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Original Work

Analysis of ankle alignment abnormalities as a risk factor for pediatric flexible flat foot

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ABSTRACT: Majority of paediatric flat feet are flexible and asymptomatic; less than 0.1% of all flat feet are rigid. If these can be diagnosed and managed early, then various complications can be prevented and they will remain asymptomatic. This study was conducted to analyse the ankle rotational mal-alignments in the natural course of flexible flat foot in children. Seventy-six patients of flexible flat foot and one hundred controls were included in this study. The height of foot arches was judged clinically by inspecting the height of the medial arch and by measuring the arch index on weight-bearing podograms. Tibial torsion and bimalleolar angle were assessed in all subjects. Tibial torsion was assessed in the first twenty subjects (ten cases and ten controls) both by clinical methods (foot-thigh angle) and CT. As no statistical difference in the two methods was observed, tibial torsion was measured by clinical methods only in the remaining subjects. Bimalleolar angle was measured on weight-bearing podograms in all subjects. For a minimum of two years, cases were followed up regularly with a standard conservative protocol and the height of the arches observed. Majority of cases of flexible flat foot were found to have increased tibial torsion and increased foot-bimalleolar angle (high talar spin). The severity of collapse of the medial arch and the response to conservative treatment was found to correlate with these rotational mal-alignments of the ankle. Ankle rotational mal-alignments were seen to make these flexible flat foot deformities more complex and less responsive to conservative treatment.

KEY WORDS: Flat foot; Pediatric flat feet; Flexible flat feet

INTRODUCTION

Flat foot (over-pronated) is the term used to describe a condition of the foot which consists of an absent or abnormally low, longitudinal arch. It was once thought that flat feet denoted poor health and its absence indicated well-being and aristocracy[1]. Pronation is the natural motion of the foot as it rolls inward after the foot makes contact with the ground. It allows the foot to act as a shock absorber for the body and adapt to the contour of the ground. Too much pronation will cause the arch of the foot to flatten excessively, placing stress and pressure on tissues and ligaments of the foot. Almost all babies are born with flat feet. In most children, the arch of the foot does not develop until they

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are around 3-4 years old[2]. It may continue to develop till the age of 4-6 years. The child should not be assessed or treated prior to 3 years of age and no active treatment (orthosis) is required before the age of 4-6 years. In about 20 percent of children, an arch does not develop at all[3] and this may continue into adulthood – flat foot in adults[4]. The incidence of flexible flat foot is about 1 in 1000 live births[5]. About 20 percent of children never develop arches and this is carried into adulthood as flat foot. Out of these, only 0.1 % are rigid flat feet[3]. So, most flat feet are flexible. Initially flexible flat foot may be asymptomatic but later, if neglected, may become symptomatic. The term "flexible" means that the foot is flat when standing (weight-bearing) and the arch returns when not standing or standing on toes only. "Rigid" means the arch is always stiff and flat, whether standing on the foot or not and valgus (outward tilt) of the heel remains unaltered. This study was conducted to analyse the ankle rotational mal-alignments as a risk factor for paediatric flat foot and to study their correlation with the severity and extent of the deformity. We evaluated tibial torsion and talar spin for ankle rotational alignment. The research hypothesis adopted was 'if these ankle rotational mal-alignments are present, then the flat foot will be more severe and complex'.

METHOD AND MATERIAL-

This study was conducted during January 2006 – January 2007. Children of both sexes between 6-12 years of age attending our OPD and nearby schools were included in the study. Children with flexible flat foot were included in this study as 'cases'. The following children were excluded:

a) Symptomatic and stiff flat foot
b) Flexible flat foot with neuro-muscular involvement
c) Any past history of injury / treatment of the affected limb
d) Any other associated congenital abnormality
e) Definitive familial history
f) Other obvious clinical alignment abnormality of that lower limb e.g. Genu varum / valgum etc.
g) Children not in this age group (as arches develop by 4-6 years and > 12 years not paediatric age group
h) Obesity

Children attending our OPD for some other problem and children from nearby schools, with normal foot arches were included as 'controls'. Routine data such as age, height, weight, BMI were noted in the data sheet. For the clinical measurement of tibial torsion, 'foot – thigh angle' was measured by the standard technique described[6]. Weight-bearing podogram was recorded for arch index and foot-bimalleolar angle (FBA) measurement[7]. The 'foot-thigh angle' (tibial torsion) and 'FBA' (talar spin) was measured in all cases and controls (**Figure 1**). Cases were classified according to the height of the medial foot arch as mild, moderate and severe flat foot[8]. The measurement of tibial torsion by CT (**Figure 2**) was done in only the first five cases and an equal number of controls, to evaluate the statistical difference between the two methods. As there was no statistical variation between the two methods, the tibial torsion was measured only clinically. We considered 15 degrees (±2 degrees)[3] the normal value for tibial torsion and 82.5 degrees as the normal value for FBA[7].

Figure 1: Clinical Observation on collapse of medial longitudinal arch

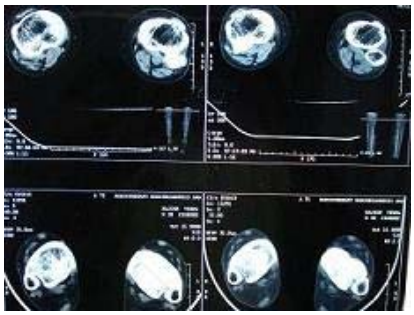

Figure 2: CT both legs measuring tibial torsion (right side with normal arch and left side with flat foot)

Arch index (arch width/heel width) (**Figure 3**) was measured on weight-bearing podograms to assess the height of the medial arch (severity of flat foot). Any foot with an arch index more than 3 (normal value- 2.2 to 3) was considered as flat

foot[9]. A standard conservative protocol (foot exercises, modified shoes- Thomas Crooked Elongated heel with medial heel raise with valgoid in sole) was advised. These cases were regularly followed up for an average of 2.4 years and the height of the medial foot arch was assessed by inspection and measuring the arch index. All the data were noted and analysed.

Figure 3: Weight bearing podograms to draw Arch Index (Arch Width/heel width)

RESULTS

Seventy-six cases and one hundred controls were included in this prospective case control study. The average age of cases was 8.9 years and 9.1 years for controls. There were 40 male and 36 female cases; whereas 54 males and 46 females were in the control group. Fifty seven (75%) cases were bilateral. The average weight was 31.9 Kg and 32.3 Kg and the average height was 105 cm and 107.3 cm for cases and controls respectively. Forty three (56.6%) cases had clinically mild (grade I) flat foot deformity and the remaining 33, (43.4%) had moderate (grade II) deformity. None of the cases had severe (grade III) deformity (**Table 1**). Out of the total of 76 cases, in 47 (61.8%), the average arch index was 3.4, while in the remaining 29 (38.2%) it was 2.8 only (i.e. with in normal limits). In controls, the average arch index was 2.4 (**Table 2**). Out of 76 cases with clinical flat foot deformity, only 61.8% had an arch index suggestive of flat foot deformity. This difference was found statistically significant. The difference between the average values of arch indices in cases with both clinical and podogram positive parameters for flat foot (47) and those with clinical deformity with normal range of arch index value (29), was statistically significant. The difference between the average values of arch indices in these 29 cases and of controls was statistically insignificant. In the first five cases and five controls, the tibial torsion was measured both clinically (foot-thigh angle) and by CT. The average values were 23.8 degrees and 22.7 degrees respectively in cases, and 19.2 and 18.4 degrees respectively in controls. The difference in the values between the two methods in each group (case / control) was statistically insignificant, but the value difference in two methods in each group was significant. The average bimalleolar angle was 82.2 degrees and 86.4 degrees in controls and cases respectively, which was highly significant. Out of all 76 cases, only 47 (62.8 %) cases had an abnormal FBA. All cases with clinical grade II flat feet (43.4 %) had an abnormal FBA. The average follow up was for 2.4 years at three monthly intervals, during which clinical arch height and arch index were evaluated. Thirty eight of seventy six (50%) cases showed improvement in arch index, but only 15 (19.7%) showed clinical improvement in arch height.

Table 1: Clinical grading of flat foot

Clinical Grading	Number	%
Mild (Grade I)	43	56.6
Moderate (Grade II)	33	43.4
Severe (Grade III)	-	-

Table 2: Showing arch index

	Number	Average arch index
Flat Feet (Both clinically and podogram)	47	3.4
Flat Feet (Only Clinically)	29	2.8
Control	100	2.4

DISCUSSION

Possible explanations for the difference in the incidence at birth and prevalence at later part of life is that a) at birth fat is present in the sole which get absorbed by three years of age and b) the hyperlaxity of ligaments gets corrected by the age of six[10-12]. Arch index has not been studied as a parameter for assessing the success of the conservative management of flat foot, as this index is usually used only to grade the severity of flat foot. There is a paucity of information regarding this aspect of the arch index in the management of flat foot in the Indian scenario.

Flexible flat foot comprises of excessive pronation of the foot with flexibility. As the calcaneum everts markedly during weight bearing, the lateral border of the foot becomes shorter than the medial border, which is increased due to the protruding head of the talus medially[13]. A study[14] was conducted on 30 subjects to investigate the effect of excessive tibial torsion on flexible flat foot. The authors concluded that if the child with flexible flat foot has excessive external tibial torsion, the torsional deformity could affect the foot making it a complex deformity. We also observed the same correlation of external tibial torsion and severity of the flat foot deformity. We have not encountered any study in which foot bimalleolar angle was correlated with flat foot deformity. We may conclude that a) arch index is a better parameter than clinical observation in the evaluation of the deformity, b) in our experience external tibial torsion also was associated with flexible paediatric flat feet, c) hind foot rotational mal-alignment (high talar spin) was associated with severity of collapse, d) correlation of tibial torsion and severity of flat foot was statistically more significant than FBA e) the mal-alignment makes these deformities more complex and less responsive to conservative treatment.

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