

Textured Foot Orthotics and Proprioception: Augmenting Cutaneous Feedback to Improve Joint Position Sense Accuracy

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Summary

This study investigated changes in ankle joint proprioception when wearing textured (FOTs) and non-textured (FOs) orthoses during a passive ankle joint position reproduction task. Four tasks were investigated and measurements included target angle accuracy, centre of pressure (COP) displacement, and EMG of the tibialis anterior and medial gastrocnemius muscles. When targeting a 5° dorsiflexion angle, middle-aged adults completed the task with reduced errors, less antero-posterior COP displacement, without modifying motor output. These results support the efficacy of FOTs for middle-aged adults to improve joint position sense accuracy during small degrees of ankle dorsiflexion change.

Introduction

The maintenance of proprioception in upright standing posture and joint position sense accuracy (JPSA), is contingent on the coordination of sensory inputs made available to individuals during tasks [1, 2]. Adding texture to augment cutaneous feedback on neuromuscular control of the ankle joint in young and middle-aged adults has yet to be investigated in JPSA. Thus the purpose of this research was to investigate the changes in ankle joint proprioception when wearing textured (FOTs) and non-textured (FOs) orthoses during a passive ankle joint position reproduction task.

Methods

Forty-eight healthy young (n=31, 21-29 years) and middle-aged adults (n=17, 31-58 years) completed a JPSA task standing in standardized footwear (Athletic Works) with either a non-textured (FO) or textured (FOT) orthosis. Passive JPSA of the right ankle was measured using a custom device, housing individually powered pedals (Nanotec) that rotated in the sagittal plane towards 4 target angles: 5° or 10° in plantarflexion and 5° or 10° dorsiflexion. The center of pressure (COP) (Novel, Munich, Germany, SR=100Hz) and surface electromyography (EMG) (Trigno® Wireless, Delsys, Inc., USA) from the tibialis anterior and medial gastrocnemius muscles were recording during each proprioception task. Data was normalized to reference (ref) trials and statistical differences were analyzed with a 3-way repeated measures ANOVA.

Results and Discussion

In the dorsiflexion 5° task, a statistically significant interaction (p=0.001) was observed, and accuracy significantly improved (reduced errors) by 31% in the middle-aged group wearing FOTs ($0.56^\circ \pm 0.44^\circ$) compared to FOs ($0.81^\circ \pm 0.44^\circ$, p=0.011). There was also significantly less COPy (antero-posterior) displacement of the stabilizing left foot (middle age: $101.8\% \text{ref} \pm 10.2\% \text{ref}$; young: $108.2\% \text{ref} \pm 17.04\% \text{ref}$;

p=0.0069) without altering EMG amplitude or COP displacement of the right foot (Figure 1).

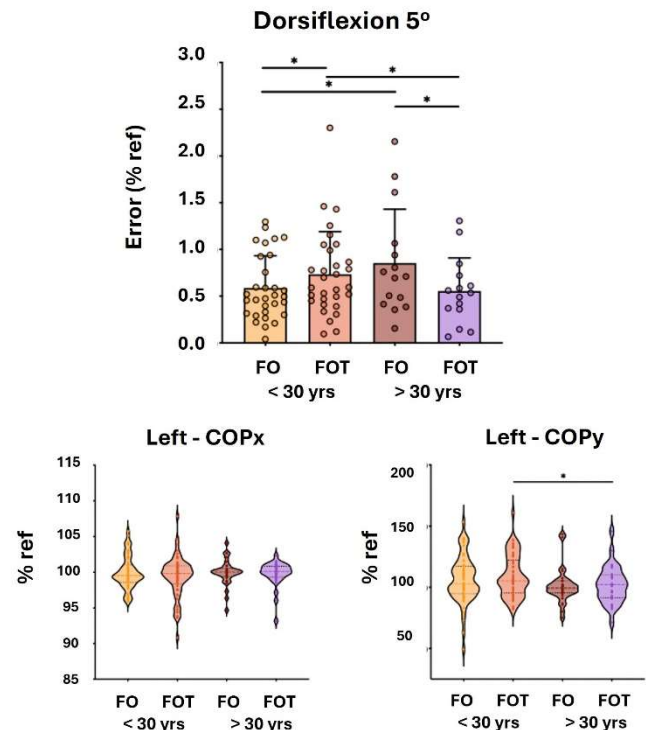


Figure 1: Accuracy errors, tibialis anterior and medial gastrocnemius EMG and left COP during the dorsiflexion 5° joint reproduction task (COPy: antero-posterior COP displacement).

Improved ankle proprioception and mainly unchanged balance outcomes are in line with a previous study [3]. The middle-aged participants exhibited a larger potential to improve joint position sense accuracy during FOT use. Unchanged postural parameters may be due to a lack of balance threat during the trials, especially for the young group.

Conclusions

This study supports the efficacy of textured foot orthoses (FOT) in middle-aged adults to improve JPSA in small degrees of ankle dorsiflexion change.

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References

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