The effect of lateral and medial wedges on control of postural sway

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1. Introduction

The human body is represented as a set of independent or related rigid segments that are linked by simple mechanical connections (Roll et al., 1988) described an internal representation of the body’s geometry with a proprioceptive chain which links muscles of eye and foot.

Kavounoudias et al. (2001) showed that supra-threshold vibratory stimulation of the feet induces predictive and oriented postural regulations. The plantar sole works as a dynamometric map which quantifies the plantar pressure (Kavounoudias et al., 1998). Insole interventions play a role in the control of posture.

Postural imbalances like anterior inclination of the trunk are source of muscular and discal constraints in the spine. Posturology insoles can correct this improper posture that creates strain and compensations.

The objective of our study is to evaluate the effect of foot orthoses with medial and lateral wedges, simultaneously placed under the rear foot. We assess the shift backward of the barre sagittal line.

This type of insoles is used in posturology in order to help the trunk to move in the backward direction and to stop painful phenomena. We hypothesized that the selective stimulation of the rear foot induces an oriented displacement of the center of pressure. In clinical practice posturologists use such inserts to take care of patients suffering from postural disorders. Many studies have shown the effect of an orthotic treatment on standing postural stability (Janin et al., 2005).

2. Methods

Thirty-four young and healthy male subjects (23 ± 2.7 yrs, 73 ± 6 kg, 1.80 ± 0.7 m), clinically diagnosed with anterior scapular posture measured with a laser level participated in the study. Allocation of the subjects into an experimental group (22 subjects) and a control group (12 subjects) was performed.

Recordings were made using the Medicapteurs Fusyo pressure platform. This device measures oscillations of the center of pressure (CoP). The acquisition frequency was 40 Hz. Participants stood barefoot in an orthostatic position for four conditions: open eyes (OE), open eyes and on medial and lateral wedges (OEW), closed eyes (CE), closed eyes and on medial and lateral wedges (CEW). During open eyes tests, participants have to focus on a cross mark positioned at eye level marked at a distance of 90 cm away with their feet 4 cm apart and with arms alongside the body. We used 2 mm thick, 70A shore rating, and 250 kg/mm\textsuperscript{3} density plantar inserts as wedges.

Four static stance trials, 51.2 s in duration, were performed with a 2-min period rest between each recording in order to avoid a phenomenon of habituation of the sole cutaneous mechanoreceptors. The order of the conditions was randomized for each participant.

To assess the effects of thin plantar inserts upon postural control, we analysed the classical postural parameters: the surface and length of CoP excursions, the antero-posterior (Y) position, the medio-lateral (X) position and the mean speed of CoP. The surface area of the CoP represents 90% of the instantaneous positions of the CoP included within the confidence ellipse, eliminating the extreme points (Gagey et al., 2004).

The data were recorded and interpreted using the Fusyo Analysis software program.

We used the Mann-Whitney-Wilcoxon test (non-parametric) to assess differences between wedges and non-wedges conditions (experimental group) and between two subsequent non-wedges recordings (control group).
According to Eslami et al. (2006), there is also evidence that standing on the medial wedge induces the external rotation of the hip accompanied by a posterior pelvic tilt. Also, the literature reports the presence of bilateral internal rotation of the hip with anterior pelvic tilt while standing on the lateral wedge. It is possible that these two inserts used together would generate some responses of neuromuscular adaptation of the scapular girdle during locomotion. This effect would result in an increased neural feedback from plantar mecanoreceptors to the central nervous system and contribute to improved postural sway control.

4. Conclusions

This study shows that the acute effect of foot orthoses with medial and lateral wedges, simultaneously placed under the rear foot, did not change significantly the standing posture. Future studies should investigate the long-term effects of such orthotic aids. It would be of interest to evaluate the efficacy of these foot orthoses on postural sway during walking.

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3. Results and discussion

The results which concern our hypothesis are shown in Table 1. This study was designed to investigate the effects of foot orthoses on vertical posture in the sagittal plan. The results of this study suggest that standing on lateral and medial wedges does not have a significant effect on foot posture with respect to stabilometry.

Our initial experimental hypothesis that a podological correction would help the trunk to move in the backward direction and the CoP on the Y axis is not confirmed \( p = 0.30 \). This is also noticeable when eyes are closed.

A possible mechanism is that the corrective wedges may not have produced higher plantar pressures providing stronger sensory stimulation to the plantar cutaneous mechanoreceptors.

However, there is no reason to suppose that statistical significance would be attained by wearing the longer-term podological correction.

It is true that the double stimulation with medial and lateral wedges should be considered in dynamics by the stabilization of the rear foot and an additional stimulation to the mecanoreceptors (Bricot, 1996).

In the present study, the surface area of the CoP increases when the subjects are on conditions eyes closed with wedges (CEW) or without wedges (CE).

This finding suggests the important role of visual information on postural sway.

Table 1 Results for the 5 studied parameters.

| Group | Cond | Surface of CoP (mm²) | Length XY (mm) | Mean X position (mm) | Mean Y position (mm) | Mean speed (mm/s) |
|-------|------|----------------------|---------------|----------------------|----------------------|------------------|
| Exp   | OE   | 132.32               | 345.4         | −3.8                 | −35                  | 6.74             |
| (n=22)| OEW  | 165.49               | 371.64        | −2.54                | −38.04               | 7.18             |
|       | \( p \) | 0.32 | 0.26 | 0.53 | 0.30 | 0.34 |
| Cont  | OE1  | 160.43               | 370.98        | 0.02                 | −41.35               | 7.26             |
| (n=12)| OE2  | 177.62               | 389.25        | −2.44                | −40.6                | 7.62             |
|       | \( p \) | 0.84 | 0.44 | 0.40 | 0.93 | 0.44 |
| Exp   | CE   | 209.15               | 498.05        | −2.44                | −34.77               | 9.66             |
| (n=22)| CEW  | 243.84               | 506.4         | −2.02                | −36.99               | 9.82             |
|       | \( p \) | 0.61 | 0.79 | 0.75 | 0.35 | 0.80 |
| Cont  | CE1  | 246.9                | 503.75        | −1.57                | −37.6                | 10.07            |
| (n=12)| CE2  | 267.98               | 510.92        | −2.08                | −38.36               | 10.31            |
|       | \( p \) | 0.98 | 0.84 | 0.95 | 0.76 | 0.91 |