe with orthosis in the symptomatic foot and shoe only in the asymptomatic foot again according to the above mentioned procedure.
Fig: - 3. Application of CDG to the patient
Measurement of pain intensity
Pain intensity was assessed on a horizontal line by using a Visual analogue scale (VAS). This horizontal line consists of 11 marks from 0 to 10 at an equal distance. A Zero (0) denotes no pain and ten (10) indicate worst pain. The subject was explained about Visual analogue scale and asked to mark on the horizontal line that best denote her level of pain intensity and the mark tells about where the pain is in relation to the extreme points. The number indicated by the patient was measured from the left hand side to the mark on the horizontal line. The pre data was taken before the treatment and post data was taken at the time of follow up.

Result:

Graph 1: - vertical ground reaction force without orthosis (baseline data)

Graph 2: - Vertical ground reaction force with orthosis during follow up

In the graph 1, above graph is showing result of left foot and result of right foot is showing on below graph. In the left foot maximum force was 776 N during midstance and during loading and terminal stance force was very less that is only 20 N and 19N which is very negligible. At right foot force during heel off, midstance and terminal stance was 285 N, 244N and 265 N respectively. Graph 2 is showing result of vertical forces during follow up.
In table 1 is showing the result of vertical force without orthosis during baseline and follow up. This vertical ground reaction force was represented as percentages of body weight as a result, force at left foot during loading response, midstance and terminal stance was 4.25%, 164% and 4.03% respectively and at right foot was 60.5%, 51.87% and 56.33% respectively without orthosis during baseline data taking which was not normal. Reduction of forces at different phases of gait shows that patients put weight on the symptomatic limb in a protected manner due to pain. During follow up, vertical ground reaction force was represented as percentage of body weight as a result, force at left foot during loading response, midstance and terminal stance was 108%, 101% and 110% respectively and at right foot force was 121%, 115% and 127% respectively. This force was near to normal vertical ground reaction force. If a person walks at speed of 82m/min ground reaction force at loading response, midstance and terminal stance is 110%, 80% and 110%. This result is due to orthosis provides little cushioning and less shock absorption which resulting in a greater vertical impact force compared to without orthosis. Another cause might be hard undersurface of the orthosis, which increases the acceleration of the foot, ultimately increased the vertical forces. This result also may be due to reduction of pain for which subjects bear the weight all over the planter surface.

The pain as measured by Visual analog scale was 7.3 before the orthosis application which was reduced at 3.8 after the use of orthosis. In current study it was found that 47.9% reduction in pain in the symptomatic limb after orthotic intervention over a period of 4 weeks. The pain reduction mechanism is supported by Root theory; modified foot orthosis inverted the subtalar joint to its neutral throughout the stance phase of gait. As a result, an increased supinatory moment is created in the medial aspect of the transverse plane position of subtalar joint axis. This moment oppose the pronatory ground reaction force acting lateral to the subtalar joint axis. The foot realigned with the supporting surface and acts like a rigid
EFFECTS OF MODIFIED FOOT ORTHOSES ON VERTICAL GROUND REACTION FORCE AND PAIN

lever like structure which re-establishes the propulsive function of foot. By aligning the foot in neutral position, modified foot orthosis reduces the stress placed on the plantar fascia and ultimately reduces symptoms.\textsuperscript{16} From the findings of the above study it may be concluded that, there was a significant difference in vertical ground reaction force and pain when walking with and without orthosis. Modified foot orthosis increases force at loading response and terminal stance which leads to equal distribution of vertical ground reaction forces at symptomatic foot. Long term follow up may result better result in case of vertical ground reaction force and pain. The focus of this research study is to find out the efficacy of modified foot orthosis in plantar fasciitis.

ACKNOWLEDGMENTS
Special thanks to National Institute for the Orthopaedically Handicapped, Kolkata, India Gait Lab for allowing me to collect the data.
EFFECTS OF MODIFIED FOOT ORTHOSES ON VERTICAL GROUND REACTION FORCE AND PAIN

REFERENCES:


EFFECTS OF MODIFIED FOOT ORTHOSES ON VERTICAL GROUND REACTION FORCE AND PAIN


ACKNOWLEDGMENTS

Special thanks to National Institute for the Orthopaedically Handicapped, Kolkata, India Gait Lab for allow me to take the data.