Journal of Orthopaedic Science 21 (2016) 662–666

Contents lists available at ScienceDirect

Journal of Orthopaedic Science

journal homepage: http://www.elsevier.com/locate/jos

Original article

Do corrective shoes improve the development of the medial longitudinal arch in children with flexible flat feet?

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ARTICLE INFO

Article history:
Received 29 November 2015
Received in revised form
15 April 2016
Accepted 20 April 2016
Available online 17 May 2016

ABSTRACT

Background: Flexible flatfoot, as the most prevalent foot deformity in pediatric population still has no standardized strategy for its management hence some orthopedic surgeons have the tendency to use orthotic devices. The objective of this study is to evaluate whether orthotic shoes effect the natural course of the developing medial longitudinal arch in children diagnosed with moderate flexible flatfoot.
Methods: Fourty-five children (33 boys and 12 girls) with moderate flexible flatfoot were enrolled in this study. They were followed up for 34.6 ± 10.9 months (24–57 months). Patients in group 1 were treated with corrective shoes whereas group 2 was left untreated. Patients were evaluated according to; general joint laxity, arch index, lateral talo-first metatarsal (TM), talo-horizontal (TH), calcaneal pitch (CP), lateral and anterior talocalcaneal (TC) angles.
Results: Although there was a significant decrease in general laxity in both groups, decrease of laxity percentage was not significant between groups ($p = 0.812$). TM, TH and anterior TC angles were found to be decreased in groups whereas there was no difference between group 1 and 2. The arch index was found to be correlated with TM and TH angles in both groups ($p = 0.004$, $p = 0.013$).
Conclusions: Corrective shoes for flexible flatfoot was found not effective on development of foot arches. Therefore, they should be limited only for selected cases.

1. Introduction

Pes planus in general can clinically be defined as absence of the medial longitudinal arch. Pes planus, commonly referred as flatfoot, is a combination of foot and ankle deformities. Mostly the main deformity is the subtalar joint complex [1].

Flatfoot is especially common in 0–3 years of age, due to ligamenteous laxity and the plantar fat that hasn't been resorbed yet. The first 6 years is important for the longitudinal arch development. It can be explained by the influence of three factors; the neurovascular system, decrease in joint laxity and increase in ossification of the foot.

Pes planus can be flexible or rigid and congenital or acquired. Although rigid pes planus almost always require surgical treatment, flexible pediatric pes planus can be mainly considered as a common benign childhood condition, but also having the potential to result in pain and altered gait in adulthood.

Pediatric flatfoot has been observed for many years by orthopedic surgeons but there is still no standard strategy for its management and an ongoing debate whether flexible flatfoot is a pathologic condition and whether or not to use orthoses [2].

Flatfoot in children are initially suspected by their parents mostly because of shoe wear or inability to perform complex physical tasks [3,4].

Treatment mainly consists of conservative and surgical management. Existence of pain, age, gender, body mass index, joint laxity, alignment of the lower extremity, neurological disorders, existence of achilles contracture are all factors that should be taken in account before initiating the appropriate treatment [3,5]. Strengthening therapy, nonsteroidal anti-inflammatory medication, braces, inserts, night splints and modified shoes compromise conservative treatment options [6–8]. Pfeiffer and colleagues reported that 10% of the children diagnosed with flatfeet are wearing arch supports [9,10].

Aggressive long-term orthotic managements are still being advocated by some orthopedic surgeons for flexible flatfoot with

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http://dx.doi.org/10.1016/j.jos.2016.04.014
0949-2658/

moderate deformity. The question is; what happens to the medial longitudinal arch when left to its natural course and if orthotic shoes are necessary to achieve a asymptomatic, functional foot.

The purpose of the study was to evaluate the impact of corrective shoes over the natural course of flexible flatfoot in the pediatric population.

2. Material and methods

45 children (33 boys and 12 girls), mean age 39.5 months (17–72 months) with moderate flexible flatfoot were enrolled in this study. They were followed up for 34.6 ± 10.9 months (24–57 months). All patients were pain free. Patients were randomized and separated in two groups. Randomization was made by weekly basis. Patients that fulfilled the inclusion criteria during even number weeks consisted group 1 and in odd number weeks consisted group 2. The study was initiated with an odd number week and after reaching the necessary number of patients for statistical significance, ended with an odd number week. Patients in group 1 (21 children) were treated with custom made orthopedic shoes that have 0.5–0.9 cm longitudinal arch support and 3–4 mm heel wedges (Fig. 1). Shoes were renewed every 6 months and the efficacy of the new shoe was evaluated radiographically each time (Fig. 2). Patients consisting of group 2 (24 children) were left untreated. Mean age of group 1 was 41.6 months and group 2, 36 months. The data accumulation was in conformity with the Institutional Ethical Committee and the study was in adherence to the tenets of the declaration of Helsinki. Study was in compliance with Gazi University Ethical Council regulations and was approved by the Ethical Council. The aim of study was described and informed consent was received from the parents.

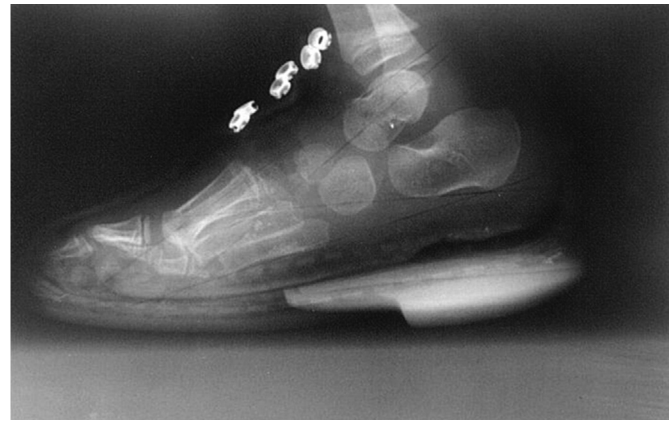

Fig. 2. The efficacy of renewed shoes were evaluated with lateral weight bearing radiographs of the feet every 6 months.

Patients were classified according to Volpe's treatment classification system and children with mild and moderate deformities were included to the study [11]. Patients with rigid deformities, neuromuscular disorders, genetic disease associated with collagen abnormalities were excluded from the study. Patients were evaluated determining the lower extremity kinematic chain and physical examinations were carried out with the child in the standing and sitting positions. The varus, valgus and neutral position of the heel

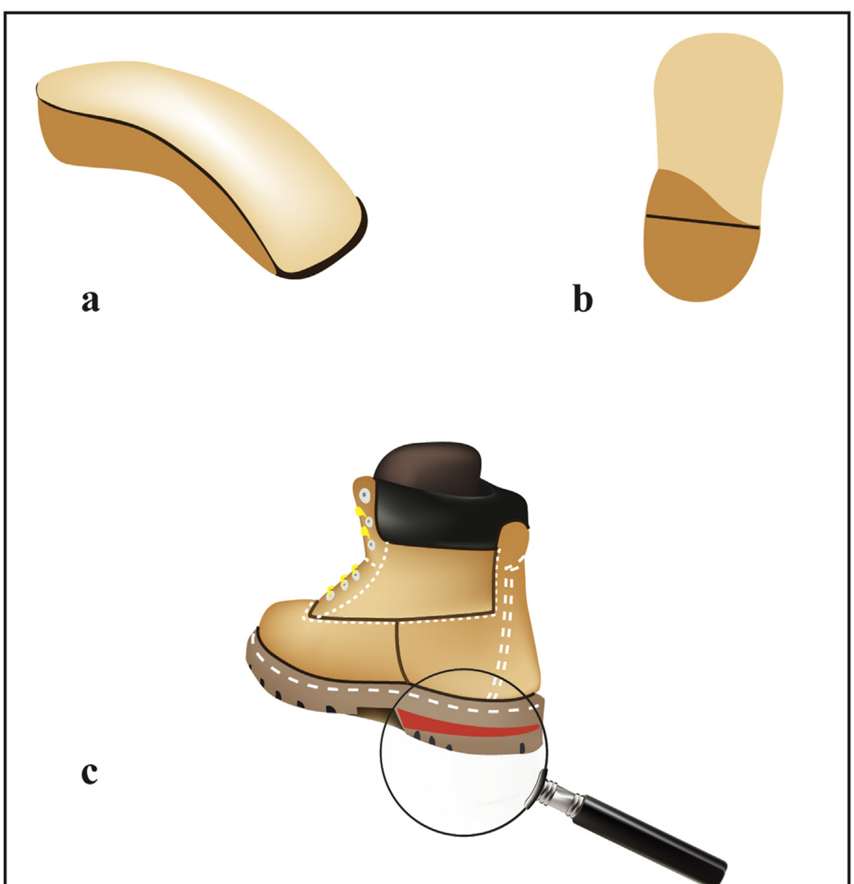

Fig. 1. Illustration of custom made shoes (c) with 0.5–0.9 cm longitudinal arch support (a) and 3–4 mm heel wedges (b).

was recorded with the patient in the standing position. All joints of the foot were assessed for restriction of motion. The Jack's test was performed to assess the efficacy of extensor hallucis longus on medial longitudinal arch. The test is performed with the patient weight bearing, with the foot flat on the ground. The clinician dorsiflexes the hallux and watches for an increasing convexity of the arches. A positive result is formation of the arch that indicates flatfoot being flexible. A negative result, lack of arch formation, indicates flatfoot being rigid (Fig. 3). Initial and last measurements for general joint laxity were evaluated in both groups using the method described by Wynne-Davies [12].

The radiologic analysis comprised a lateral and anterior weight-bearing radiogram for each foot. Lateral talo–first metatarsal, talo–horizontal, calcaneal pitch, lateral and anterior talocalcaneal angles were measured using the method described by Simons and Vanderwilde respectively initially and at last follow-up [13,14] (Fig. 4).

A Harris–Beath mat (Schein, Orthopadie service, Remscheid, W. Germany) was used for static foot print analysis and the arch index was calculated using the method described by Staheli at the same time points [15] (Fig. 5).

3. Data analysis

Statistical comparisons were generated using Statistical package for Social Sciences-16 for Windows programme (SPSS, Chicago,-IL,USA). All data are expressed as median (min–max). The percentage changes in radiologic angle measurements and ligamanteous laxity of the feet between treated and control groups were evaluated using Mann Whitney-U test. The difference between the initial and last values for radiologic angle measurements in groups were analyzed using Wilcoxon test. The relationship between the last arch index and last angle measurements of the right feet were evaluated using Pearson correlation analysis. The percentage change of joint laxity points between two groups was evaluated using Mann Whitney-U test. The difference between the initial and last values for joint laxity points in groups were analyzed using Wilcoxon test.

4. Results

The decrease of talo–first metatarsal, talo–horizontal and anterior talocalcaneal angles were found to be statistically significant in both groups whereas there was no statistically significant difference between the two groups of those measurements (Table 1). The lateral talocalcaneal angle was also found to be decreased in both groups but this was not statistically significant

Fig. 3. Jack's test; the clinician dorsiflexes the hallux and watches for an increasing convexity of the arches. A positive result is formation of the arch that indicates flatfoot being flexible.

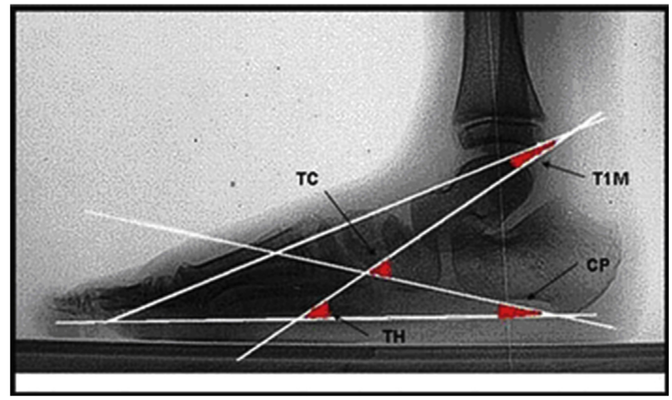

Fig. 4. Radiograph of the foot demonstrating; Lateral talo–first metatarsal (T1M), talo–horizontal (TH), calcaneal pitch (CP) and lateral talocalcaneal (TC) angles.

Fig. 5. A/B is the arch index calculated from a static foot print analysis using a Harris–Beath mat.

($p = 0.736$, $p = 0.113$). Though a statistically significant increase in calcaneal pitch angle was observed in both groups there was no statistically significant difference between groups (Table 1).

A positive correlation between arch index and the values of talo–first metatarsal and talo–horizontal angles was observed (Table 2).

Table 1
Change of angle measurements in and between groups.

	Initial	Last	Initial	Last	Change in angle degree	
	Group 1	Group 1	Group 2	Group 2	Group 2	Group 1
	n:21	n:21	n:24	n:24	n:24	n:21
Anterior-talocalcaneal (^{0})	33.45 M: 34 (22–53)	26.82 M: 23 (12–37)	33.38 M:33 (20–45)	26.84 M: 30 (13–37)	−0.19 M:−0.23 (−0.6–0.28)	−0.13 M:−0.12 (−0.5–0.20)
P	0.002		0.003		0.19	
Lateral-talocalcaneal (^{0})	46.55 46 (27–56)	45.57 44 (32–57)	43.68 46 (34–55)	43.24 43 (32–51)	−0.2 −0.2 (−1.2–0.25)	−0.34 −0.3 (−0.28–0.33)
P	0.736		0.113		0.24	
Talo–first metatarsal (^{0})	19.5 16 (7–29)	10.45 10 (0–26)	15.08 18.4 (6–35)	8.04 9.3 (0–34)	−0.46 −0.44 (−1–0.8)	−0.45 −0.50 (−1– (−0.02))
P	0.001		0.001		0.72	
Talo-horizontal (^{0})	35.7 34 (16–49)	28.85 29 (19–42)	34.00 35 (21–52)	29.44 27 (21–44)	−0.13 −0.2 (−0.32–0.23)	−0.17 −0.16 (−0.44–0.16)
P	0.003		0.001		0.09	
Calcaneal-Pitch (^{0})	10.9 12 (2–20)	14.80 15 (4–20)	10.52 10 (1–16)	13.44 14 (4–22)	0.27 0.23 (−0.2–1.4)	0.6 0.4 (0.0–3.0)
P	0.002		0.001		0.18	

Table 2
Correlation between last arch index and angle measurements for both groups.

	Arch Index (n = 45)
Talo-horizontal (^{0})	r = 0.447, p = 0.013
Talo-first metatarsal (^{0})	r = 0.461, p = 0.004
Calcaneal-Pitch (^{0})	p = 0.168
Lateral-talocalcaneal (^{0})	p = 0.332
Anterior-talocalcaneal (^{0})	p = 0.721

Laxity recorded initially and at the end of the study for group 1 was 3.85 ± 1.2 (2–5), 2.59 ± 1.4 (0–5) and for group 2, 4.0 ± 1.3 (0–5), 2.7 ± 1.4 (0–5) points respectively. Although there was a statistically significant decrease for joint laxity points in group 1 and 2, there was no statistically significant difference between groups (Table 3).

5. Discussion

Pediatric flexible flatfoot is a pathomechanically complex deformity and may become confusing for orthopedic surgeons especially if they are symptomatic. There is little argument about the need to treat the forms of flatfoot that are clearly pathologic, the controversy is about moderate forms of flexible flatfoot.

There is still no consensus whether orthopedic shoes are necessary for its treatment and a specific treatment algorithm does not exist. Gould et al. studied 225 beginning walkers and followed them for 4 years. All of the normal toddlers had pes planus determined by radiographic and photographic parameter and children who had arch-support footwear developed arches faster [16]. Contrary to this finding, Rao et al. and Sachitenandan et al. studied the influence of footwear on the prevalence of flatfoot and concluded that the incidence was found to be higher in children with footwear compared to those without [17,18]. Rose et al. concluded that 6 years of age is critical for the development of flatfoot and footwear worn before this age predisposes pes planus [19].

Regarding the inconsistency between these studies, there is a tendency to use orthotic devices in order to satisfy parents and to avoid a likely painful foot. Different treatment modalities have come to sight consisting of a wide range of options varying from follow-up to complex surgical procedures. Among these, orthotic devices and orthopedic shoes are the most preferred options. Although up to date, there is no defined standard indication for orthoses use, pain while performing daily living tasks is referred to be the major criteria in moderate and severe flexible flatfoot. Similar to moderate flatfoot, severe flatfoot does not have a longitudinal arch, but distinctively, the medial border of the foot is convex due to plantar flexion of talus and a prominent valgus deformity of the heel can be detected while weight bearing.

Helfet, in 1958 used an insert that maintained the heel in neutral position and avoided excess pronation, medial shoe wear and corrected the deformity. Bleck and Bordelon without a control group used Helfet inserts and University of California Biomechanic Laboratories (UCBL) inserts and concluded that use of these inserts diminished symptoms and had corrective effects on the deformity till the age of 8 [20,21]. Theologis et al. also used Helfet inserts and came up with decreased symptoms and shoe wear [22].

Bleck et al. studied the effects of the Thomas heel, an over-the-counter insert and molded foot orthosis in a limited number of children, and found no radiographic improvement in flatfoot deformity compared with the baer foot. Staheli concluded the development of the arch was not sufficient in preschool children but had the tendency to progress in a slow manner over time [23].

Table 3
The change of laxity in groups and between groups.

	Initial	Last	Initial	Last	Change in laxity (%)	
	Group 1	Group 1	Group 2	Group 2	Group 1	Group 2
	(n:21)	(n:21)	(n:24)	(n:24)		
Joint Laxity Points	3.85 ± 1.2 (2–5)	2.59 ± 1.4 (0–5)	4.0 ± 1.3 (0–5)	2.7 ± 1.4 (0–5)	−0.34–0.4 (−1–0)	−0.32–0.3 (−1–0.25)
P	0.001		0.001		0.812	

The insufficient development of the arch can be explained mainly by the consequence of ligamanteous laxity. Barry et al. explains the progression of arch with the development of neuromuscular system, decrease in joint laxity and increase in ossification of the foot [24].

In this study ligamentous laxity of both groups showed a decrease in number. Though there was a decrease in numeric values, there was no statistical difference between two groups and the correlation between ligamanteous laxity and change in radiographic measurements were not significant. This finding concludes that the change in bony structure is independent from the change of ligamanteous laxity.

The statistically significant decrease in the lateral talo–horizontal, lateral talo–first metatarsal angles and the arch index that are used to describe the height of the medial longitudinal arch of the foot showed no difference between groups concluding that corrective shoes did not have the desired effect.

Changes of calcaneal pitch and A-P talocalcaneal angles, indicating the developing arch also did not reveal any difference between groups. Pfeiffer et al. studied 835 children and concluded that more than 90% of the treatments instituted in their patient population were unnecessary. Parents with flexible flatfoot children usually seek for inserts and shoes especially if they have a symptomatic adult relative in their family. According to our findings it is not logical to justify treating moderate forms of flexible flatfoot with orthotic devices on the presumption that they will prevent pain and disability in adulthood. Only %1–2 of the patients are symptomatic and there exists no evidence that this deformity will lead to a painful condition in adulthood. We advocate that systemic conditions such as rheumatoid arthritis, cerebral palsy, poliomyelitis, meningomyelocele and tarsal coalition must be eliminated and the surgeon must distinguish pathologic and non-pathologic conditions and classify the deformity. If the final diagnose is flexible flatfoot with moderate deformity, avoid unnecessary treatment with shoes, since they do not have the estimated effect on the medial longitudinal arch.

Conflict of interest

The authors declare that they have no conflict of interest.

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