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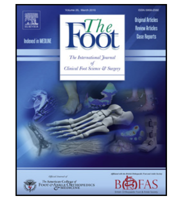

Review

Foot orthotics for low back pain: The state of our understanding and recommendations for future research

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HIGHLIGHTS

- A review of the biomechanical mechanisms underlying the effectiveness of foot orthotic treatment.
- A review of the current state of knowledge regarding the clinical use of foot orthotics to treat and/or prevent the occurrence of low back pain.
- A discussion of the most influential studies in the area of foot orthotic conducted during the past decade.
- Recommendations based on our review that may prove useful in directing future clinical research are provided.

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ABSTRACT

Purpose: The purpose of the article is to evaluate the literature on the use of foot orthotics for low back pain and to make specific recommendations for future research.

Methods: Database searches were conducted using PubMed, EBSCO, GALE, Google Scholar, and clinicaltrials.gov. The biomedical literature was reviewed to determine the current state of knowledge on the benefits of foot orthotics for low back pain related to biomechanical mechanisms and clinical outcomes.

Results: It may be argued that foot orthotics are experimental, investigational, or unproven for low back pain due to lack of sufficient evidence for their clinical effectiveness. This conclusion is based upon lack of high quality randomized controlled trials (RCTs). However, there is extensive research on biomechanical mechanisms underlying the benefits of orthotics that may be used to address this gap. Additionally, promising pilot studies are beginning to emerge in the literature and ongoing large-scale RCTs are addressing effects of foot orthotics on chronic low back pain.

Conclusions: Based upon the critical evaluation of the current research on foot orthotics related to biomechanical mechanisms and clinical outcomes, recommendations for future research to address the evidence-practice gaps on the use of foot orthotics for low back pain are presented.

1. Introduction

There is wide spread clinical use of foot orthotics in the developed nations to treat a variety of musculoskeletal conditions. Surveys indicate both chiropractors and podiatrists have high rates of utilization [1–3] and patients report high levels of compliance and satisfaction [4]. Industry analysts have estimated the world-wide market for orthotic devices to be 4.7 billion USD for 2015 [5]. Previous recommendations regarding the use of orthotic intervention as a treatment for those with low back pain (LBP) are varied. The United States Veterans Administration recommends the use of orthotics for treatment of those with work related LBP [6], yet the European Guidelines for the Management of Chronic Non-Specific Low Back Pain does not mention foot orthotics [7].

The purpose of this article is to highlight the current state of knowledge regarding the clinical use of foot orthotics to treat and/or prevent the occurrence of LBP, and to review the biomechanical mechanisms underlying the effectiveness of such treatment. We also have identified gaps in the literature that exist based on the findings of studies on foot orthotics. A summary of the most influential studies conducted during the past decade is provided and recommendations that may prove useful in directing future clinical research initiatives involving foot orthotics for back pain is suggested.

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2. Methods

The biomedical literature was searched to identify key articles that reveal the current state of knowledge on the benefits of foot orthotics for LBP related to biomechanical mechanisms and clinical outcomes. Database searches were conducted using PubMed, EBSCO, GALE, Google Scholar, and clinicaltrials.gov. The following search terms were used for each database ("foot orthotics", insoles, "foot orthoses", "shoe inserts", excluding "foot ankle"). In addition, reference lists from key articles were searched for relevant literature. Articles for use in this review were identified based on the level of evidence [8] as well as clinical relevance to orthotic use in treating LBP. Preference was given to recent meta-analyses and randomized controlled trials in the area of interest, where available.

3. Results

3.1. Biomechanical mechanisms of foot orthotics for LBP

The high impact forces and repetitive stress associated with heel strike during gait has been implicated as a contributing factor in the development of both lower limb pain and LBP [9]. The added shock absorption properties of orthotics have been proposed as a significant source of pain relief. An early study of viscoelastic insoles showed a decrease of 42% in the peak vertical impact forces at heel strike [10]. Subsequent studies found strikingly positive effects of shock absorbing insoles alone to treat LBP with approximately 80% of subjects reporting significant improvement in both pain and mobility after one year of use. Forty five percent of patients from this study whom discontinued the intervention were found to have significant improvement in pain and mobility with conservative care alone, illustrating the wide variability experienced by those treated for LBP [9].

Impaired or abnormal foot function has been implicated as a possible mechanism that may contribute to the development of LBP. Excessive pronation of the foot during gait has been proposed to induce prolonged and/or excessive internal rotation of the lower limb resulting in abnormal forward progression [11]. This hampered progression can result in a significant increase in strain at both the sacroiliac and lumbosacral joints [11–13]. These increased strains theoretically lead to increased pain and muscular dysfunction.

Ball and Afheldt highlighted the differences between rigid orthotics based on "Root theory" foot classification, where the focus of intervention is to maintain subtalar neutral position and semi-rigid orthotics with the intention of "supporting" the three arches of the foot [14].

The review, relying on several studies of biomechanical analysis of normal subjects [15,16], cast some doubt on the utility of the Root approach. Three areas of criticisms were described: the poor reliability of clinical identification of subtalar neutral position, the unrealistic representation of non-weight bearing identification subtalar neutral position, and the lack of demonstrated functional significance of this position during normal gait [14].

The effect that static standing foot posture has on the incidence of injury or pathology has been a topic of much debate [9,17–20]. Predisposition to injury based on static arch height during standing has been proposed with several studies finding that those individuals with high arches had a higher incidence of lower limb pathology when compared to low arched individuals [9,21,22]. Natural shock absorption of the foot was addressed through biomechanical testing, those with higher arches were found to have more internal rotation of the tibia at heel strike and absorb shock earlier in stance phase [23,24]. Theoretically, this increases the capacity for shock absorption and should lead to a protective effect.

A recent study by Menz et al. found that increased dynamic foot pronation, as measured with center of pressure excursion, was significantly associated with LBP in women, while the static posture of the foot was not. However, no such association was found in the male subjects. The implications of this finding are limited, as the back pain was only indicated on a body chart and not described in severity, duration, or frequency [17].

A recent review by Kendal et al. summarizes the current understanding of dynamic aspects of functional foot kinematics associated with lumbopelvic muscular dysfunction [25]. The authors point to recent findings of increased navicular drop associated with LBP [26], and decreased shock absorption found in those with a pronated static foot posture as evidence for the relationship [23]. The review however goes on to conclude that the changes in foot posture are associated with relatively small magnitude changes in pelvic posture, have little evidence of clinical significance [25]. The relationship between lumbopelvic muscular dysfunction and altered foot mechanics is puzzling. There is evidence of association between the two [18,27], also there is evidence that each is associated with LBP [28–30]. In a review of both foot and lumbopelvic-hip motion Barwick et al. summarizes nicely several key elements of the proposed mechanisms of orthotic intervention: affecting foot pronation [31–33], internal tibial rotation [32,34,35], joint moments [32,36,37], muscular activation [38–40], neuromuscular control [41,42], and sensory feedback [32,41,43,44]. The authors concluded that evidence of coupling of the foot and lumbopelvic-hip complex suggests that the use of foot orthotics may have an effect on more proximal structures [45].

Contradictory evidence is reported in the description of the kinematic effects of orthotic intervention, where multi-segment biomechanical models of the foot are able to give a more complete indication of the kinematic effects of orthotic introduction. Sinclair et al. found that the introduction of custom orthotics acted to reduce motion in the coronal and transverse plane during running [46] opposing earlier work in this area that found no such reductions [47,48]. The authors hypothesize that the composition of the medial arch support may explain the discrepancy [46]. This area of research is rife with inconsistent results stemming from the comparison of studies describing custom interventions. The proprietary nature of many orthotic interventions hinders the ability of researchers to directly compare specific mechanisms of action, and has been identified as a barrier to research [49].

Small and widely disparate kinematic and kinetic changes have been documented with the use of foot orthotics; to date the clinical implications of these changes are unclear. The direct link from documented prolonged kinematic or kinetic changes to clinical efficacy has not been made. Clinical studies lack the rigorous biomechanical analysis needed while detailed biomechanical studies do not provide a longitudinal view of intervention and generally lack clinically relevant outcome measures. A truly translational approach is needed to address the evidence gaps that are currently present in this area of research.

3.2. Recommendations for studies on biomechanical mechanisms

There is a clear need for the dynamic biomechanical characterization of foot function prior to an intervention. The static characterization of foot posture falls short of giving a clear indication of foot dysfunction during gait. Interventions based on a clearly defined set of kinematic and/or kinetic variables would produce improved specificity of treatment effects. However, this approach is thwarted by the need for clinically available equipment, processes, and protocols by which to produce such a characterization.

Future research in the area of biomechanical consequences of foot orthotic intervention should focus on the systematic alteration of foot kinematics and/or kinetics during the stance phase of gait.