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Orthotic treatment for stage I and II posterior tibial tendon dysfunction (flat foot): A systematic review

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Abstract

Objective: To investigate whether orthotic treatment is effective for the treatment of posterior tibial tendon dysfunction stages I and II (flat foot).

Data Sources: Five databases (PubMed, Scopus, PEDro, SPORTDiscus and The Cochrane Library) were searched for potential RCTs from their inception until August 2020.

Review Methods: Only randomised controlled trials (RCT) that included subjects diagnosed with posterior tibial dysfunction in the initial stage and treated with orthotic treatments were selected. The outcomes assessed were whatever symptom related to posterior tibial tendon dysfunction stage I and II. Included RCTs were appraised using the Cochrane collaboration risk of bias tool.

Results: Four RCT articles and 186 subjects were included. 75% were at high risk of bias for blinding of participants and personnel. Three different types of conservative treatment were used in the studies: foot/ankle-foot orthoses, footwear and stretching /strengthening exercises. Foot orthoses, together with exercise programmes, seemed to improve the effect of orthotic treatment. Foot orthoses with personalised internal longitudinal arch support were more effective than flat insoles or standard treatments in reducing pain.

Conclusions: The use of orthotic treatment may be effective in reducing pain in the early stages of posterior tibial tendon dysfunction. Further research is needed into individualised orthotic treatment and high-intensity monitored exercise programmes.

Keywords

Posterior tibial tendon dysfunction, flat foot, orthotic treatment, foot orthoses, pain

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Introduction

The tibialis posterior muscle is considered the main dynamic stabilising muscle of the medial longitudinal arch (MLA) height.[1–4] When posterior tibial tendon dysfunction (PTTD) takes place pronation is prolonged until the end of the stance phase of gait

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resulting in pain and walking disfunction,[5,6] excessive mechanical stress and collapse of the MLA, being one of the main causes of acquired flat foot deformity in the adult.[7–9] Although further structures are involved, the PTTD is established as one of the leading causes of flat foot in the adult.[9–14]

Considering Bluman and Myerson's refined classification of PTTD,[15] in stage I patients have tenderness along the posterior tibial tendon (PTT) and in some cases a slight hindfoot valgus (5 degrees or less). Patients in stage II have flexible hindfoot valgus, and a wide range of weakness, lower limb functional problems and foot deformity.[16–20] This stage is subdivided into three categories; Stage IIA presents with forefoot varus (flexible or fixed) and possible pain along the PTT. Stage IIB involves forefoot abduction. However in stage IIC a fixed forefoot varus exists, together with medial column instability and first ray dorsiflexion.[15,21] This may be the reason why a wide typology of patients could be classified as having 'flexible flat foot', and there may be variability in the treatment prescribed. Geideman and Johnson referred that conservative treatments should eliminate clinical symptoms, prevent progression foot deformity and improve hindfoot alignment.[8]

Foot orthoses are frequently recommended as non-operative treatment.[14,15,22–24] They are prescribed with the main objective of reducing pain by supporting the MLA as well as by controlling the valgus angulation of the hindfoot.[23,25–27]

Clinicians remark the importance of early diagnosis and treatment, especially of stage II while the deformity continues being moderate and is not structured.[3] The Cochrane Collaboration accepts the relevance of evaluating and synthesising research-based evidence so that it can be incorporated into healthcare decisions.[28] To the authors' knowledge, a literature review with this aim has not been previously published. This systematic review has been carried out to know whether or not orthotic treatment has any effect when used to treat patients with stage I and II posterior tibial tendon dysfunction, or adult flexible flat foot.

Methods

The protocol of this systematic review was registered in PROSPERO (registration number: 42020149684). PRISMA guidelines were adopted for reporting details on this systematic review.

After designing the final strategy and its adaptations to the differences of each database, five databases were searched: PubMed, Scopus, SPORTD iscus, PEDro and The Cochrane Library, being the last date of search on August 2020. Neither the year of publication nor the language of the documents was limited in any of the documents.

PubMed was used as free access tool for the search in Medline and Premedline. The search and the free search were done via Mesh terms. In Scopus the advanced search was performed, adding the predetermined options 'randomised controlled trial', 'randomisation', 'randomised controlled trial', 'randomised', 'randomised controlled trial (topic)' and 'randomised controlled trial as topic'. Also the following childcare subjects were excluded using filters with predetermined options: 'child', 'child healthcare', 'child preschool', 'childhood disease', 'children'. The advanced search was done in PEDro, SPORTDiscus and in The Cochrane Library. The search strategy used can be consulted in Appendix 1.

The inclusion criteria were randomised clinical trials whose participants were adults diagnosed with posterior tibial tendon dysfunction stage I or II.[15] Those randomised clinical trials which sample had no evidence about presenting posterior tibial tendon dysfunction stage I or II were excluded. There were no restrictions related to sex, race or ethnicity, kind of job position and physical or sports lifestyle.

The interventions included consisted in prescribing orthotic treatment of any characteristic. The use of another supplementary treatment and/or physical treatment was not a reason for exclusion, although this was taken into account in the analysis of the data. Any kind of comparison between interventions was valid, as long as one of them consisted in orthotic treatment. The type of results that the studies were required to report was, at least, the level of pain before and after the orthotic treatment but no studies were excluded for not presenting such results. Besides, other results were taken into account.

This review was carried out considering the method of The Cochrane Collaboration for systematic reviews.[28] Two different reviewers did the

selection process independently. Both reviewers evaluated via reading the title and the abstract of each of the articles if these fulfilled the inclusion criteria previously described:

- Participants: subjects with posterior tibial tendon dysfunction stage I and II.
- Intervention: orthotic treatment.
- Comparison: whatever.
- Outcomes: whatever symptom related to posterior tibial tendon dysfunction stage I and II.
- Study design: randomised clinical trials.

After this first selection, a sole reviewer sought for the complete reports. In both evaluations, the nonfulfilment of a single criterion of eligibility was enough reason to exclude the study. This way, after the first negative item appeared, each reviewer could exclude the study without the need to continue valuing the rest of it. The risk of bias assessment in the studies was done using the software Review Manager (RevMan) recommended by The Cochrane Collaboration.[28] Reasons for exclusion were those studies that did not join the eligibility criteria previously described and/or whose level of methodological quality was doubtful. Studies in which the participants did not have pain related with their posterior tibial tendon dysfunction were excluded, as were those which did not use an orthotic treatment, or used it as a preventive or postoperative treatment without foot pain. After obtaining the manuscripts, a complete reading of the documents selected by each of the reviewers was done. In the complete reading, we again valued their eligibility in accordance with the strict fulfilment of the inclusion criteria described before. This was necessary for the study to be finally selected for review.

Each reviewer had an Excel sheet to facilitate the first selection process of the studies. The selected studies were recorded in this sheet, as well as those not included and the reason for exclusion. After this process, the results of both reviewers were grouped together. Those papers which had been selected by only one of the reviewers needed of the opinion of a third evaluator to decide on the definitive inclusion or exclusion of them in the following review phase.

For the second evaluation of the reports, each reviewer used the data collection form in Word format to record each report's general information, both its identification (ID study or report) and its main characteristics (type of participants, interventions, results, etc.). The data collected were based on the eligibility criteria previously described. In this phase the complete reading and the data extraction of those studies selected in the previous process was carried out. In this case the intervention of a third reviewer was not necessary to make the final decision about whether to include some of the articles.

Finally, a sole reviewer did the complete extraction of the data of the documents eventually selected in the second evaluation. In this case a data collection form in Word format that was more extensive than the previous one was used. The Word forms were based on the translation and adaptation of the existing model designed by The Cochrane Collaboration for randomised clinical trials.[28]

Results

The selection process of the articles included in the systematic review is shown in Figure 1, for which a flow diagram was elaborated based on the recommendations of the PRISMA declaration.[29,30]

The four articles finally included in this systematic review are randomised clinical trials with parallel groups. Table 1 summarises the data extracted from the studies included in the systematic review. Figures 2 and 3 show the risk of biases of the studies included in this systematic review.

Three of the four studies compared the effect of orthoses to the effect of the orthotic treatment plus exercise programmes. In the Yurt et al.'s study,[31] three different types of orthoses were compared and every group did stretching and strenghening exercises. The group with CAD-CAM orthoses and conventional orthoses significantly improved the pain level compared to the group of flat insole orthosis, but there were not significant differences between the CAD-CAM orthosis group and the conventional orthosis group. Both groups had a medium size effect while the flat insole orthosis group obtained a small size effect.

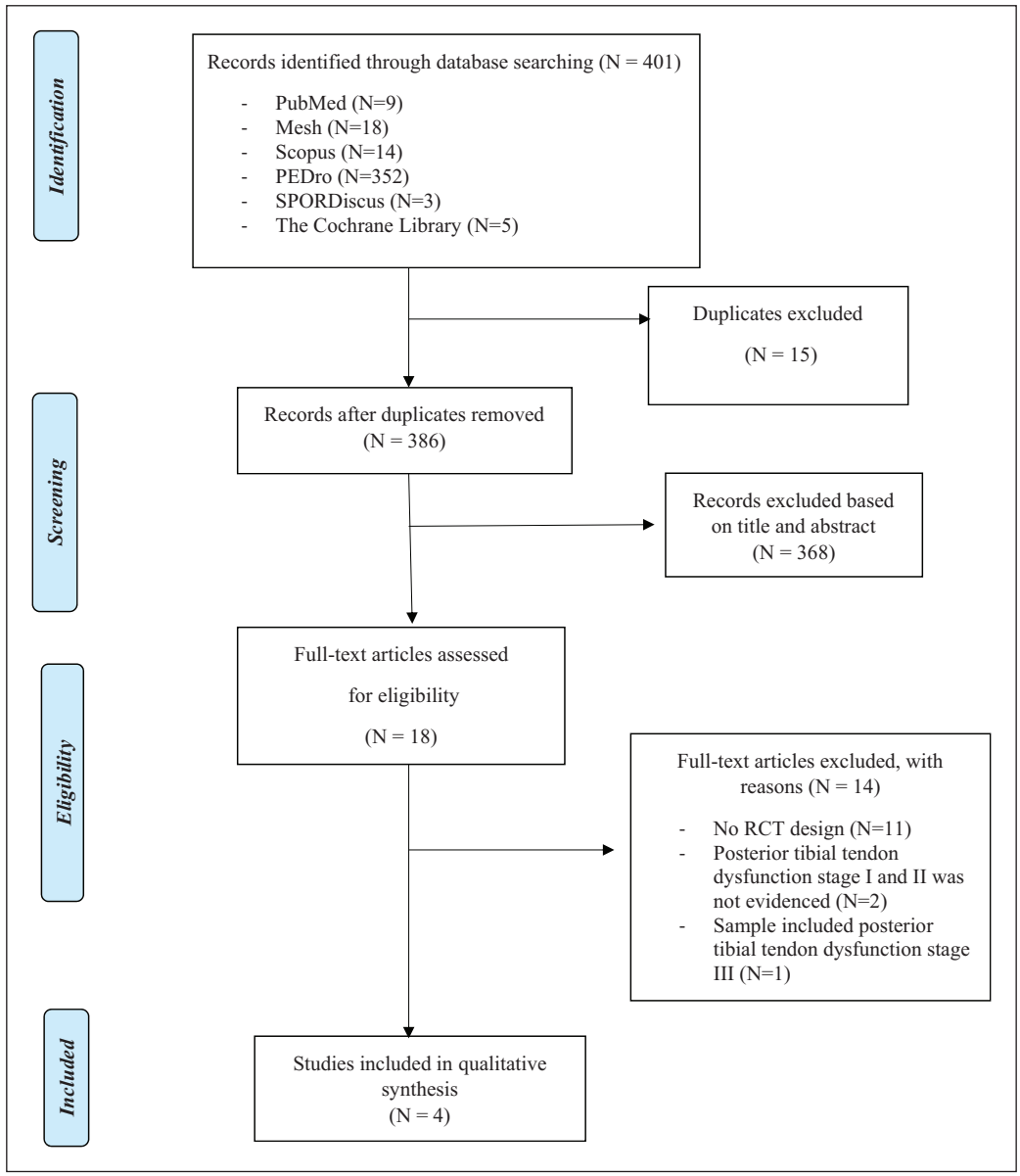

Figure 1. Stages of the selection process of the studies included in the review.

In case of Houck et al.'s study[32] all participants used the same type of foot-ankle orthosis, although this orthosis has a medial arch support with an adjustable height for each patient. One group carried out soleus, gastrocnemius and tibialis posterior stretching, while the other group did tibialis posterior and ankle plantarflexors strengthening exercises apart from the aforementioned stretching and the orthosis. Both treatments were significantly effective for pain and functional capability, but the differences between groups were minimum.

However, in the study of Kulig et al.'s study[16] all the participants used custom-made foot orthoses with arch support. One group carried out soleus

Table 1. Main characteristics of the studies included.

	N	Men/ women	Average age	Follow up period	Stage of PTTD	Types of orthotics	Variables	Pre-treatment/post-treatment pain	Size effect
Yurt et al.[31]	67	28/39	21.73 ± 2.89[a] 23.05 ± 5.53[b] 21.09 ± 1.95[c]	8 weeks	I and II	CADCAM	Pain, limitation of activity, and mental and physical health	**CADCAM:** 59.27 ± 17.26 (51.62-66.93) / 27.84 ± 18.41(19.67-36.01) mm (VAS)	Cohen's d = 0.660
						Conventional		**Conventional:** 60.32 ± 16.82 (52.86-67.78) / 27.05 ± 16.82 (18.29-32.21) mm (VAS)	Cohen's d = 0.703
						Flat insole		**Flat insole:** 58.48 ± 17.51 (50.91-66.05) / 46.39 ± 20.18(37.66-55.12) mm (VAS)	Cohen's d = 0.304
Houck et al.[32]	39	8/28	58 ± 9[d] 57 ± 12[e]	12 weeks	II	Precast foot-ankle	Pain, disability, limitation of activity, perception of mobility, dysfunction and discomfort, and the PTT's isometric strength	**Stretching group:** 35 (29-40)/18(12-25) mm (VAS) **Strengthening group:** 38 (29-46)/19 (11-27) mm (VAS)	Stretching group: $P < .001$ Strenghening group: $P < .001$
Kulig et al.[16]	36	8/28	51.3 ± 17.2[d] 55.3 ± 16.4[f] 49.4 ± 12.6[g]	12 weeks	I and II	Custom-made	Pain, disability and limitation of activity	**Orthoses:** 37.5 (25.8, 49.2) / 21.2 (10.2, 32.2) mm (VAS) **Orthoses and concentric exercise:** 34.8 (23.6, 46.0) / 13.0 (7.6, 18.4) mm (VAS) **Orthoses and excentric exercise:** 46.9 (37.3, 56.5) / 10.6(5.8,15.4) mm (VAS)	ANCOVA identified differences among the groups ($P = .048$)
Esterman and Pilotto[35]	47	44/3	14 subjects are <21 years old and 11 subjects ⩾21[h] 9 subject are <21 years old and 13 subjects ⩾21[i]	8 weeks	I and II	Precast and thermo-adapted	Pain, mental and physical health, general foot health and injuries after training	**Custom-made ortheses:** Had lower limb pain = 10 / 4 No lower limb pain = 15 / 16 **No treatment:** Had lower limb pain = 5 / 4 No lower limb pain = 17 / 8	$P = .606$

PTTD: Posterior tibial tendon dysfunction. CAD-CAM: computer-aided design/computer-aided manufacturing. VAS: visual analogue scale. PTT: posterior tibial tendon. ANCOVA: analysis of covariance.

[a]CAD-CAM ortheses; [b]Conventional ortheses; [c]Flat insole; [d]Ortheses and stretching; [e]Ortheses, stretching and strengthening; [f]Ortheses, stretching and concentric; [g]Ortheses, stretching and eccentric; [h]Custom-made ortheses; [i]No treatment.

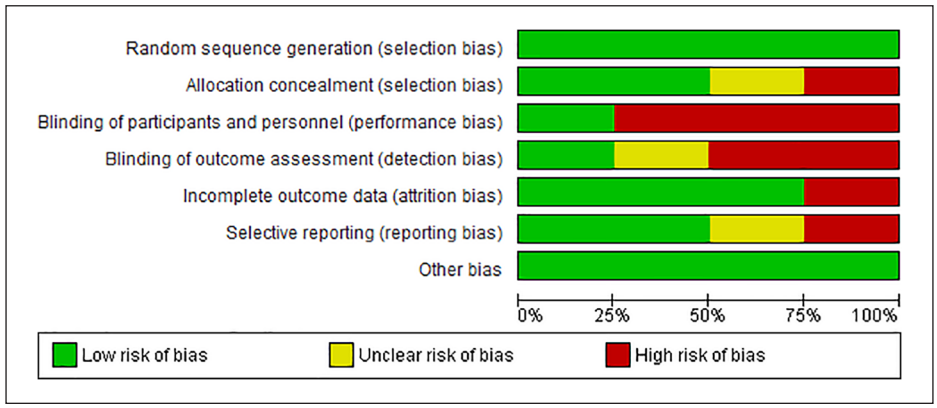

Figure 2. Risk of biases among the studies included.

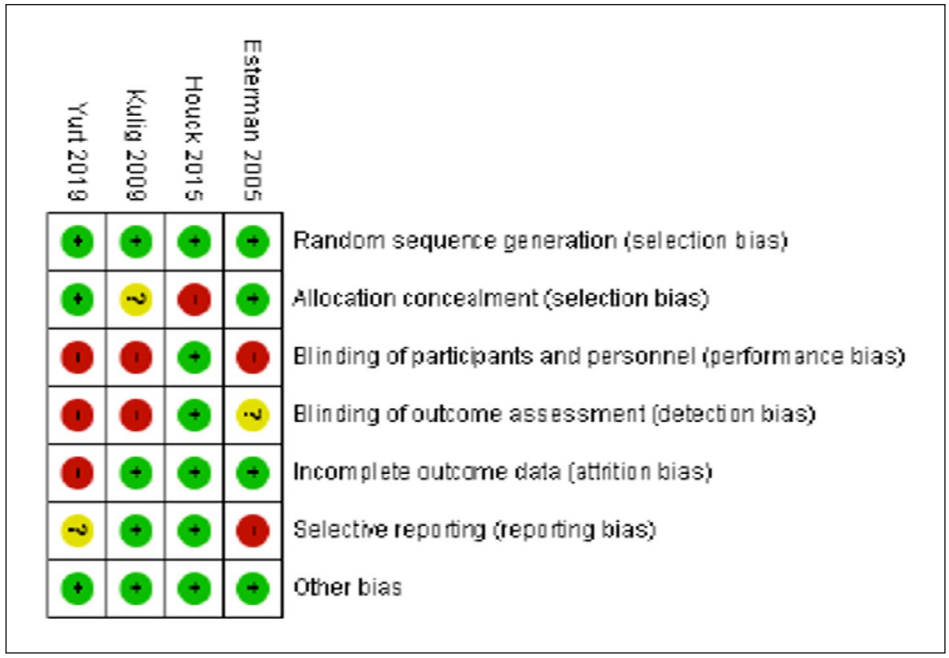

Figure 3. Risk of biases of the studies included.

and gastrocnemius stretching, other group did stretching and concentric exercises of progressive tibialis posterior resistance, and a third group performed stretching and eccentric exercises of tibialis posterior progressive resistance. The pain and disability measured with the Foot Function Index,[33] significantly improved in all the study groups, although the group treated with foot orthoses plus eccentric exercises showed more improvement. However, the intensity of pain after the '5-Min Walk Test' measured with Visual Analogic Scale,[34] reported significant improvements in all the groups after the intervention, but there were not significant differences between groups.

Finally, Esterman and Pilotto[35] compared the effect of foot orthoses with a placebo treatment, and no participants executed any exercise protocol. This study reported that participants who used the foot orthoses had less pain, fewer injuries and a better quality of life, but statistically significant results did not exist due to the low treatment adherence.

Discussion

The aim of this systematic review was to answer the question of whether orthotic treatment was effective when used to treat stage I and II posterior tibial tendon dysfunction, also known as adult acquired flexible flat foot. According to the qualitative analysis of the studies included, foot orthoses have shown to have positive clinical outcomes in patients with this condition, when used in conjunction with some type of exercise programme.

Among 4 RCTs included in this review, only one analysed the effect of foot orthoses without any kind of exercise programme.[35] That pilot clinical trial provided some (although limited) evidence that foot orthoses could improve lower limb pain and general foot health, and decrease injury in people with flexible flat feet. However, the quantitative analysis was based on a very small sample size and the subjects' poor treatment adherence, as only 10 participants wore the orthotics provided all or most of time. Although those who used the orthoses had favourable results, half of the group did not use them for reasons related to discomfort and the negative fit between the shoe and the orthosis. This emphasises the importance of footwear for effective orthotic treatment, although in this case, the orthosis were not personalised either, presenting exactly the same elements for all patients, according to the stage of the pathology. The remaining RTCs combined foot orthoses and home-based exercises programmes to treat all participants, from only calf stretching, to calf stretching and concentric or eccentric exercices,[16] stretching or strengthening tibialis posterior muscle,[32] or these together with intrinsic muscles strengthening.[31]

Regarding the type of foot orthoses employed, Yurt et al.[31] sustained that CAD-CAM and conventional orthoses have a similar effect size to reduce pain, probably because both type of orthoses have exactly the same elements, although they were manufactured in a different way. Therefore the only difference between these two types of orthoses seemed to be that the CAD-CAM method was faster, simpler and more accurate. The positive results of flat insole orthosis, not only in their study but also in Wrobel et al.'s,[36] probably came from complementary treatments; but we cannot know it since these interventions were not monitored. McCormick et al.[37] sustain that the flat insoles could reduce the plantar pressures of the heel and consequently the pain, possibly due to shock absorption.

Some uncontrolled studies show the benefits of combining orthoses with exercise programmes in this pathology[21,38] and also the controlled study by Kulig et al.,[16] although the appropriate intensity is not clear. To obtain a good adaptation of the tendon, the load and frequency of the exercises must be sufficient. Álvarez et al. presented positive results with a protocol of high-intensity isokinetic exercises and long sets.[21] However, Kulig et al.[38] and Bek et al.[39] used lower intensity protocols in their studies and did not replicate such good results.

In the study of Kulig et al.[16] the eccentric PT exercises group probably showed better results in terms of pain and tendon function because they performed exercises with loads three times higher than the group of concentric exercises to achieve tendon recovery. However, at pre-intervention testing, baseline Foot Function Index scores were significantly different among the three intervention groups. Furthermore, participants in the concentric PT exercises group had higher values of age and BMI, and lower values of arch index. Although the authors performed an ANCOVA to enable comparisons of post-intervention means after adjusting for the differences in the baseline scores, we cannot know whether the results obtained by Kulig et al. could have been influenced by these differences. The limitation of the activity did not give rise to significant results in any group, as it happened in the study of Yurt et al.[31] This can be explained by the slight limitation that patients suffered in their daily life before treatment, despite presenting pain. Nonetheless, all groups experimented notable improvements in function and reductions in pain, so wearing custom orthotics and stretching the Achilles tendon seems to be a sufficient intervention.

On the other hand, in the study of Houck et al.[32] the improvements observed in the group that performed exercises as a complementary treatment to the use of orthosis, although significant, were lower compared to the study of Kulig et al.,[16] being a possible cause the insufficient intensity or duration of the exercise protocol to demonstrate greater effects on pain and function. In addition, in the study by Kulig et al.[16] the orthoses were personalised, while in Houck et al.'s were adjustable but standardised.

The greater therapeutic adherence to the orthotic treatment in the studies by Houck et al.[32] and Kulig et al.[16] may have been linked to comfort and individualised treatment adaptation. Not all subjects had the same degree of deformity or the same stage of posterior tibial dysfunction, and therefore the degree of correction and MLA support should have not been the same. Furthermore, in the studies by Esterman and Pilotto,[35] and by Yurt et al.[31] non-personalised orthoses were used presenting metatarsal elements with a standard height and shape to all participants, while in stage II there are different deformities and degrees of severity at the forefoot.

In the authors' opinion, the studies included have certain limitations. They do not specify the process of design, manufacturing and adaptation of the orthoses to the patient or their footwear, nor whether modifications of them were made. There are other studies that report positive effects of custom-made foot orthoses pain reduction and foot function improvement in flexible flat feet,[21,40] but there is not a consensus in their material, design or production,[41] probably due to the different characteristics of the participants of each study. In addition, some of the studies do not describe the methods followed for the diagnosis of the posterior tibial tendon dysfunction.[31,35] Also, some of the exercises programmes applied to the participants were not monitored,[31] so it cannot be known their real influence on the orthoses effect.

The present study also has certain limitations, as the heterogeneous use of tools in the different studies to measure the same result. This hindered the synthesis of the results concerning the reduction of the pain, so it was carried out qualitatively. The measurement of size effect also differs between studies, so it was difficult to assess the real size effect.

To summarise, the orthotic treatment, when used in conjunction with exercise programmes, seems to improve symptomatology in patients with stage I and II posterior tibial tendon dysfunction. Regarding to the manufacturing process of the orthoses, different methods have shown to be effective in the studies reviewed. Elements that support medial longitudinal arch seem to have a greater effect in reduction of pain than the orthoses that do not include them. The customisation of the foot orthoses or their elements (including the arch supports) appears to have greater benefits, as well as to increase the treatment adherence. Although the positive effects of the orthotic treatment is known, there do not exist studies in which foot orthoses have eliminated pain completely. Further research is needed to find out whether or not a conservative treatment consisting only on foot orthoses is capable to completely release symptoms in adult flexible flat foot.

Clinical messages

- Foot orthoses, with exercise programmes, may be effective in reducing pain in the early stages of posterior tibial tendon dysfunction (adult acquired flexible flat foot).
- Foot orthoses with medial longitudinal arch support may have a greater effect in reduction of pain.
- Custom-made orthoses may have greater benefits than standardised ones.

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Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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Supplemental material

Supplemental material for this article is available online.

References

1. Erol K, Karahan AY, Kerimoğlu Ü, et al. An important cause of pes planus: the posterior tibial tendon dysfunction. *Clin Pract* 2015; 5(1): 699.
2. Kulig K, Popovich JM, Noceti-Dewit LM, et al. Women with posterior tibial tendon dysfunction have diminished ankle and hip muscle performancedecreased. *J Orthop Sports Phys Ther* 2011; 41(9): 687–694.
3. Bowring B and Chockalingam N. Conservative treatment of tibialis posterior tendon dysfunction – a review. *Foot* 2010; 20: 18–26.
4. Gao L, Yuan JS, Heden GJ, et al. Ultrasound elasticity imaging for determining the mechanical properties of human posterior tibial tendon: a cadaveric study. *IEEE Trans Biomed Eng* 2015; 62(4): 1179–1184.
5. Johnson KA and Strom DE. Tibialis posterior tendon dysfunction. *Clin Orthop Relat Res* 1989; 239: 196–206.
6. Chao W, Wapner KL, Lee TH, et al. Nonoperative management of posterior tibial tendon dysfunction. *Foot Ankle Int* 1996; 17(12): 736–741.
7. Neville C, Flemister AS and Houck J. Effects of the airlift PTTD brace on foot kinematics in subjects with stage II posterior tibial tendon dysfunction. *J Orthop Sports Phys Ther* 2009; 39(3): 201–209.
8. Geideman WM and Johnson JE. Posterior tibial tendon dysfunction. *J Orthop Sport Phys* 2000; 30: 68–77.
9. Smyth NA, Aiyer AA, Kaplan JR, et al. Adult-acquired flatfoot deformity. *Eur J Orthop Surg Tr* 2017; 27: 433–439.
10. Bowring B and Chockalingam N. A clinical guideline for the conservative management of tibialis posterior tendon dysfunction. *Foot* 2009; 19(4): 211–217.
11. Crevoisier X, Assal M and Stanekova K. Hallux valgus, ankle osteoarthrosis and adult acquired flatfoot deformity: a review of three common foot and ankle pathologies and their treatments. *EFORT Open Rev* 2016; 1(3): 58–64.
12. Dyal CM, Feder J, Deland JT, et al. Pes planus in patients with posterior tibial tendon insufficiency: asymptomatic versus symptomatic foot. *Foot Ankle Int* 1997; 18(2): 85–88.
13. Yeap JS, Singh D and Birch R. Tibialis posterior tendon dysfunction: a primary or secondary problem? *Foot Ankle Int* 2001; 22(1): 51–55.
14. Kohls-Gatzoulis J, Angel JC, Singh D, et al. Tibialis posterior dysfunction: a common and treatable cause of adult acquired flatfoot. *Brit Med J* 2004; 329: 1328–1333.
15. Bluman EM, Title CI and Myerson MS. Posterior tibial tendon rupture: a refined classification system. *Foot Ankle Clin* 2007; 12: 233–249.
16. Kulig K, Reischl SF, Pomrantz AB, et al. Nonsurgical management of posterior tibial tendon dysfunction with orthoses and resistive exercise: a randomized controlled trial. *Phys Ther* 2009; 89(1): 26–37.
17. Tome J, Nawoczenski DA, Flemister A, et al. Comparison of foot kinematics between subjects with posterior tibialis tendon dysfunction and healthy controls. *J Orthop Sports Phys Ther* 2006; 36(9): 635–644.
18. Wacker J, Calder JDF, Engstrom CM, et al. MR morphometry of posterior tibialis muscle in adult acquired flat foot. *Foot Ankle Int* 2003; 24(4): 354–357.
19. Beeson P. Posterior tibial tendinopathy what are the risk factors? *J Am Podiatr Med Assoc* 2014; 104(5): 455–467.
20. Newman P, Witchalls J, Waddington G, et al. Risk factors associated with medial tibial stress syndrome in runners: a systematic review and meta-analysis. *Open Access J Sport Med* 2013; 4: 229–241.
21. Alvarez RG, Marini A, Schmitt C, et al. Stage I and II posterior tibial tendon dysfunction treated by a structured nonoperative management protocol: an orthosis and exercise program. *Foot Ankle Int* 2006; 27(1): 2–8.
22. Trnka HJ. Dysfunction of the tendon of tibialis posterior. *J Bone Joint Surg B* 2004; 86: 939–946.
23. Wapner KL and Chao W. Nonoperative treatment of posterior tibial tendon dysfunction. *Clin Orthop Relat Res* 1999; 365; 39–45.
24. Kulig K, Burnfield JM, Requejo SM, et al. Selective activation of tibialis posterior: evaluation by magnetic resonance imaging. *Med Sci Sports Exerc* 2004; 36(5): 862–867.
25. Pinney SJ and Lin SS. Current concept review: acquired adult flatfoot deformity. *Foot Ankle Int* 2006; 27: 66–75.
26. Elftman NW. Nonsurgical treatment of adult acquired flat foot deformity. *Foot Ankle Clin* 2003; 8: 473–489.
27. Pomeroy GC, Pike RH, Beals TC, et al. Acquired flatfoot in adults due to dysfunction of the posterior tibial tendon. *J Bone Joint Surg A* 1999; 81: 1173–1182.
28. Centro Cochrane Iberoamericano T. Manual Cochrane de Revisiones Sistemáticas de Intervenciones, versión 5.1. 0. Man Cochrane Revis Sist Interv versión 510 [Internet], 2012, www.cochrane.es/?q=es/node/269
29. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting iitems for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009; 6(7): e1000097.
30. Urrútia G and Bonfill X. PRISMA declaration: a proposal to improve the publication of systematic reviews and meta-analyses. *Med Clin* 2010; 135(11): 507–511.
31. Yurt Y, Şener G and Yakut Y. The effect of different foot orthoses on pain and health related quality of life in painful flexible flat foot: a randomized controlled trial. *Eur J Phys Rehabil Med* 2019; 55(1): 95–102.
32. Houck J, Neville C, Tome J, et al. Randomized controlled trial comparing orthosis augmented by either stretching or

stretching and strengthening for stage II tibialis posterior tendon dysfunction. *Foot Ankle Int* 2015; 36(9): 1006–1016.
33. Budiman-Mak E, Conrad KJ, Mazza J, et al. A review of the foot function index and the foot function index – revised. *J Foot Ankle Res* 2013; 6: 5.
34. Langley GB and Sheppeard H. The visual analogue scale: its use in pain measurement. *Rheumatol Int* 1985; 5: 145–148.
35. Esterman A and Pilotto L. Foot shape and its effect on functioning in Royal Australian Air Force recruits. Part 2: pilot, randomized, controlled trial of orthotics in recruits with flat feet. *Mil Med* 2005; 170(7): 629–633.
36. Wrobel JS, Fleischer AE, Crews RT, et al. A randomized controlled trial of custom foot orthoses for the treatment of plantar heel pain. *J Am Podiatr Med Assoc*. 2015; 105(4): 281–294.
37. McCormick CJ, Bonanno DR and Landorf KB. The effect of customised and sham foot orthoses on plantar pressures. *J Foot Ankle Res* 2013; 6: 19.
38. Kulig K, Lederhaus ES, Reischl S, et al. Effect of eccentric exercise program for early tibialis posterior tendinopathy. *Foot Ankle Int* 2009; 30(9): 877–885.
39. Bek N, Şimşek IE, Erel S, et al. Home-based general versus center-based selective rehabilitation in patients with posterior tibial tendon dysfunction. *Acta Orthop Traumatol Turc* 2012; 46(4): 286–292.
40. Nielsen MD, Dodson EE, Shadrick DL, et al. Nonoperative care for the treatment of adult-acquired flatfoot deformity. *J Foot Ankle Surg* 2011; 50(3): 311–314.
41. Banwell HA, Mackintosh S and Thewlis D. Foot orthoses for adults with flexible pes planus: a systematic review. *J Foot Ankle Res* 2014; 7: 23.