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Correlation of the functional scores with the beighton score, radiological measurements, and clinical assessment in patients diagnosed with flexible pes planus

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Abstract

To evaluate the relationship between radiological and clinical evaluation instruments used in children with flexible pes planus (FPP) with quality of life and functional scores. The study group consisted of sixteen children with FPP (mean age: 9.8 1.1 years). The patients were examined in detail using static pedobarography with the Win-Track system. A physical examination was also undertaken using the Foot Posture Index-6 (FPI-6). The four angles were measured on foot radiographs. For functional evaluation, the Pediatric Outcomes Data Collection Instrument (PODCI) score was employed. A single experienced rehabilitation specialist performed Beighton scoring. No correlation was found between the FPI-6 clinical rating scale and Beighton scores, radiographic data, and pedobarographic evaluation. The PODCI and Beighton scores, on the other hand, had a negative connection (P=0.000, r=-0.781). The radiological, clinical, and pedobarographic values were not correlated with the PODCI functional score. In the management of patients with FPP, the commonly used FPI-6, radiographic and pedobarographic measurements were not correlated with the PODCI functional score. However, children with extensive joint laxity are more likely to have functional limitations. Therefore, it is important to evaluate children with FPP in terms of common joint laxity before treatment planning.

Keywords: Pediatric orthopedics, flat feet, PODCI, generalized joint hypermobility, score

Introduction

Flexible pes planovalgus (FPP) is a common orthopedic condition in children and adolescents, with prevalence rates ranging from 2.7 to 18.1 percent. [1-2]. The medial longitudinal arch (MLA) of the foot is low in height, and the calcaneus is in a valgus position while standing [3].

FPI-6 is a simple and quick clinical tool that doesn't require any special equipment [4-5]. It has been proven to be reproducible and verifiable in the evaluation of pediatric foot [4,6]. Foot pressure (pedobarographic measurement) is useful in the assessment of foot deformities since it allows for the quantitative measurement of foot functionality and can be used to monitor and examine changes over time [7]. The effect of FPP on children's functional status is important in terms of guiding the clinician in the management of treatment [3,8]. To assess the general health state of children, several health-related quality of life indicators have been established. The Juvenile Outcomes Data Collection Instruments (PODCI) is a 114-item questionnaire designed by Shriners Hospitals for Children - Houston (SHC-Houston) to examine the real-life functional levels of pediatric orthopedic patients more directly [9]. However, to the best of our knowledge, no research has been undertaken to compare the efficacy of PODCI scores with other methods used in FPP evaluation.

The main purpose of our study was to evaluate the relationship between radiological, pedobarographic, and clinical evaluation instruments used in children with FPP with quality of life and functional scores. The secondary aim was to determine the correlations of these instruments with each other.

Materials and Methods

Study Population

This study was carried out following the Declaration of Helsinki's principles and was approved by our hospital's institutional review

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board (ID: 78/549). We reviewed the database of our institution to identify pediatric orthopedic patients that presented to our hospital with flexible pes planus from January 2017 to December 2018. Sixty children with flat feet were referred to the pediatric orthopedics clinic between 2017 and 2018. Of the patients, 16 met our criteria and were included in this study.

If the MLA elevation was achieved with the toe up the test and the foot valgus could be corrected, the deformity was considered flexible and these patients were included in the study (Figure 1) [3]. Based on the dynamic arch index, children younger than seven years were excluded, since the foot arch stabilizes from approximately seven years of age [10]. Failure to restore the MLA height by standing on the toes was considered to indicate the presence of rigid flatfoot, and these patients were not included in the study [3]. Patients with congenital foot anomalies, cerebral palsy, or other neurological or musculoskeletal disorders, structural lower limb deformities such as foot shape or right and left size asymmetry between the sides, rheumatic joint pathology, inability to walk independently, and those with a history of foot or ankle fractures, major trauma affecting the ankle joint's stability, or surgery in the lower extremities were excluded from the study.

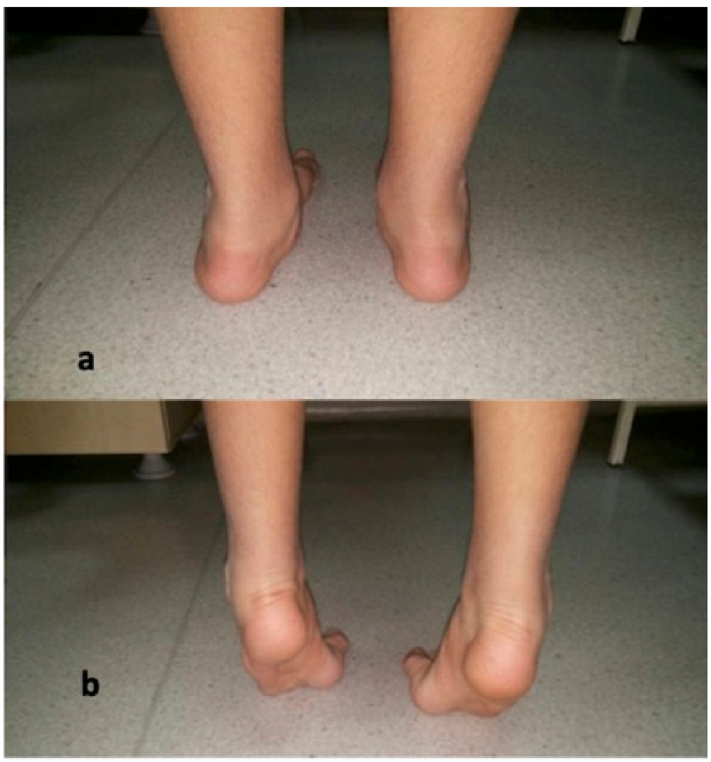

Figure 1. a) The medial longitudinal arch of the foot is low in height in flexible pes planus, and the calcaneus is in a valgus position while standing. b) The medial longitudinal arch elevation is achieved with the toe up the test and the foot valgus could be corrected

Data Evaluation

The examiner was a senior pediatric orthopedist with ten years of clinical expertise assessing static foot posture and using the FPI-6. All the measurements were carried out by the same supervisor because FPI-6 has strong intra-observer reliability but relatively low interobserver reliability [11]. To facilitate visual and manual examinations, the participants were evaluated on a 30 cm elevated platform with bare feet in a comfortable standing position. As detailed by Redmond in 2005, in the present investigation we used the scoring system, reference values, and measurement technique given by Redmond: 1) talar head palpation, 2) observation of symmetrical malleolar curvature in the lateral plane at the supra- and infra malleolar levels, 3) inversion/eversion of the calcaneus, 4) prominence of the talonavicular joint, 5) height of the medial longitudinal arch, and 6) abduction/adduction of the forefoot. Each item was scored as –2, –1, 0, +1, or +2 (0 for neutral, –2 for obvious supination, and +2 for obvious pronation), and all the scores were summed up. The final score varied from –12 to +12, with a higher positive number indicating a more pronated foot than a lower positive one [12].

The Win-Track system was used to perform a complete static pedobarography assessment on the patients (Medicaptures, Balma, France). According to reports, Win-Track is a reliable method for assessing plantar pressure distribution [13]. During the experiment, the volunteers walked about on the pressure sensor platform barefoot in a natural way, as instructed. They were instructed to keep their gaze fixed on the road ahead and their arms relaxed at their sides at all times [13]. Plantar foot pressure measurements were taken for both feet at the same time for 30 seconds. The results were saved and the trial was repeated if the individual moved during the testing. Data were acquired from six trials in which the individual remained motionless. The participant was unaware when a trial was being videotaped. The pressures of the points on the plantar surface were measured with a computer connected to the pressure sensor platform. A pressure map was created for the plantar surface of the foot, showing the total surface contact area for each foot, the surface contact area of the forefoot and heel, and the distribution of the center of gravity of the foot. In the detailed static analysis, the center of pressure (COP), mean forefoot pressure, maximum anterior pressure for the right and left sides (MAR-MAL), maximum posterior pressure for the right and left sides (MPR-MPL), MAR-MAL internal tangent distance (r1-l1), MAR-MAL external tangent distance (r2-l2), MPR-MPL internal tangent distance (r3-l3), MPR-MPL external tangent distance (r4-l4), COP right and left internal tangent distance (dR-dL), foot contact surface area, and foot contact load (weight) data were obtained digitally (Figure 2) [13].

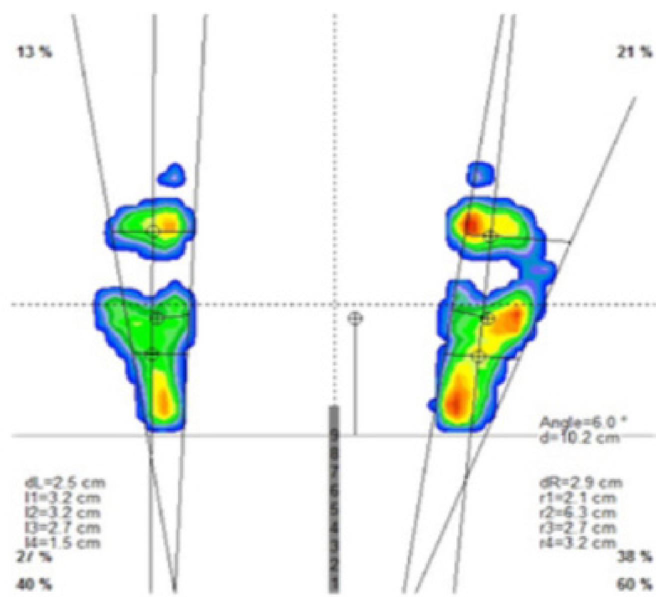

Figure 2. Pedobarographic measurements

Anterior-posterior (AP) and lateral x-ray images were obtained separately for each foot in each patient. The participants stood with their knees stretched and their heels and toes aligned on a wooden platform. The X-ray cassette was positioned between the feet vertically [4]. The patients were instructed to put the same amount of weight on each foot [4]. The exposure was adjusted to 2.8 mA at 45 kV and the tube film distance was 105 cm [4,14].

The talus-first metatarsal angle, talohorizontal angle, talocalcaneal angle, and calcaneal inclination angle are four regularly used angles to evaluate flatfoot on lateral radiography (Figure 3) [4,7]. The picture archiving and communications system (PACS) workstation were used to conduct the tests (Koninklijke Philips Electronics, Eindhoven, The Netherlands).

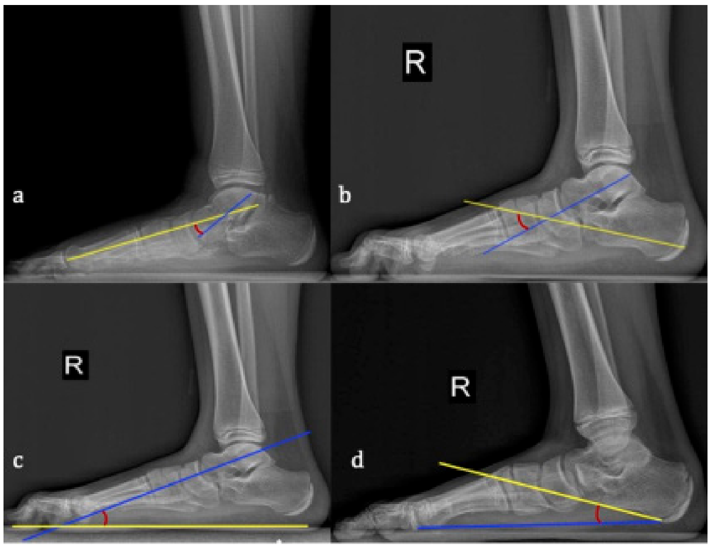

Figure 3. a) The talus-first metatarsal angle, b) talocalcaneal angle c) talohorizontal angle, b) talocalcaneal angle, d) calcaneal inclination angle

The PODCI score was used for functional evaluation [9]. PODCI is a 114-item questionnaire that provides four functional assessment scores (upper extremity functions, basic mobility, sports, and physical functions, comfort/pain) and a global function score (upper extremity functions, basic mobility, sports, and physical functions, comfort/pain) (average of four functional assessment scores) [9]. All the scores are scaled, with 0 being the lowest possible score and 100 being the highest score [9]. In all circumstances, higher ratings reflect a more functioning state of the individual [9]. The children completed the questionnaires in the company of their parents. As previously indicated, after applying all the questions, upper extremity function, transfers, basic mobility, sports, and physical function, comfort/pain, global function, and happiness scores were computed using the algorithms included inside the POSNA questionnaire [9].

All the parameters evaluated for Beighton scoring were described and documented with photographs. Goniometry was used to measure the passive bilateral dorsiflexion of the fifth metacarpophalangeal joint, as well as the passive bilateral hyperextension of the elbow and knee [15-17]. A physical therapy and rehabilitation specialist with at least ten years of experience performed all the measurements blinded to the study design to ensure the reliability of data.

Statistical Analysis

The statistical analysis was carried out using the SPSS program version 20.0. (SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was used to examine whether the data distribution was normally distributed. The Spearman correlation matrix was used to evaluate correlations between the variables. P values of <0.05 were considered statistically significant. Correlations with a coefficient (r) of <0.20 were excluded from further analysis while those with an r-value of 0.20-0.39 were categorized as weak, 0.40-0.59 as moderate, 0.60-0.79 as high, and 0.80-1.0 as very high. The power of our study was calculated by post hoc analysis. The threshold probability for rejecting the null hypothesis was accepted as 0.05 (Type I error rate, α (two-tailed), and the probability of failing to reject the null hypothesis under the alternative hypothesis (Type II error rate, β) was accepted as 0.20. The expected correlation coefficient was accepted as 0.7 (r). And we calculated minimum case number was 13 which was smaller than our case numbers (32 feet).

Results

Sixteen children (12 boys and four girls) were included in the study. The mean age of the children was 9.8 (8-12 years). The mean FPI-6 was 8.5 (8-12). There was no difference in the FPI-6 score between the right and left feet (p=0.164). The mean Beighton score was 4.64 (3-7). The mean PODCI score was 74.9 (59-99). There was no difference in plantar pressure and radiographs between the right and left feet (p=0.126, p=0.138). The average FPI-6 values, Beighton scores, and PODCI values of the study group are listed in Table 1.

No correlation was found between the FPI-6 clinical rating scale and Beighton scores, radiographic data, and pedobarographic evaluation (Table 2). A negative correlation was found between the functional score and the Beighton score (P=0.000, r=-0.781). The radiological, clinical, and pedobarographic values were not correlated with the functional score (Table 2). A positive correlation was found between the Beighton score and the talus-first metatarsal angle (p=0.040, r=0.518) (Table 2).

Table 1. The average FPI-6 values, Beighton scores, and PODCI values of the study group

Variable	Mean	Min-Max
FPI-6	8.5	4-12
Beighton	4.64	3-7
PODCI	74.9	59-99

FPI-6: Foot Posture Index-6, PODCI: Pediatric Outcomes Data Collection Instrument

Table 2. The table of correlation between the FPI-6, Beighton score, radiographic data, and pedobarographic evaluation. The FPI-6, radiographic and pedobarographic measurements are not correlated with functional score (PODCI). However, a negative correlation is found between the functional score and the Beighton score

	RL1	RL3	FPI	LT1M	TH	TK	KP	PODCI	
RL3	r	0.441							
	p	0.088							
FPI-6	r	-0.037	-0.178						
	p	0.893	0.510						
LT1M	r	0.398	0.034	0.399					
	p	0.127	0.901	0.126					
TH	r	0.254	-0.058	0.419	0.911				
	p	0.342	0.830	0.106	0.000				
TC	r	-0.059	-0.085	0.371	0.639	0.844			
	p	0.827	0.753	0.157	0.008	0.000			
CI	r	-0.506	0.058	-0.196	-0.837	-0.659	-0.224		
	p	0.046	0.830	0.466	0.000	0.006	0.405		
PODCI	r	0.257	-0.005	-0.258	-0.339	-0.311	-0.398	0.096	
	p	0.336	0.987	0.334	0.200	0.240	0.127	0.724	
Beighton	r	0.039	-0.127	0.000	0.518	0.422	0.403	-0.383	-0.781
	p	0.887	0.640	1.000	0.040	0.104	0.122	0.143	0.000

Spearman's correlation test
RL1: MAR-MAL internal tangent distance, RL3: MPR-MPL internal tangent distance, FPI-6: Foot Posture Index-6, LT1M: talus-first metatarsal angle, TH: talohorizontal angle, TC: talocalcaneal angle, CI: calcaneal inclination angle, PODCI: Pediatric Outcomes Data Collection Instrument

Discussion

In this observational study, we expected that an increase in the FPI-6 score would be correlated with the Beighton and pedobarographic values in children with FPP, and there would be an inversely proportional relationship between these scores and the functional score. However, we did not find a relationship between the FPI-6 score, pedobarographic findings, radiological measurements, and the PODCI score. However, we determined that the Beighton score and the PODCI score had a negative correlation. This finding shows the importance of evaluating the Beighton score in the treatment management of FPP.

In many studies investigating FPI-6 in large pediatric populations, the average FPI-6 values are reported to be in the range of 3.72-3.96 in boys and 3.67- 3.82 in girls between the ages of 8-12 years [18-19]. In other studies involving children with FPP, it has been shown that they have significantly increased FPI-6 [18]. In our study, increased FPI-6 scores were obtained from the children with FPP, similar to previous studies conducted with the same age group. There is a close to perfect relationship between the FPI-6 score and functional status in adults [12]. However, studies on the relationship between the FPI-6 score and daily life functions in the pediatric population are limited [4,6]. In our study, we did not find any correlation between the FPI-6 score and the other parameters evaluating pediatric foot and the PODCI score in children with FPP. FPI-6 is a physical examination finding that may not always be associated with functional status. There are many studies investigating the compatibility of pedobarography with radiological and clinical findings in the pediatric population with FPP [4,20]. However, the relationship between pedobarography and radiological findings in the evaluation of pediatric FPP is inconsistent in many studies [4,7,20]. In our study, we found a negative relationship between the pressure increase in the medial foot and the calcaneal inclination angle. This explains the agreement between the calcaneal inclination angle, which indicates the flattening of the medial arch, and the pressure increase in this area. In our study, we did not detect a relationship between the medial shift of the center of gravity and functional score. Since deformity is not rigid in FPP, compensatory mechanisms may develop to balance the local pressure increases. As a result, health-related quality of life may not be affected.

Joint hypermobility in children is a common occurrence with a variety of clinical manifestations. Hypermobility, if left untreated or undiagnosed, can sometimes lead to persistent discomfort and a high level of impairment [16-17]. As a result of their hypermobility, children with benign joint hypermobility syndrome frequently have very noticeable flat feet, which may lead to lower extremity problems [16]. This is also supported by the negative correlation between the Beighton score and the PODCI score observed in our study. In many other studies, it has been reported that diffuse joint laxity is strongly associated with a decrease in the height of the medial longitudinal arch in pediatric feet [16-17,21]. The increase in the angle between Talus and the first metatarsal bone is one of the radiological findings of the decrease in the height of the medial longitudinal arch [22]. The Beighton score and the talus-first metatarsal angle had a statistically significant positive connection in our study. This finding is compatible with previous studies [21-22].

This study has limitations. The lack of a control group is the most significant weakness of this study. One of our study's limitations is the small number of patients. Another limitation can be considered as the inclusion of only children with FPP who were referred to the orthopedic clinic, which may have led to the clinical sample representing a severely affected group. As a result, our findings are not yet applicable to all FPP instances. Finally, because our study did not look at research validity in different BMI groups, this is something that should be looked into in future studies.

Conclusion

In this study, the FPI-6, radiographic and pedobarographic measurements that are commonly used in the management of patients with FPP were not correlated with health-related quality of life. However, children with extensive joint laxity are more likely to have functional limitations. Therefore, it is important to evaluate children with FPP in terms of common joint laxity before treatment planning.

Conflict of interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical approval
This article does not contain any studies with human participants or animals performed by any of the authors. The design and protocol of this study were approved by the Health Science University Baltalimani Bone Diseases Education and Research Hospital institutional review board (ID:78/549).

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