INTRODUCTION

Valgus knee braces are effective at decreasing pain and improving function in patients with knee osteoarthritis (OA) [1]. The braces are designed to decrease loading in the medial knee compartment but previous studies are unclear if this truly occurs. Alternatively, changes in the neuromuscular system might account for the benefits of bracing. An earlier study with a small sample demonstrated a decrease in muscle co-activation in early stance for patients with knee OA with brace application [2]. The purpose of the current study is to examine the effects of 6 months of valgus brace on muscle activation patterns in patients with moderate knee OA.

METHODS

Participants with knee OA predominantly in the medial compartment were recruited. They were prescribed a custom-fitted, valgus unloader brace by an orthopaedic surgeon. They underwent a detailed gait analysis at baseline and after 6 months of brace wear. Clinical symptoms were examined using the Western Ontario McMaster Universities Osteoarthritis Index (WOMAC) which includes pain, stiffness and physical function subscales.

Surface electromyograms (EMG) sampled at 2000 Hz were obtained with an 8 channel EMG system (AMT-8™, Bortec Inc.) from the lateral and medial gastrocnemius, vastus lateralis and medialis, rectus femoris, and lateral and medial hamstrings during walking at self-selected speeds [3]. After completing 5 trials both with and without the brace, a series of maximum voluntary isometric contractions (MVIC) for each muscle were preformed. The EMG waveforms were band-pass filtered (20-500Hz), corrected for bias and gain, liner enveloped (Fc=6Hz), time-normalized to 100% gait cycle, and amplitude normalized to MVIC. Ensemble averages waveforms were created for the 5 trials for the brace and no brace conditions.

Principal component analysis, a method to reduce the dimensionality of waveform data, was performed for each muscle group (gastrocnemii, quadriceps, hamstrings) separately [3]. Principal patterns that captured amplitude and temporal characteristics from the EMG waveforms were identified. For each muscle group, three principal patterns together explained at least 95% of waveform variance. Individual EMG waveforms were scored against the principal patterns which produced PP-score.

For each muscle, a 2-way repeated measures analysis of variance was used to test PP-score differences for significant brace (brace vs. no brace) and time (baseline vs. 6 months) main effects and interactions. Significant differences in the WOMAC subscales were examined using paired t-tests. For all statistical tests α=0.05.

RESULTS

The sample (n=28, 5 women) mean age was 59+/9 years and mean body mass index was 32.1+/5.0 kg/m². Small but statistically significant improvements in WOMAC pain (p=0.03), stiffness (p=0.04) and physical function (p=0.01) subscales were found at 6 months. The gait speed (1.22 to 1.24 m/s) was not significantly different between brace and time conditions.

A significant main effect was seen for the brace condition for the first PP-score for both the lateral gastrocnemius (p=0.03) and medial hamstrings (p=0.02). The first PP-score represents the overall amplitude of the EMG waveforms. With brace wear, participants had increased activity in the medial hamstring and decreased activity in the lateral gastrocnemius. There were no significant time or interaction effects for any of the PP-scores.

DISCUSSION AND CONCLUSIONS

The patients reported improvements in clinical symptoms with the valgus knee braces over six month although the effect was small. The effects of the brace on muscle activation were immediate with no significant time main effects found. Medial hamstring differences were greatest during early stance and late swing, corresponding to time points of greater valgus angles in previous work, suggesting a possible relationship. The decreased lateral gastrocnemius activation occurred during early to mid-stance phase. These changes in muscle activation were small in magnitude and hence would not contribute to changes in joint loading. The current findings do not appear to agree with an earlier study [2] although differences in EMG measures and bracing protocol make a direct comparison difficult.

In conclusion, the effects of valgus knee braces on muscle activation patterns were minimal but were immediate with brace application.

REFERENCES


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