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Shoe inserts alter inter-segmental foot motion and provide symptomatic relief in patients with midfoot arthritis

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Introduction

Patients with midfoot arthritis present with disabling pain, which limits their participation in walking and other physical activity. The primary aim of treatment is to afford pain relief and is often attempted using shoe inserts. The custom-molded three-quarter insert (3Q) is recommended as the first line of treatment; however clinical experience shows that patients continue to report pain. Recent reports indicate that the full length carbon graphite insert (FL) may offer symptomatic relief in patients with midfoot arthritis. However the mechanisms by which the FL may be effective remain unknown. The purpose of this study was to examine the effects of four-week intervention with the FL on self-reported outcomes and in vivo inter-segmental foot motion in patients with midfoot arthritis.

Methods

17 patients with midfoot arthritis participated in this study. Mean age: 62 ± 4 years, Mean BMI: 29.6 ± 5.4) 13/17 patients were previous users of the 3Q orthosis. In accordance with IRB and HIPAA guidelines, Informed Consent was sought prior to initiating study procedures. Patients' self-reported outcomes were documented using the Foot Function Index – Revised (FFI-R) prior to and after four week intervention with the FL orthoses.

In vivo segmental foot motion was examined using a 5 segment foot model with previously established validity, as patients walked at self-selected monitored speed (0.82 ± 0.25 and 0.89 ± 0.19 m/s, 3Q and FL respectively, p = 0.49). Modified shoes, with cut-out windows to accommodate the sensors were worn during walking. Local coordinate systems were established by digitizing anatomical landmarks of interest. Kinematic data were low pass filtered using a fourth-order Butterworth filter with a cut-off frequency of 6 Hz and analyzed using MotionMonitor™ software. Euler angles, representing three sequential rotations (Z-Y-X) were used to describe joint motion. Peak values for all dependent variables were referenced to subtalar neutral: calcaneal eversion, forefoot abduction, arch dorsiflexion, 1st metatarso-phalangeal (MTP) dorsiflexion. Paired-t tests were used to examine differences between orthoses conditions.

Results

Four week intervention with the FL orthosis provided symptomatic relief evidenced as 17 and 15% decrease in pain and activity limitation scores. Improvements were also reflected in total FFI-R score (36 ± 10 and 32 ± 9, baseline and after four week intervention respectively, p = 0.02). Compared to the 3Q orthosis, use of the FL orthosis resulted in increased calcaneal eversion, forefoot abduction and arch dorsiflexion as well as decreased 1st MTP dorsiflexion. (Table 1).

Table 1: Summary of kinematic variables

Dependent variable	3Q	FL	P value
Calcaneal eversion	2.5 ± 3.0	3.9 ± 4.2	0.05
Forefoot abduction	5.9 ± 8.6	8.3 ± 9.7	0.10
Arch dorsiflexion	12.8 ± 8.2	15.6 ± 8.1	0.02
1st MTP dorsiflexion	16.3 ± 10.9	14.4 ± 8.2	0.10

Change in pain score was correlated with arch dorsiflexion available in the FL condition ($r = 0.60$, $p < 0.05$).

Conclusion

The findings of this study demonstrate that four-week intervention with the FL affords symptomatic relief in patients with midfoot arthritis. Use of the FL was accompanied by distinct kinematic changes, all of which allowed the foot to assume a lower arched position. Arch dorsiflexion explained a third of the variance in change in pain score. Our findings suggest that kinematic changes, occurring independently or in combination, when using the FL orthoses, result in favorable short-term response to intervention. We hypothesize that kinematic changes in inter-segmental foot motion may influence articular loading and mediate relief of symptoms in patients with midfoot arthritis.

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