Non-invasive for Adult Flatfoot

Subjects: Rehabilitation
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the effect of orthoses on adult flatfoot on reducing pain could not deny, especially at the early stage of deformity [12, 13]. Exercises for flatfoot were widely used and given some benefits in terms of decreased pain [14]. Exercises were also effective at strengthening foot muscles forming an arch. Two primary treatments were designed, which are active and passive intervention. The voluntary muscles produced the active interventions (AI), and in case wearing foot orthoses while doing exercises also considered as active. For example, active interventions were to practice exercises alone or do both exercises and foot orthoses. Passive interventions (PI) did not require body effort and involuntary participants during treatment, such as foot orthoses and stretching at the same procedure. The two main approaches were active intervention (AI) and passive intervention (PI) with exercise and foot orthoses. At present, the overall effects of the active and passive intervention on adult flatfoot are still unclear because the results depend on skeletal and muscle maturity and the individual's awareness. Furthermore, flatfoot progresses silently without any acute syndrome of pain or functional impairment. Thus, noninvasive methods that can be used over the long term and are cost-effective could be adopted.

Keywords: adult flatfoot ; foot exercises ; navicular drop ; foot orthosis ; pain ; insoles

1. Introduction

Adult flatfoot can be due to musculoskeletal dysfunction, obesity, diabetes, or rheumatoid arthritis [2]. Flatfoot leads to a high risk of injury, patellofemoral syndrome, lower back pain, and poor quality of life[1][3][4]. Flatfoot was classified into two types, the rigidity, and flexibility of the flatfoot [5]. The nonoperative treatment should be considered for both rigid and flexible flatfoot [6][7] The treatment principle at the early stage were similar for both of deformity including foot orthoses and some accommodative devices[6][7]. In a study by Fernandez et al. [8], among 835 Spanish adults, 26.5% had flatfoot. Prevalence increased with age. Some individuals may not require any intervention, but management should be recommended when pain and functional problems exist [2]. Methods of flatfoot management include arch taping, insoles, shoes, wedges, braces, exercise, and surgery [1]. Surgery can be used for congenital flatfoot in mild or severe stages, but in one study, 4% of patients still reported pain due to ligament laxity [9]. Exercises and foot orthoses are commonly used because of their convenience and economic benefits [10]. Half of adults with flatfoot in Australia use foot orthoses to prevent excessive foot pronation [11]

The purpose of this study was to analyze the difference in effectiveness between AI and PI in alleviating pain and navicular drop in adult flatfoot.

2. Methods

The target population was adult patients (older than 18 years) who suffered from flatfoot. Studies were excluded if one group did not have a diagnosis of flatfoot or underwent treatment in the previous 6 months, or had a previous lower limb fracture. Also excluded were studies on patients with flatfoot as a secondary pathology associated with stroke, diabetes, or rheumatoid arthritis.

The two noninvasive interventions of interest were exercise and foot orthoses. The specific types of foot orthoses were insoles and orthoses. The interventions were divided into 2 groups: active intervention (exercise alone or combined with foot orthoses) and passive intervention (foot orthoses alone or combined with stretching). Studies comparing groups using other methods (e.g., ultrasound, electric stimulation) were excluded.

The primary outcome was pain as a consequence of flatfoot, which was assessed using a visual analog scale (VAS) and the foot function index [15]. The secondary outcome was navicular drop (ND), which can be visually assessed for improvement quickly and cost-effectively. Studies that used other outcomes were excluded from the research.

The extraction of data was based on study design, participant characteristics, intervention groups, assessment tools, and results. The data considered were first author, publication year, population age, number of participants in each group, and intensive intervention. The information used for extraction was the number of participants, and the mean and standard deviation of each group. If the data were not published, we contacted the primary authors for more specific information; if none was available, the study was excluded. The quality of studies was verified by using the physiotherapy evidence database tool.

3. Findings

All 775 studies were added to Endnote X9, and duplications were eliminated, leaving 635 papers. Then 529 studies were excluded because they focused on diseases unrelated to this study, such as internal fixation of the foot bone and musculoskeletal impairment of the lower limbs.

Ten studies enrolled 385 participants, with a median sample size of 38.5 participants. Among the participants, 50% had an average body mass index (BMI) (18.5-24.9), 30% were overweight (25-29.9), 9% were obese (>30), and 11% were not reported. The overweight and obese participants were mostly in the studies by Houck et al., Andreasen et al., and Kulig et al. Their ages ranged from early adult (20-40 years old) to middle age (40-65 years old). Overall, the included studies recruited both male and female candidates, 221 young adults (57%) and 164 middle-age adults (43%). All of the participants were from universities, outpatient hospitals, and athletic centers.

The muscles targeted for strengthening were the toe muscles and intrinsic and extrinsic foot muscles (including quadriceps, gluteus, anterior/posterior tibialis, and gastrocnemius soleus). The most commonly used exercises for muscle strength were short foot exercises, heel raises (unilateral or bilateral), plantar flexion and adduction (strengthening posterior tibialis), and Achilles tendon stretching.

The foot orthoses were made of semi-rigid materials including ethylene-vinyl acetate (EVA) shore 35 A, polypropylene, thermo-molded composite, and rubber-like material. Some studies required the participants to use the foot orthoses frequently, especially during physical activities. Some foot orthoses were made with orthotics, such as computer-aided design/computer-aided manufacturing (CAD-CAM) and custom-made orthoses. Other studies used support arch products from medical instrument companies such as Biomechanical Services and DJO. All foot orthoses supported the medial ankle side, the medial longitudinal arch (MLA), or the rearfoot's medial side.

In terms of reducing pain from flatfoot, AI was more likely to reduce pain than PI, (SMD -0.47, 95% CI -0.81, -0.13). Additionally, both AI and PI showed an effect on flatfoot compared to control (SMD -1.23, 95% CI -1.63, -0.83; SMD -0.76, 95% CI -1.11, -0.41, respectively)

On the contrary, neither AI or PI showed a superior effect on the ND test (SMD -0.19, 95% CI -0.61, 0.23). Similarly, after AI and PI, foot alignment (assessed by ND test) did not improve compared to control (SMD 0.02, 95% CI -0.29, 0.32; SMD 0.20, 95% CI -0.25, 0.66, respectively)

To answer the question of which intervention was better, we analyzed the probability rank (P-score). The P-score, based on point estimates and standard errors of NMA, can explain a treatment being better than competitors. The P-score of each treatment showed its ranking among the others; the most effective P-score is 1 and the worst is 0, and a higher score indicates a better effect . In terms of alleviating pain, AI (0.99) demonstrated superior effect and roughly double the impact compared to PI (0.5), while the control group had no change in pain. However, based solely on ranking, we could not directly determine each treatment's effect on the disease. Adding other tools, such as a netsplit plot, helped to visualize the overall picture. In terms of navicular drop, AI showed a similar impact as control or conventional intervention (P-score 0.67 and 0.63). Interestingly, AI had more than 3 times the efficacy of PI in foot realignment (0.67 and 0.19, respectively). However, they still could not reconstruct the foot into a neutral position.

Differences in clinical variation led to heterogeneity. The intervention design or the population characteristics of each study inevitably affected the reliability between studies. For example, the population target might be different, from young adults to old adults, or the follow-up time may be inconsistent. Different studies could lead to different results, which was acceptable for some criteria. Hence, heterogeneity was represented as a percentage that shows whether these differences could be acceptable; lower than 50% would mean low heterogeneity, which could be acceptable. In the results, I^2 = 27.3% with p-value = 0.18 for pain and I^2 = 19.8% with p-value = 0.27 for NDT. These indicated that there was low heterogeneity between pain and navicular drop outcomes.

Furthermore, the original result has already analyzed the overall effect of AI (exercises alone, or exercises combine with foot orthoses) and PI (foot orthoses). The question was whether there was any difference between foot orthoses alone and combination foot orthoses with exercises on adult flatfoot. Hence, this second subgroup used the meta-analysis to answer.

The forest plot investigated the standardized mean difference (SMD) (95% CI) and the weight of every single research in a random-effects model. In general, the figure showed most the duo-used exercises and foot orthoses altogether were more likely to reduce pain than the single-used footwear (SMD [0.43], 95% CI [-0.08; 0.93]). However, this difference was inappreciable because the result crosses the midline. Additionally, the heterogeneity I^2=33% (less than 50%) with p-value = 0.21 proved low heterogeneity or coherence altogether.

In the evaluation of evidence was the risk of bias. PEDro was used to assess the risk of direct evidence bias in terms of internal validity and statistical information. The studies were evaluated by two independent researchers and no disagreements occurred. Four studies (Houck et al. [18], Kulig et al. [17], Kim et al. [24], and Park et al.[19] were assessed as fair quality and six studies (Jeong et al. [21], Andreasen et al. [15], Pabón-Carrasco et al. [23], Okamura et al. [22], Yurt et al. [16], and Shih et al. [20]) were of good quality. The study limitation was evaluated in these 10 studies, to ensure that the contribution of the source was reasonable.

Among the included studies that were randomized controlled trials, seven were of good quality, and four were fair quality. There were two criteria that almost all the studies did not meet: blinded participants and blinded therapists. This means the participants did not know the participants' group allocation and were unable to distinguish differences in treatment. Most studies could not meet these criteria because exercising was a voluntary action, which required the awareness of participants and therapists.

4. Discussions

First, navicular drop was not significantly decreased after using AI or PI during 2 to 16 weeks of follow-up. This result was similar to previous studies [12][13]. Banwell et al. [13] conducted a systematic review of 13 studies on the effect of orthoses on flexible flatfoot. The authors concluded that there was a decreased pain effect but limited evidence for increased rearfoot eversion. Furthermore, the foot arch was supported passively by bones and ligaments and actively by intrinsic and extrinsic foot muscles [29]. Exercise only manipulated the active components (foot muscles) but was unable to control the passive components (bones and ligaments) of the foot arch. Even the combination of exercise and foot orthoses did not show a significant impact on flatfoot realignment in an adult population. The bony foot arch changed during the early childhood and became mostly stable at 7 years old [30]. Hence, the effects of exercise and foot orthoses could change over time, being more effective in childhood and gradually less so in adulthood.

In this study, exercise and foot orthoses showed limited results in foot arch construction. However, the foot structure conservation was undeniable during foot orthoses and exercises interventions. Some adult-acquired flatfoot deformity is from high-demand activities, such those performed by athletes and soldiers, or injuries that cause a collapsed arch, such as tibial posterior tendon dysfunction[12][21][13] . Both foot orthoses and exercises maintained the over pronated foot, which did not become worse even though the arch morphology was already fixed.

Second, both exercise and foot orthoses successfully reduced pain from adult flatfoot in about 16 weeks of follow-up. Both active and passive interventions showed better effects than the control, and AI showed a double impact compared to PI in terms of pain relief. Flatfoot caused pain by exertion during activities and reduced by relaxation in the early stage [30]. An excessively pronated foot enhanced stress on joint surfaces, spring and Achilles ligaments, and other structures [30]. This mechanism caused pain, which can inhibit muscles and result in atrophy, then limited movement [32]. Strengthening could stabilize the muscles and enhance proprioceptive feedback [29]. Exercise also supported the movement to prevent chronic overload on metatarsals, stress fractures, and stress reaction [29][33]. The combination of exercise and foot orthoses could release the tension and stabilize the surrounding soft tissue [29]. Therefore, active intervention can control the pain coming from the joint moving in extreme ranges [29]. The research of Megan et al.[14] had similar results. The authors conducted a systematic review of three studies on posterior tibial tendon dysfunction (which causes adult-acquired flatfoot deformity) with exercise. They found that pain was alleviated when participants applied specific exercises and orthoses.

The foot orthoses materials should also be considered. Semi-rigid materials such as EVA, poron, and polypropylene might be better than rigid ones [34][35]. Rigid materials can exacerbate the release syndrome. Semi-rigid insoles act as artificial foot arches that can absorb loads for normal foot pronation instead of no pronation at all, unlike rigid ones [36]. The semi-rigidity of the insoles was the reason why foot orthoses could reduce the pain from a collapsed foot. The dispersion forced evenly along the longitudinal arch could release the tension of medial pressure [34][35]. Hence, foot orthoses can decrease pain and provide comfort for the flatfoot ligaments during daily life activities.

5. Conclusions

The effects of the habitual use of foot orthoses and exercise was clearly found to be the alleviation of pain in adult flatfoot. Active interventions were found to be able to reduce pain more effectively than passive intervention. However, both interventions did not change the foot structure in adult flatfoot, which might require intensive treatment such as surgery.

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