

GAZE STABILIZATION OF BALANCE WITH AND WITHOUT AN ANKLE FOOT ORTHOSIS: A PILOT STUDY

Vickers J. N.,¹ Ronsky J. L.,^{2,3} Ramage B.,³ Morton B. ¹ & Park S. ⁴

Faculty of Kinesiology ¹ & Faculty of Engineering ², University of Calgary,

³ McCaig Centre For Joint Injury and Arthritis Research, Heritage Medical Centre, Calgary, Ewha University, Korea ⁴

INTRODUCTION

Despite extensive research “it is still not known what serves as the cue for visual stabilization of posture” (Strupp et al, 2003, 352). When a target is viewed in frontal space, sway is minimized by the vestibular ocular reflex thereby nullifying retinal slip, but when saccades or pursuit tracking occur sway increases. Suppression of eye movements is known to reduce sway and improve balance when fixating near targets (Jahn et al, 2002). Fixations hold the gaze on one location in space and provide on-going sensory feedback of target location. When an external cue is present, fixation is typically maintained within 1 degree of visual angle of the target (Strupp et al, 2003).

The purpose of this pilot study was to determine the effects of wearing an ankle-foot orthosis on fixation stability while gazing at a plain surface devoid of cues. Orthoses are designed to improve posture and decrease sway, but little research has been carried out to determine the effects of wearing an orthosis on the gaze when external cues are present and absent. Fixation frequency, fixation duration, and inter-fixation visual angle were assessed while four subjects maintained balance and fixated a vertical plain surface, with and without an orthosis. Two subjects served as controls and fixated an X at eye height.

METHODS

Four adults ranged in age from 20-24. They maintained balance for 3 trials of 30 s while fixating a surface 2 meters in front. Two subjects also fixated the X, with and without the orthosis. Fixation data were collected using a mobile eye tracker (ASL 501H) and a magnetic head tracker (Flock of Birds) as shown in Figure 1. Eye-head data at 60 Hz recorded the gaze relative to the surface and the X. EYENAL software determined fixation onset when the gaze was located within 0.5 degrees (SD) of visual angle for 100 ms; fixation duration was a minimum of 100 ms; inter-fix angle was measured in degrees of visual angle between successive fixations relative to the X. Repeated measures ANOVA's was used to determine fixation differences due to Condition (No Orthosis, Orthosis) x Trials (3).

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Figure 1. Vision-in-action data showing fixation behaviour relative to an X (left) and when the X was absent (right). Image A shows the eye of the subject; image B the location of the gaze as indicated by the black cursor (accuracy 1 degree of visual angle) and image C the movements of the subject filmed from the sagittal perspective.

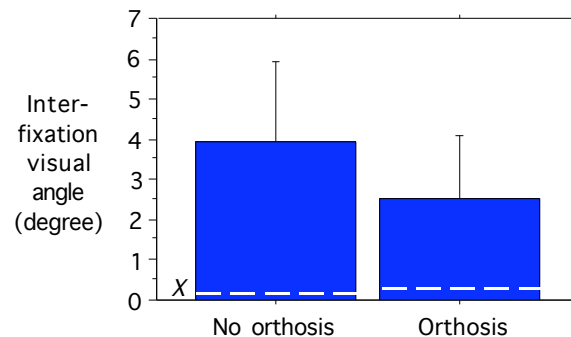


Figure 2. Mean inter-fixation angle without an ankle-foot orthosis and with one. The white line shows the non-significant difference in interfix angle when fixating the X.

RESULTS

The results for the X condition were similar to those reported by Strupp et al (2002) and Jahn et al (2003) for fixation frequency (M = .33/s; SD = .31/s), fixation duration (M = 4.05 s; SD = 2.04), and inter-fix visual angle (M = .24 degrees; SD = .34). Fixating the X improved gaze stability compared to fixating the plain surface, and wearing the orthosis did not affect gaze stability.

Analysis of fixation relative to the plain surface found a significant difference due to Orthoses for inter-fix angle $F(2, 10) = 6.58, p < 0.05$, but not for fixation frequency or duration. Fixation was more stable while wearing the orthosis than not (see Figure 2). A significant Trials effects showed that fixation frequency increased, fixation duration decreased, and inter-fixation angle increased across trials, suggesting holding fixation was difficult for the full 90 s, irrespective of wearing the orthosis.

DISCUSSION

1) Anchoring the gaze to an X in space improved gaze stability for all subjects, in agreement with the findings of other researchers.

2) On many occasions subjects do not have external anchors for their gaze and have to still maintain their balance. Wearing the orthosis had no effect on fixation frequency or duration, but a significant difference was found for inter-fix angle indicating wearing the orthosis improved gaze stability.

3) Since mean fixation duration and fixation frequency were not affected due to wearing the orthosis, then it was unlikely that the difference in inter-fixation angle was due to loss of focus or concentration. **Instead the results suggest that wearing the orthosis improved fixation stability relative to the plain surface.**

REFERENCES

Jahn et al, T. (2002). Suppression of eye movements improves balance. *Brain*, 125; 2005-2011.
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