

Valgus Bracing in Knee Osteoarthritis: Effects on Lower Limb Muscle Activity Following a Six-Week Intervention

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Summary

We examined the effect of valgus bracing on lower limb muscle activity in participants with knee osteoarthritis (KOA) at baseline and after six weeks of brace use. KOA patients exhibited increased hamstring synergy activity during loading response across all measurements compared to controls. Valgus bracing did not alter neuromuscular activation patterns, likely due to persistently elevated external hip flexion moments during loading response in the KOA cohort.

Introduction

KOA is associated with both mechanical and neuromuscular alterations during level walking [1]. Muscle synergy analysis allows for insight into the structure of neuromuscular activation patterns by reducing dimensionality of sEMG data [2]. Valgus braces reduce the external knee adduction moments (eKAM) [3], but it is not clear whether neuromuscular alterations can also be targeted by valgus brace treatment. Therefore, we investigated whether valgus bracing affects muscle synergy activity either immediately, or after a six-week intervention period.

Methods

43 Participants (21 with medial KOA, KL-Score ≥ 2 , 10F:11M, 61.4 ± 7.4 yrs, 84.1 ± 10.8 kg, 177.6 ± 0.1 cm, BMI 26.6 ± 2.3 and 22 controls 11F:11M, 64.7 ± 8 yrs, 68.9 ± 11.1 kg, 170 ± 0.1 cm, BMI 22.1 ± 5.8) completed level walking trials with and without a valgus brace at self-selected speed. Trials were conducted at the timepoints *baseline* (BAS) and *follow-up* (FU) after six weeks of brace use in everyday life. Muscle synergy analysis of 16-Channel bilateral sEMG data from the lower limbs was conducted using non-negative matrix factorization [4]. Joint moments were determined via scaled inverse-dynamic OpenSim models [5]. Joint angles, moments and normalized activation patterns of the hamstring synergies (M. biceps femoris and M. semitendinosus) were compared via a 3-way ANOVA (group x brace condition x timepoint) using statistical parameter mapping (SPM)[6].

Results and Discussion

Participants with KOA exhibited a significantly higher hamstring synergy activity between 13% - 24% stance phase at BAS without a brace compared to CTRL (Fig. 1).

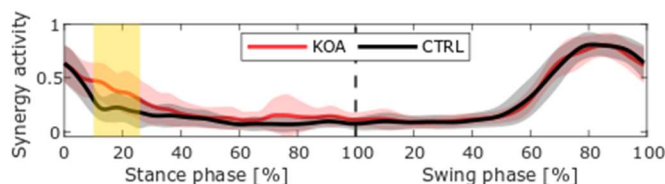


Fig. 1: KOA patients showed increased hamstring synergy activity (13% - 24% stance phase) during level walking.

95% of the KOA cohort reported wearing the brace for > 3 days per week and > 3 h per day. A 3-way ANOVA revealed a significant main effect for group affiliation ($p < .001$, Fig. 2). No significant differences were observed for 'brace condition' or 'timepoint', nor interaction effects. Thus, the increased hamstring activity during early stance phase persisted with brace use at both BAS and FU. Participants with KOA exhibited greater hip flexion angles and external flexion moments during early to mid-stance phase ($p < .001$).

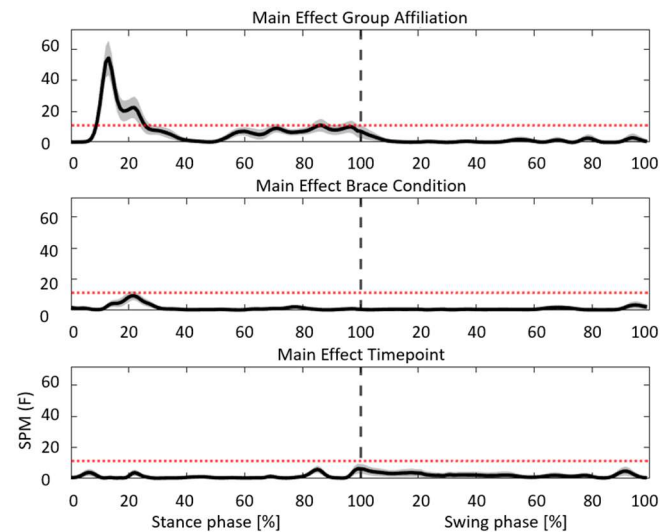


Fig. 2: A 3-way ANOVA using SPM revealed significant main effect on group affiliation during early stance phase

Conclusions

Although valgus bracing reduces eKAM during level walking [3], it does not affect neuromuscular activation patterns in KOA patients, either immediately or after six weeks of regular use. Increased activation of the biarticular hamstrings likely results from unaltered, elevated external hip flexion moments. This activation can increase the knee joint contact force during early stance phase, prospectively worsening KOA progression [7]. Higher sagittal plane hip joint moments appear to remain unaffected by valgus bracing, likely explaining the absence of an effect on the elevated hamstring synergy activity.

References

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