Review

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Effect of Different Insoles on Postural Balance: A Systematic Review

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Abstract. [Purpose] The aim of the present study was to perform a systematic review of the literature on the effect of different insoles on postural balance. [Subjects and Methods] A systematic review was conducted of four databases. The papers retrieved were evaluated based on the following inclusion criteria: 1) design: controlled clinical trial; 2) intervention: insole; 3) outcome: change in static postural balance; and 4) year of publication: 2005 to 2012. [Results] Twelve controlled trials were found comparing the effects of different insoles on postural balance. The papers had methodological quality scores of 3 or 4 on the PEDro scale. [Conclusion] Insoles have benefits that favor better postural balance and control.

Key words: Postural balance, Proprioception, Foot

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INTRODUCTION

Balance and posture are aspects of the postural control system. Postural orientation is the position of body segments in relation to each other and the surrounding environment. Postural balance is the forces that act on the body and the maintenance of equilibrium during motor actions[1)]. Individuals stabilize themselves in their environment using information from the eyes, vestibular system and soles of the feet[2, 3)]. The functions of the feet involve the distribution of plantar pressure, support of the body, the absorption of impact and postural adjustments for the maintenance of an erect standing posture[2, 4)]. Exteroceptors and proprioceptors in the feet play an important role in postural control. The central nervous system uses ascending motor pathways that receive information from the feet to control the position of the body and coordinate posture in relation to the surrounding environment[5, 6)].

Posturology unites knowledge about the prevention and treatment of postural problems in neurophysiology with the use of orthopedic insoles. According to Bricot[4)] and Viladot[9)], the aim of orthopedic insoles is to support the body, correct deformities and improve foot function. Postural insoles simulate correction reflexes, affect muscle proprioception in the feet and modify the activation of ascending proprioceptive chains[4, 7–9)]. The aim of postural insoles is to assist in the treatment of postural problems, relieve pain and treat conditions of the locomotion system (legs, knees, ankles and feet)[10)]. Postural insoles are custom made and thermal molded in orthopedic material, such as microfoam, rigid or semi-rigid rubber of different densities, polypropylene, plastazote, evazote, etc[10)]. A number of studies have reported the importance of insoles for improving postural balance.

Systematic methods are used to avoid bias and to make possible a more objective analysis of the results, facilitating a conclusive synthesis about certain interventions[11)].

The aim of the present study was to perform a systematic review of the literature on the effect of different insoles on postural balance.

SUBJECTS AND METHODS

Searches were carried out of the Medline, LILACS, PEDro and SciELO databases using the keywords insole and postural balance.

The papers retrieved were evaluated by two blinded researchers employing the following inclusion criteria: 1) design: controlled clinical trial; 2) intervention: insole; 3) outcome: change in static postural balance; and 4) year of publication: 2005 to 2012.

The selected papers were analyzed with regard to the methodological quality using the PEDro scale. This scale has 11 items for the assessment of internal validity and statistical information in randomized, controlled trials. Each adequately met item contributes one point to the maximal score of 10 points except Item 1, which is related to external validity. The official score of the papers described in the electronic database was used. For cases in which the manuscript was not found in this database, the evaluation was performed independently by two blinded researchers. A

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third researcher performed the evaluation when divergences occurred in the evaluations of the first two researchers.

RESULTS

The search of the Medline, PEDro, LILACS and SciELO databases led to the retrieval of 12 different titles and abstracts of papers on the comparison of the effect of different insoles on postural balance. All 12 papers had a minimum of 3 points on the PEDro scale and were therefore considered methodologically adequate (Table 1).

The 12 studies[12–23] involved a total of 392 individuals. The majority involved older volunteers (mean age: 59.2 ± 20.4). The number of participants in each study ranged from 17 to 50. All papers compared the effect of different insoles on postural balance. The kinds of insoles used were: vibrating insoles, textured insoles, quick-comfort insoles, insoles with spikes, flat insoles with different Shore A hardness,

Table 1. Characteristics of papers included in review

Paper	Authors and year of publication	PEDro score	Design
1	Hamlyn C et al. 2012[12]	8/10	Clinical trial
2	Iglisias MEL et al. 2012[13]	7/10	Clinical trial
3	Qiu F et al. 2012[14]	5/10	Clinical trial
4	Hatto et al. 2011[15]	7/10	Clinical trial
5	Wang CC, Yang WH. 2011[16]	3/10	Clinical trial
6	Sungkarat et al. 2011[17]	7/10	Clinical trial
7	Hatton AL et al. 2009[18]	8/10	Clinical trial
8	Hijmans JM et al.2008[19]	5/10	Clinical trial
9	Palluel E et al. 2008[20]	5/10	Clinical trial
10	Perry SD et al. 2008[21]	6/10	Clinical trial
11	Geffen JAV et al. 2007[22]	5/10	Clinical trial
12	Priplata AA et al. 2006[23]	5/10	Clinical trial

Table 2. Methods and results of papers included in review

Paper	Equipment and balance analysis	Type of insole	Results
1	Force plate	Quick-comfort insole	Prefabricated insoles improve postural stability, global stability and proprioception.
2	Force plate	Soft gel insole and hard insole	Soft and hard insoles lead to significant improvements in postural sway.
3	Force plate	Textured insole	Textured insoles reduce postural sway of older individuals, especially during more challenging balance tasks.
4	Force plate and EMG	Textured insole	Textured insoles reduce mediolateral sway of healthy elderly individuals.
5	Force plate	Vibrating insole	Vibrating insoles improve balance, especially in the anteroposterior direction. Postural stability was not significantly increased with the use of vibrating insoles.
6	Force plate	Insole with wedge + set-up sensors	Improved balance and symmetry
7	Force plate and EMG	Textured insole	Textured surfaces do not affect control of bipedal static postural sway or lower limb muscle activity
8	Force plate	Vibrating insole	Both groups (control and neuropathy) showed significant effects and the displacement velocity of center of pressure was improved in the anteroposterior direction
9	Force plate	Insole with spikes	Spiked insoles improve postural control.
10	Gait disturbance protocol	Balance enhancing insole	Balance-enhancing insoles constitute a viable strategy for improving balance control.
11	Force plate	Flat insoles with different Shore A (15° or 30°)	Insole rigidity exerts no influence on balance.
12	Electronic version of Romberg test + camera based on motion analysis system	Vibrating insoles	Vibrating insoles assist in improving balance control in patients with diabetes and stroke victims.

insoles with wedges and sensors and balance-enhancing insoles (Table 2).

With regard to data acquisition, nine papers[12–18, 22, 23] employed balance analysis using a force plate, mainly investigating displacement from the center of pressure and sway in the anteroposterior and mediolateral directions. The remaining papers analyzed postural balance using the following methods: surface electromyography, an electronic version of the Romberg test with a camera-based motion analysis system, and a gait disturbance protocol (Table 3).

DISCUSSION

The maintenance of postural balance is a complex task. For balance, the body needs to receive information on its position in space and the surrounding environment. This information is transmitted through the neural system, which integrates sensory information from the soles of the feet to determine the position and motion of the body in space with information from the musculoskeletal system, which generates the forces necessary to control the body[24].

As points of contact between the body and ground, the feet contribute to the balance and maintenance of posture in the standing position. Different types of insoles have been developed to enhance somatosensory information from the plantar region and improve postural stability.

The studies carried out by Gagey et al.[16], Hijmans et al.[19] and Priplata et al.[13] used vibrating insoles and found improvements in balance and oscillation velocity in the anteroposterior direction. Those vibrating insoles have a mechanical noise that allows auditory feedback, with a positive effect on postural stability. The first study took into account the individual sensitivity of each patient, with six vibration options (0 V, 10 V, 20 V, 30 V, 40 V and 50 V). The second study employed 90 percent of the individual tactile threshold of each participant as the noise amplitude parameter; when this threshold was not reached, the maximal amplitude offered by the piezoelectric elements in the insole was used (120 V). The third study employed insoles molded in viscoelastic silicone and three vibration elements denominated “tactors” (two under the forefoot and one under the heel); the stimulation level was adjusted to 90% of the sensory threshold of each foot.

Textured insoles were employed in four studies. Hatto et al.[15] and Hatton et al.[18] used two types of insoles. The first study used the following: Texture 1 − Evalite Pyramid EVA, 3 mm in thickness, A50 shore value, black, OG1549; Texture 2 − Nora® Lunasoft non-slip, 3 mm in thickness, A50 shore value, black, OG2250. The second study used an insole with pyramid peaks for texture 1 and insoles with a convex circular pattern for texture 2. Qiu et al.[22] and Palluel et al.[20] used insoles with rigid discs and spikes, respectively. All studies report that textured insoles help reduce postural oscillations, especially in the mediolateral direction, and the activation of the tibialis anterior muscle.

Geffen et al.[22] investigated different densities: insoles measuring 8 mm in thickness, black foam rubber, with a 15 degree shore value and harder insoles measuring 8 mm in thickness, multi-shape, with a 30 degree shore value. Iglisias et al.[13] studied the effect of a soft gel insole (SoftSock Foot Support, Addison, TX, USA) with a 6.35 mm sole of solid gel and a hard insole (A50 shore value, Algeos Ltd. Liverpool, UK) with a 6.35 mm surface of smooth ethylene vinyl acetate.

According to Geffen et al.[22], patients with diabetic neuropathy are often prescribed insoles with a low shore value to protect the feet from pressure sores. These insoles redistribute pressure between the foot and insole, thereby offering shock absorption. However, insoles with a low shore value are less rigid and lead to a reduction in the sensory input, which may result in difficulties with regard to postural stability. Moreover, postural stability is expected to decline when patients use shoes with thicker, softer and more elastic soles.

Sungkarat et al.[17] carried out a study to determine whether external feedback promotes the symmetrical distribution of weight and better posture control in stroke victims using insoles with wedges and set-up sensors. The A I-sample set-up consisted of a wedge insole and pedal for the non-paretic leg and a pressure sensor on the paretic leg. Perry et al.[21] studied the use of balance-enhancing insoles.

Although not found in the literature based on the inclusion criteria, Geffen et al.[22] reported that magnetic insoles were used to reduce postural sway due to increases in blood flow and sensory alterations in the foot.

Regarding the aforementioned insoles, the various authors explain that mechanoreceptors respond to mechanical stimuli, including recesses and stretching of the skin,

Table 3. Methodological quality of papers included in this review

PEDro	1	2	3	4	5	6	7	8	9	10	11	12
Eligibility	+	+	+	+	−	+	+	+	+	+	+	+
Randomized allocation	+	+	−	+	−	+	+	−	−	+	−	−
Concealed allocation	+	+	−	+	−	+	+	−	−	−	−	−
Baseline similarity	+	+	+	+	−	+	+	+	+	+	+	−
Blinded subjects	+	−	−	−	−	−	+	−	−	−	−	+
Blinded therapists	−	−	−	−	−	−	−	−	−	−	−	−
Blinded assessors	−	−	−	−	−	+	−	−	−	−	−	−
Key outcomes	+	+	+	+	+	−	+	+	+	+	+	+
Comparison between groups	+	+	+	+	+	+	+	+	+	+	+	+
Point measures and measures of variability	+	+	+	+	+	+	+	+	+	+	+	+

providing information on texture, which allows detection of the spacing, roughness and direction of the texture pattern. Thus, the principle of using textured surfaces is to increase the sensory input. Based on this same principle, vibrating insoles have also been proven to reduce static postural sway. The various findings indicate effects on both static and postural balance, regardless of the nature or degree of the stimulus.

A large number of studies report the advantages of orthopedic insoles, but few have compared the effect of different insoles on postural balance. The studies included in the present systematic review of the literature report the benefits of insoles with regard to improvements in balance and postural control.

Since this study is a review, it shows existing data of the usage of insoles for treatment on postural balance. It is necessary to continue studies of this research segment in order to find out the most appropriate insole as well as standardize tests and evaluations of balance for a better comparison.

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