The Evaluation of a Custom-Made Insole on Foot Plantar Pressures in an Individual with Flexible Flatfoot: Single Case Study

Mobina Khosravi Farsani [a], **Aliyeh Daryabor** [b*], **Mehdi Rezaei** [b], **Farshad Okhovatian** [b]

[a] School of Rehabilitation, Department of Orthotics and Prosthetics, Iran University of Medical Sciences, Iran, Tehran; ; [b] Physiotherapy Research Center, School of Rehabilitation, Shahid Beheshti University of Medical Sciences

Corresponding Author:** Aliyeh Daryabor, Physiotherapy Research Center, School of Rehabilitation, Shahid Beheshti University of Medical Sciences, Damavand Street, Emam Hossein square, Tehran, 1616913111, Iran. ***E-mail: r_daryabor@yahoo.com, aliyehdaryabor@gmail.com

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Abstract

Flexible flatfoot is one of the most common types of foot disorders. The aim of the present study was to assess the effectiveness of a custom-made 3D printed insole for a subject with flexible flatfoot. The subject was a 10-year-old boy who had the flexible flatfeet. The custom-made foot insoles for both feet were made using the 3D scanner for both feet**.** The feet data was evaluated after a 8-month use of insole compared with before wearing. The findings revealed that foot type improved in the subject after the 8-month use of the insoles. Right foot in dynamic surface and both feet in static surfaces changed from light flat to normal type. It seems using the 3D printed insoles can be useful in reducing the foot plantar pressure and the surface in individuals with flexible flatfoot.

Keywords: Orthotic, Insole, Flatfoot, Pressure

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Introduction

Flatfoot (pes planus) is defined as a postural deformity in which the foot arches collapse along with the entire foot sole coming into complete or near-complete contact with the ground(1). People with pes planus may have foot pain, especially in the arch or heel area, and pain may markedly be worsen during activity(2). Many young children have flexible pes planus, a condition that, the feet look flat when standing; but a slight arch appears when arising to his/ her toes. In most cases, as children grow older, the arches develop(3).

The primary purposes of flatfoot treatment are decrease of pain and the prevention of future disability (e.g. damage to joints and a fixed rigid foot deformity)(4). Conservative management and surgical options have been recommended in the treatment of flexible flatfoot. In some individuals whose pain is not adequately relieved by conservative treatments, operation may be recommended. Many foot insoles (orthoses) are usually used for the treatment of flexible flatfoot. Arch supports, shoe inserts, and corrective shoes are some examples of these orthotics interventions. Foot orthoses help to provide a suitable biomechanical alignment of the ankle-foot complex, thereby creating more effective mechanics of the foot during activity and develop normal foot growth(5).

Custom-made insoles using 3D digital scan are suggested as a better comfort for individuals with symptomatic flatfoot(6, 7). Customized orthoses led to improve the biomechanics of the ankle-foot complex and even the lower limbs in comparison with traditional orthoses. Through optimizing the traditional insoles structure, it can be more appropriate for the subject's sole structure, hence decreasing damage and improving comfort(8, 9). However, there are limited investigations regarding the custom-made insoles using 3D digital scan for subjects with flexible flatfoot. So, the aim of this single-case study was to evaluate the long-term effect of use of a scanned insole for a child with flexible flatfoot.

Material and Methods

Case description

The subject was a 10-year-old boy (BMI: 24.77), who had symptomatic flexible pes planus based on 10-foot posture index (FPI)**.**

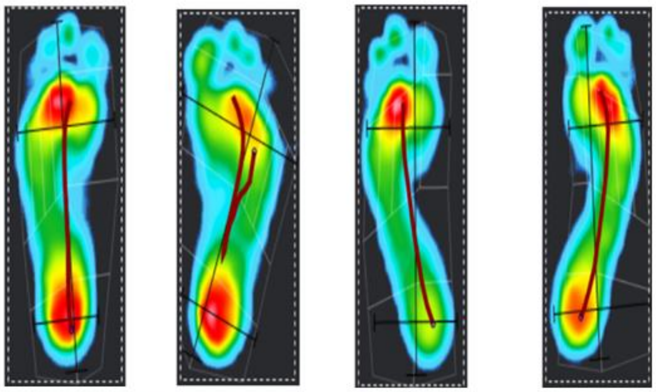

Figure 1: *A*) the dynamic scan in the first evaluation; *B*) the dynamic scan in the second evaluation

Test procedure

The participant was referred by an orthopedic specialist to an orthotics and prosthetics clinic at Tehran. The subject's parents filled out the informed consent for participating in this study. Firstly, the subject's feet were scanned in 2 conditions: standing on foot scan system (static scan) and then walking on that with his self-selective walking speed (dynamic scan). Then, the data was gathered by a PayaTek software. The foot scan system recorded contact surfaces of foot, planar pressure according to foot areas in static condition and contact surfaces of foot in dynamic condition. Then, the insoles were prepared based on subject's scan data. After 2 weeks, the individual referred to the clinic again and the insoles were fitted in his shoes. He was recommended to wear the insoles during his daily activity. After a 8-month period, the person referred to clinic for the second static and dynamic scanning in the bare foot condition.

Intervention

The characteristics of the custom made insoles used in this study included a sufficient arch support and a 5-mm medial heel wedge. An expert orthotics measured foot length, metatarsophalangeal (MP), and mid-foot width of feet. After scanning and preparing process, insoles were fitted in by an orthotist in subject's shoes.

Findings and Outcomes

All data were obtained by the PayaTek software. The static scan recorded the data of foot pressure and surface, and the dynamic scan recorded the foot surface**.** The evaluation of the dynamic data in the first session showed light flatfoot and normal foot type for left and right sides respectively. Static scan revealed light flatfoot for both feet. After 8 months of use the insoles, dynamic and static data demonstrated normal type of both feet according to reported foot surfaces (Figure 1). All dynamic and static data are shown in tables 1 and 2, respectively.

Table 1. Dynamic data resulting from PayaTek scanner

Dynamic data				
	First session		Second session	
surface	left	Right	left	Right
Rear-foot	20.9%	20.0%	27.2%	26.6%
Mid-foot	27.9%	28.4%	23.9%	26.6%
Hind-foot	51.2%	51.6%	48.8%	46.8%

Table 2. Static data resulting from PayaTek scanner

Static data				
	First session		**Second session**	
	left	**Right**	**left**	**Right**
Pressure%	48.00%	52.00%	46.21%	53.79%
Fore–foot%	19.88%	22.31%	19.30%	21.31%
Rear-foot%	38.12%	38.14%	26.81%	32.58%
Surface(CM²)	212.39%	213.46%	111.48%	115.01%
Total Avg	0.21%	0.23%	0.22%	0.24%
Fore-foot Avg	0.15%	0.17%	0.15%	0.16%
Rear-foot Avg	0.32%	0.39%	0.33%	0.39%

The comparison of two sessions based on reported data by the software demonstrated that the foot type changed. This has been described in details as below:

Based on dynamic data, right rear-foot, mid-foot and fore-foot surface differences in the second session in comparison with the first session were changed 6.6%, 1.8% and 4.8% (CM2), respectively. For the static data, additionally, the total left and right foot surface showed 100.91% cm2 and 97.38% cm2 reduction in the second session compared with the first session, respectively.

There was a difference 3.79% in total pressure in the static data for both feet after the 8-month usage of insoles. The rear-foot pressure was also reduced 11.31% and 5.56% after the 8-month use of the insoles for left and right feet, respectively.

Discussion

The purpose of present study was to report a subject's scan data with flexible flatfoot which showed foot type improvement after the 8 months wearing the insoles. The aim of insoles are to provide an optimal arch support and surface (contact area) that can assist to distribute load in the midfoot area(10).

Based on the results in this case report, mid-foot surface was decreased during walking after the 8-month wearing the insoles due to flexible structure of foot. In the first evaluation, the child had left normal foot during walking resulting from the dynamic data, while static data revealed light flatfoot for both feet. It was just because of left foot pronation which caused foot type alteration between static and dynamic data. The results demonstrated that insoles with arch support and medial heel wedge can correct light flatfoot type in children with flexible flatfoot after the use of insoles.

Concerning the rear-foot pressure, it was reduced after the 8-month use of the insoles for both feet. Based on the previous works, the rear-foot region bears the maximum pressure on the foot(11, 12). Redmond et al. reported that custom-made orthoses led to less pressure for the rear-foot region, probably resulting from the height and shape of the custom heel cup(10). In addition, the present study showed that foot total pressure data resulting from the static data in the second assessment was lower than the first one. One of the main mechanisms for the efficiency of foot orthoses is reduction of mid-foot pressure(13, 14). However, we did not measure mid-foot pressure in the present study. Nevertheless, the findings of present study were in agreement with previous investigations that found the custom-made insoles were better than pre-fabricated insoles in reducing foot pressure and being comfortable (8, 9). Additionally, the footscan system has been considered as a device for evaluating foot plantar accurately(15, 16). We assumed that 3D scanned insoles could be considered as a useful conservative intervention for treatment of flexible pes planus. However, the further studies should be conducted to investigate the comparison of the scanned insole with other types.

Limitation

This work was performed with only one individual, thus generalizing the findings achieved difficult. Also, the comparison of this insoles with different types of insoles including traditional orthoses was not performed.

Conclusion

Customized 3D printed insoles decreased the foot pressure and surface in a subject with flexible flatfoot.

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Conflict of interest:

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Authors' contributions:

All authors made substantial contributions to the conception, design, analysis, and interpretation of data.

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