Academy of PHYSICAL MEDICINE

Research Paper Review

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REDUCING OVERPRONATION & THE EFFECT OF ORTHOTICS ON GAIT

1. Efficacies of different external controls for excessive foot pronation: A meta-analysis

British Journal of Sports Medicine 2011; 45: 743-751

Cheung RTH, Chung RCK & Ng GYF

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2. Foot Orthoses and Gait: A systematic review and meta-analysis of literature pertaining to potential mechanisms

British Journal of Sports Medicine 2010; 44: 1035-1046

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ABSTRACTS

1. Efficacies of different external controls for excessive foot pronation:

OBJECTIVES: This meta-analysis investigated the efficacies of foot orthoses, motion control footwear and therapeutic adhesive taping in controlling foot pronation as compared with no-intervention conditions.

DATA SOURCES: Electronic searches on four electronic databases were performed and the reference lists of the screened articles were also scrutinised.

REVIEW METHODS: Two reviewers screened the quasi-randomised or clinical controlled trials that examined the efficacy of the selected interventions in controlling calcaneal eversion. Heterogeneity and publication bias were assessed by I(2) index and Egger's regression intercept, respectively. Trial quality was rated by the Physiotherapy Evidence Database scale.

RESULTS: 29 studies were selected. The I(2) indices revealed large heterogeneity which supported the use of a random effect model of meta-analysis. The Egger's regression intercepts suggested that publication bias of the included studies was marginally present in the motion control footwear and the therapeutic adhesive taping groups ($p=0.06$-0.07). All three interventions were effective in reducing calcaneal eversion ($p<0.001$) with therapeutic adhesive taping being most effective whereas Low-dye taping was less effective than the other taping techniques, such as high-dye and stirrups taping. Custom-

made foot orthoses were more effective than prefabricated orthoses. Motion control footwear with heel flare or wedge design was less effective than those with dual midsole materials.

CONCLUSIONS: Foot orthoses, motion control footwear and therapeutic adhesive taping were able to control rearfoot eversion with therapeutic adhesive taping being the most effective. In the clinical practice, selection of an antipronation intervention should be based on patient characteristics, type of activity and personal preference.

2. Foot Orthoses and Gait

This article systematically reviews the available literature to improve our understanding of the physiological basis for orthoses under the kinematic, shock attenuation and neuromotor control paradigms. The propositions made under these three paradigms have not been systematically reviewed collectively, and as such, there is no single-point synthesis of this clinically relevant body of evidence and somewhat disparate findings. Our comprehensive search strategy yielded 22 papers. Under each paradigm, the role of orthoses with different design features including combinations of posting, moulding and density was analysed. Where possible, data have been pooled to provide an increased level of confidence in findings. The main findings in the kinematic paradigm were that posted non-moulded orthoses systematically reduced peak rearfoot eversion (2.12° (95% CI 0.72 to 3.53)) and tibial internal rotation (1.33° (0.12 to 2.53)) in non-injured cohorts. In the shock attenuation paradigm, it was found that non-posted moulded and posted moulded orthoses produced large reductions in loading rate and vertical impact force when compared with a control and to a posted non-moulded orthosis. The neuromotor control paradigm seems to be the least conclusive in its outcome. Based on our review, this paper concludes with rudimentary guidelines for the prescription of orthosis, that sports medicine practitioners may use in their clinical decision-making process. The need for further research focusing on the role of injury, particularly in neuromotor control modification and long-term adaptation to orthoses, was highlighted.

ANALYSIS

Background Information

In clinical practice, gait patterns and lower extremity alignment and kinematics are routinely assessed when clinicians are confronted with conditions ranging from local injuries to low back pain to general movement dysfunctions. Important components of a comprehensive evaluation are to observe the static and dynamic function of the medial arch of the foot. Although no consensus exists on the definition of *'overpronation'*, its consequences are well known, biomechanically logical, and supported by the literature. In conjunction with internal rotation of the tibia, valgus collapse at the knee and an increased adduction moment at the hip, overpronation can contribute to a myriad of biomechanical concerns and conditions such as stress fractures, Achilles tendinopathy, patellofemoral pain syndrome, plantar fasciitis and medial tibial stress syndrome, to name a few.

A variety of interventions are commonly employed to address overpronation, including pre-fabricated and custom foot orthotics, motion control footwear and taping. The two papers included in this review sought to synthesize the literature on the efficacy of these interventions on addressing overpronation (1) and summarize the effects of foot orthotics on gait (2).

SUMMARY

Efficacy of Foot Orthoses, Motion Control Shoes & Taping for Controlling Overpronation

- Of the 29 studies included in this review (which included a total of only 429 subjects!), 13 evaluated foot orthotics, 10 looked at motion control foot wear and 10 at adhesive taping (some examined more than one intervention).
- Average PEDro scores were ~5.5/11 across the included studies.
- Overall, the reduction in calcaneal eversion (an indicator of pronation) for the three anti-pronation interventions was significant when compared with no-intervention control ($p <$

0.001). The reduction with therapeutic adhesive taping was the highest (mean difference = 2.64°; 95% CI = 1.39 to 3.90), followed by the motion control footwear (mean difference = 2.52°; 95% CI = 1.71 to 3.33), and lastly were foot orthoses (mean difference = 2.24°; 95% CI = 1.42 to 3.07). It should be noted that the overall difference between the most effective and least effective interventions was less than 0.5°.

- Within the orthotic data presented above, custom made orthoses seemed to have a bigger effect on rearfoot eversion than prefabricated orthoses (2.35° vs. 2.08° on average; again, a small difference).
- Regarding the design of motion control footwear – the shoes with dual materials in the midsole produced a reduction in calcaneal eversion (mean change = 2.77°; 95% CI = 1.74 to 3.81; $p < 0.001$). Conversely, the effects of motion control footwear with heel flare or wedge modification were not significant.
- Regarding taping techniques - Low-dye taping had a non-significant weighted mean change in the reduction of foot pronation (mean change = 1.50°; 95% CI = -0.73 to 3.73; $p = 0.19$). Interestingly, other taping techniques, including high-dye and stirrups taping techniques, were found to be effective in controlling foot pronation (mean change = 4.62°; 95% CI = 3.73 to 5.50; $p < 0.001$).
- Overall, all 3 interventions can potentially improve overpronation. Foot orthotics were the least effective means and therapeutic taping was most effective. However, remember the difference among the three interventions was only about 0.5°. The relevance of such a difference is questionable and it could result from measurement error and inconsistencies amongst the studies included.

Mechanisms of Action for Gait Alterations with Foot Orthotics

- Quality index scores of the 22 included studies ranged from 17-24 out of a possible score of 28.
- The most common shortcomings of the studies included lack of assessor and participant blinding, and generalizability of the samples.
- To date, research has focused primarily on the kinematic paradigm and least on the neuromotor control aspects of orthotic utilization.
- **Kinematic paradigm:** Pooled results demonstrated a relatively small effect on rearfoot eversion and tibial internal rotation (~2° each) – both were measured via skin markers and may therefore overestimate actual bone motion. Posted, non-moulded orthoses (moulding = customizing contour of orthotic to patient's foot, +/- posting) seemed to have a greater effect. The clinical relevance of this small change is unknown, but the cumulative effect of smaller changes on overall mechanics and tissue strain should not be discounted. Wide confidence intervals in most studies suggest that responses may be very individual.
- **Shock attenuation:** Surprisingly, altering material density had no effect on tibial acceleration, loading rate or vertical impact force. However, moulded orthoses may reduce loading rate and favorably affect vertical impact and ground reaction forces.
- **Neuromotor control:** Only 2 studies contained enough data to derive point estimates of effect, but pooling was not possible due to dissimilarity of the cohorts. Having said that, orthotics do seem to increase tibialis anterior and posterior activity (the myofascial 'sling' supports of the foot's arch), as well as variably affecting medial gastrocnemius activation and thigh muscle activity (contingent on injury status) – further research is required in this area.
- Overall this review concluded that there is wide variability in how individuals respond to orthotics. Posted orthotics that aren't customized seem to affect rearfoot kinematics and tibial internal rotation, while moulded (customized) orthotics may attenuate loading rate and vertical impact force.
- Readers should keep in mind that most studies included subjects with no history of injury so further research is certainly required on a variety of patient populations.

CLINICAL APPLICATION & CONCLUSIONS

These two studies did a nice job of summarizing the existing literature on the effect of orthotics on gait mechanics and how external devices can influence pronation and other movement/force variables.

In general, it appears that orthotics, motion control footwear and taping are all potentially effective for reducing overpronation. Practically speaking, orthotics or footwear seem more reasonable despite the fact that taping was most effective when data was pooled. This difference was minimal, and taping is not a reasonable, long term solution in most cases. The literature also suggests that non-customized, posted orthotics may control rearfoot eversion and tibial motion more than a control intervention, while customized orthotics may have more of an effect on loading and force attenuation than if they are just posted (When was the last time an orthotic company rep gave you this information?).

Given that patient response to orthotics seems to be variable (this is something the literature demonstrated quite clearly), clinicians should continue to customize their prescription after careful assessment and evaluation of each patient.

STUDY METHODS

Both studies conducted appropriate literature searches utilizing standard databases. Authors from each project then selected studies according to well described inclusion criteria that were appropriate for the topics at hand. Cheung and colleagues (1) included randomized or quasi-randomized trials (n = 29) published in peer-reviewed journals that investigated the efficacy of foot orthotics, motion control shoes or taping versus no-intervention control groups for patients diagnosed with conditions related to excessive foot pronation (who were otherwise healthy). Mills and colleagues (2) included only studies (n = 22) that focused on the mechanisms of effect for foot orthotics on gait (studies looking at the effects on running, jumping, single-leg squatting etc. were excluded). Studies evaluating the efficacy of orthotics were not included. Reporting on study selection and quality assessment was adequate in both papers.