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Treatment of Symptomatic Flexible Flat Foot in Pediatrics with A Modified Mosca's Lateral Column Lengthening

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Abstract

Background: The optimal treatment of flat foot is still controversial. In this study, we evaluated the outcome the Mosca's lateral column lengthening with the advancement of the tibialis posterior.

Methods: In a retrospective study . fifty symptomatic pediatric flexible flat feet with or without hindfoot valgus were included in this study. Lateral column lengthening was done as described by Mosca. The tibialis posterior advancement was made on the navicular bone instead of the medial cuneiform. Radiographic measures of outcome were evaluated before the surgery and immediately after the surgery and included Calcaneal Inclination (Pitch) Angle, Talonavicular Coverage Angle, Talo-1st metatarsal Angle (Meary's Angle), Lateral Talocalcaneal Angle, Anteroposterior Talocalcaneal Angle (kite's angle), and Talar Declination Angle (Talo-Horizontal Angle). A paired t-test or its nonparametric counterpart (Wilcoxon T-test) was used to compare the mean value of preoperative and postoperative measures. A chi-square test was used to compare qualitative variables

Results: The mean age of the patients was 9.2±2.2 years. The mean follow-up of the patients was 2.6±1.1 years. All radiographic measures were significantly improved after the surgery. According to the radiographic measures, under-correction was seen in seven feet. Overcorrection was seen in one of the patients. Union of the osteotomy site was observed in all feet. No patients had postoperative pain or limited ankle range of motion. One superficial infection occurred that was managed with oral antibiotics.

Conclusion: Lateral column lengthening and advancement of tibials posterior on navicular bone is a safe and effective procedure in the treatment of the symptomatic pediatric flexible flat foot.

Keywords: Flat Foot, Pes Planus, Pes Planovalgus, Lateral Column Lengthening, Calcaneus, Osteotomy

Conflicts of Interest: None declared
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Introduction

Pes planus, also known as flat foot, is a common deformity of the foot characterized by the loss of the medial longitudinal arch, leading to contact with the ground (1). It could be associated with hindfoot valgus, termed pes planovalgus (2). Pes planus has two forms of rigid and flexible flat foot. In the rigid form, no ar ch is available, while in the flexible form, an arch is observed in non-weight-bearing conditions (3). Although pes planus is usually asymptomatic, it can cause pain by altering the biomechanics of the lower limbs and lumbar spine (4).

Treatment of pes planus includes a wide range of options,

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↑What is "already known" in this topic:
Treatment of pes planus includes a wide range of options from conservative to surgical procedures. The optimal treatment of flat foot is still controversial.

→What this article adds:
Lateral column lengthening and advancement of tibials posterior on navicular bone is a safe and effective procedure in the treatment of the symptomatic pediatric flexible flat foot.

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from conservative to surgical procedures. In pediatrics, activity modification, physical therapy, and foot orthosis are among the nonsurgical treatments of painful pes planus (5). Surgical treatment includes a variety of procedures including soft-tissue reconstruction, repositioning arthroeresis, and joint fusions (6). Despite plenty of treatment options, achieving a painless plantigrade foot that adequately fits into the shoe is difficult and under-correction or overcorrection of a deformity frequently occurs (7). Therefore, the most appropriate surgical treatment of pediatric pes planus is still controversial and attempts continue to develop an optimized surgical procedure.

Lateral column lengthening calcaneal osteotomy (LCLCO) has been introduced by many investigators as the treatment of choice for correcting pes planus in children and adolescents (8-11). However, LCLCO has also been reported to be associated with functional limitations (smaller sagittal range of motion), leading to a compromised quality of life (12). Therefore, optimization of LCLCO could result in lower functional limitations and improved quality of life of the affected patients.

The conventional LCLCO procedure introduced by Mosca also is composed of a lateral portion consisting of calcaneal osteotomy and a medial portion that includes detachment of the tibialis posterior tendon from its origin on the navicular bone and its advancement on the medial cuneiform bone. We hypothesized that the advancement of the tibialis posterior tendon on its native bone (navicular) could improve the outcome of LCLCO by preserving the basic tendon anatomy.

In this study, we evaluated the outcome of LCLCO with the navicular advancement of the tibialis posterior in the treatment of pediatric flexible pes planus.

Methods

This retrospective study was approved by the review board of Iran university of medical sciences. Medical profiles of pes planus patients who underwent surgical treatment at our university hospital between 2016 and 2018 were reviewed. Patients who were managed with the modified LCLCO procedure were evaluated for eligibility to include in the study. The indication for surgery was pes planus with severe symptoms (pain or impairment of daily activities) or failure of one-year conservative treatment with orthosis and arc support. The inclusion criteria were flexible pes planus, age of fewer than 16 years, and a minimum follow-up of 2 years. Flexible pes planus, post-traumatic pes planus, and painful pes planus for reasons other than loss of the medial longitudinal arch were excluded from the study. Patients who were lost to follow-up were excluded from the study, as well. Finally, 50 patients with pediatric pes planus were included in the analysis. Characteristic features of the patients are demonstrated in (Table 1).

Table 1. Characteristic features of pediatric patients with pes planus who underwent modified lateral column lengthening surgery

Variable	Pes planus patients (n=50)
Age (year)	9.2±2.2
Gender	
Male	27 (54)
Female	23 (46)
Follow-up (year)	2.6±1.1
Laterality	
Right	29 (58)
Left	21 (42)
Pain	
Yes	23 (46)
No	27 (54)
Limited ankle ROM	
Yes	19 (38)
No	31 (62)
Sore	
Yes	5 (10)
No	45 (90)
Calluses	
Yes	20 (40)
No	30 (60)

Data are presented as mean±SD or number (%). ROM: range of motion.

Surgical technique

LCLCO was performed as described by Mosca (10) with some modifications. Under general anesthesia, a thigh tourniquet, and in the supine position, the sinus tarsi was exposed, and the peroneus longus and the peroneus brevis tendons were released. An open wedge calcaneal osteotomy was performed between the anterior and middle facets about 1 cm posterior to the calcaneocuboid joint. The osteotomy site was temporarily fixed with a pin and checked under C-arm. After that, it was opened for about 8-10 mm using a spreader and fixed with an H-plate with 8 or 10mm wedge. In the medial portion, a longitudinal incision was made along the medial border of the foot. Then the tibialis posterior tendon was detached from its origin and after shortening to provide 1cm advancement, we re-attached it to the navicular bone. Achill tendon lengthening was also done if it was necessary.

After the surgery, a short-leg non-weight-bearing cast was applied for 6 weeks. The first visit of the patients was two weeks after the surgery. The next visit was four weeks later. The cast was removed in this session, and weight-bearing was started. The patients visited every three months afterward.

Outcome measures

The outcome measures were evaluated before the surgery and immediately after the surgery and followed up for about 2 years and included Calcaneal Inclination (Pitch) Angle, Talonavicular Coverage Angle, Talo-1st metatarsal Angle (Meary's Angle), Lateral Talocalcaneal Angle, Anteroposterior Talocalcaneal Angle (kite's angle), and Talar Declination Angle (Talo-Horizontal Angle). Calcaneal Inclination Angle was regarded as the angle between the calcaneal inclination axis, and the supporting horizontal surface is drawn on a weight-bearing lateral foot radiograph (Fig. 1). An angle of 20-32º was considered normal (13). Talonavicular Coverage Angle was regarded as the angle between the articular surface of the talar head and the articular surface of the proximal navicular drown on a weight-bearing dorsoplantar foot radiograph. An angle of <7º was considered normal (13). Talo-1st metatarsal Angle (Mearys Angle) was defined as the angle created by

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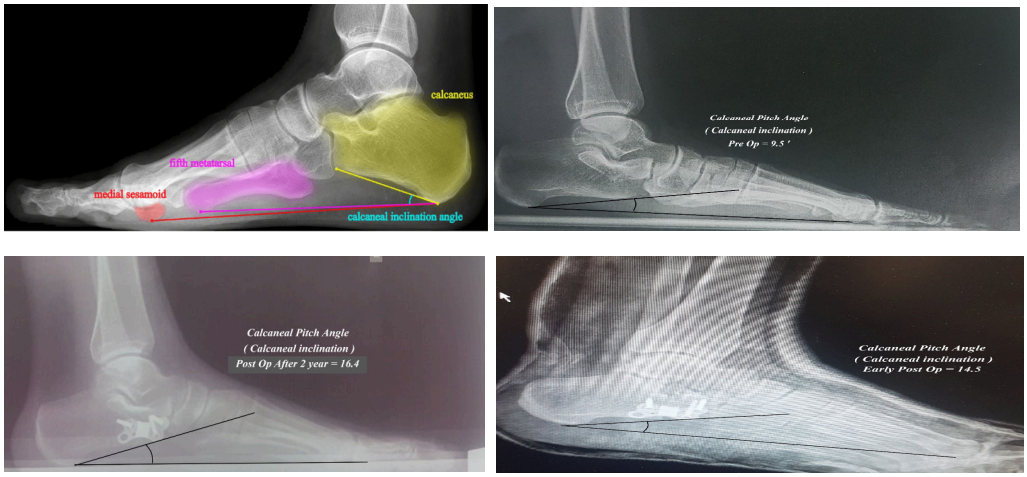

Fig. 1. Calcaneal Pitch Angle (Calcaneal inclination angle) in a 17 years old patient

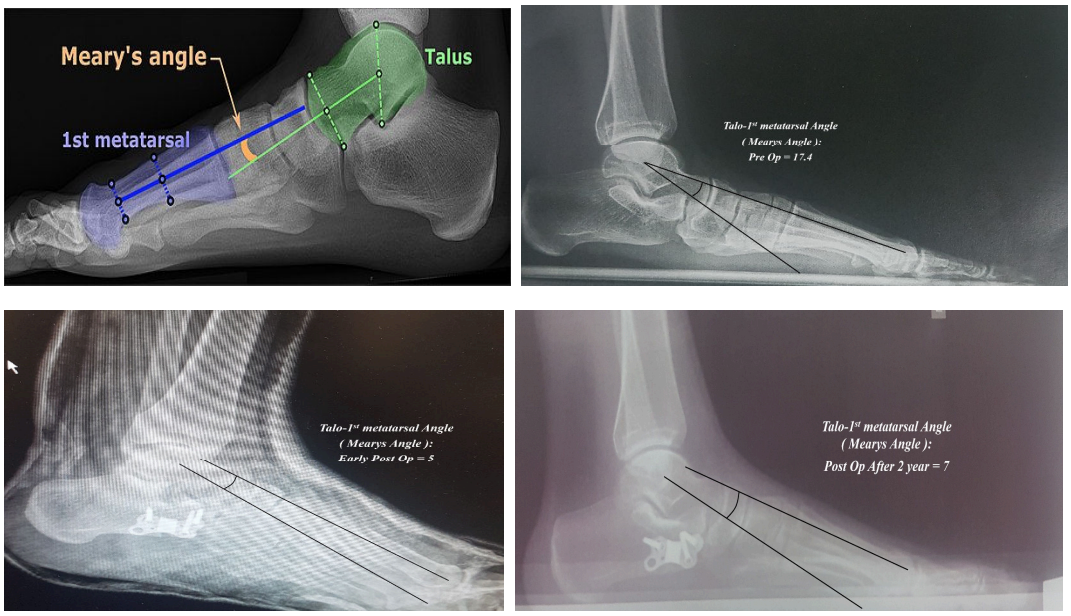

Fig. 2. Talo-1st metatarsal Angle (Mearys Angle) in a 17 years old patient

the intersection of the line that bisects the first metatarsal and the talus midline axis (Fig. 2). An angle <4º was regarded as normal foot, while an angle between 4º and 15º was regarded as mild, between 15 and 30º as moderate, and >30º as severe pesplanus (14). Lateral Talocalcaneal Angle was defined as the angle created by the intersection of the line bisecting the talus with the line along the axis of the calcaneus on the lateral weight-bearing radiograph. An angle between 25º and 45º was regarded as normal. An angle over 45º was regarded as pes planus and hindfoot valgus (15). Talocalcaneal Angle (kite's angle) was defined as the angle between the lines drawn down the axis of the talus and calcaneus assessed on a weight-bearing dorsoplanter foot radiograph. An angle between 15º and 30º was regarded as normal. An angle over 30º was regarded as pes planus and hindfoot valgus (15). Talar Declination Angle (Talo-Horizontal Angle) was defined as the angle between the mid-talar axis and the supporting surface drown on the weight-bearing lateral foot radiograph. An angle <21º was regarded as normal, while an angle ≥21º was indicative of the talotarsal joint dislocation and pes planus (16).

Statistical analysis

Data analysis was performed using SPSS for Windows version 16 (SPSS Inc., Chicago, Ill., USA). The descriptive variables were presented by mean ± standard deviation or number and percentage. The Shapiro–Wilk test was used to assess the normality of variable distribution. A paired t-test or its nonparametric counterpart (Wilcoxon T-test) was used to compare the mean value of preoperative and postoperative measures. A chi-square test was used to compare qualitative variables. A p-value of less than 0.05 was considered significant.

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Results

The mean Calcaneal Inclination (Pitch) Angle was 11.9±3.5º before the surgery and 24.4±5.1º after the surgery (p<0.001). The mean Talonavicular Coverage Angle was 13.9±4.2º before the surgery and 5.7±1.8º immediately after the surgery (p<0.001). Before the surgery, Talo-1st metatarsal Angle (Meary's Angle) showed normal arch in 2 (4%) patients, mild pes planus in 18 (36%) patients, and moderate pes planus in 23 (46%) patients, and severe pes planus in 7 (14%) patients. After the surgery, Meary's Angle was normal in 45 (90%) patients and mild pes planus in 5 (10%) patients. The difference between pre- and postoperative status of Meary's Angle was statistically significant (p=0.034). The mean Lateral Talocalcaneal Angle was 43.7±4.8º before the surgery and 30.6±5.9º immediately after the surgery (p<0.001). The mean Talocalcaneal Angle (kite's angle) was 35.5±6º before the surgery and 22.6±5.3º immediately after the surgery (p<0.001). The mean Talar Declination Angle was 27.6±5.8º before the surgery and 16.9±3.6º after the surgery (p<0.001). The preoperative and postoperative outcome measures are summarized in (Table 2).

Overall, the flat foot was under-corrected in seven (14%) patients. Detection of under-correction was based on Calcaneal Pitch and Talonavicular Coverage Angle in two patients, based on Calcaneal Pitch and Meary's Angle in one patient, and based on Meary's and Talocalcaneal Angle in the remaining four patients. Overcorrection was not seen in any of the patients.

Postoperative complications

Surgical site infection occurred in one patient that was superficial and managed with oral antibiotics. No other postoperative complications such as pain, limited range of motion (ROM), non-union and secondary subsidence of the arch was recorded in this cohort.

Discussion

In this study, we evaluated the outcome of Mosca's lateral column lengthening with the advancement of the tibialis posterior on navicular bone in the treatment of pediatric flexible pes planus with or without hindfoot valgus. According to our results, the radiologic measures of patients were significantly improved after the surgery. Under-correction was seen in seven patients. No patient had overcorrection. One superficial infection was the only postoperative complication.

Mosca used a modification of the calcaneal lengthening osteotomy described by Evans to treat 31 severe, symptomatic valgus deformities of the hindfoot in 20 pediatric patients who either had a flat foot (n=25) or skew foot (n=6). The satisfactory clinical and radiologic outcome was achieved in all patients but two who had the most severely deformed feet. Even though the correction was adequate to remove the symptoms in these two patients, as well. The subtalar motion was preserved in all feet except those who had a limited joint arthrodesis (n=4). They concluded that calcaneal lengthening osteotomy is an effective treatment for the correction of severe, symptomatic valgus deformities of the hindfoot and is associated with a low rate of complications compared to arthrodesis (10). A satisfactory radiologic outcome was achieved in all patients in the present study. Symptoms were resolved in all patients. The subtalar motion was also preserved in all patients.

Dogan et al. used calcaneal lengthening osteotomy for the treatment of 22 feet from 11 pediatric patients with flexible pes planovalgus. Clinically, the results were perfect in 17 feet, good in three feet, fair in one foot, and poor in one foot. Radiographically, perfect, good, and fair result was recorded in five, 13, and four feet, respectively. No overcorrection was seen. All patients were able to walk without support. They concluded that calcaneal lengthening osteotomy is an effective method for the treatment of symptomatic pes planovalgus (17).

Ahmed reported the outcome of Mosca's lateral calcaneal lengthening in the management of 19 feet with symptomatic flexible flatfoot. At a mean follow-up of 27.89 months, the mean American Orthopaedic Foot and Ankle Society score increased from 57.53 to

96.32. All radiographic measures were also significantly improved. Mild occasional pain was noticed in four patients. They concluded that Mosca's lateral calcaneal lengthening is an effective method to restore normal foot alignment and good function in adolescents with flat foot deformity (11). Postoperative pain was not seen in any patient in the present study.

The effectiveness of lateral calcaneal lengthening in the treatment of flat foot has been demonstrated in several other studies, as well (18-22). On the other hand, some studies have demonstrated functional limitations following the lateral column lengthening osteotomy of the calcaneus. Nüesch et al. aimed to quantify limitations in sagittal ankle ROM in 15 patients at least two years after lateral column lengthening osteotomy of the calcaneus. The used

Table 2. Radiographic measures before and immediately after treatment of pes planus with modified lateral column lengthening calcaneal osteotomy

Radiographic Measure	Before the surgery	After the surgery	*P*-value
Calcaneal Inclination (Pitch) Angle (º)	11.9±3.5	24.4±5.1	<0.001
Talonavicular Coverage Angle(º)	13.9±4.2	5.7±1.8	<0.001
Talo-1st metatarsal Angle (Meary's Angle)			
Normal arch	2 (4)	39 (78)	0.034
Mild pes planus	18 (36)	11 (22)	0.034
Moderate pes planus	23 (46)	0	0.034
Severe pes planus	7 (14)	0	0.034
Lateral Talocalcaneal Angle (º)	43.7±4.8	30.6±5.9	<0.001
Talocalcaneal Angle (kite's angle) (º)	35.5±6	22.6±5.3	<0.001
Talar Declination Angle (Talo-Horizontal Angle) (º)	27.6±5.8	16.9±3.6	<0.001

Data are presented as mean±SD or number & percentage.

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goniometer and fluoroscopy to measure ankle joint complex ROM in plantarflexion and dorsiflexion. The quality of life of the patients was also assessed using the short-form health questionnaire (SF36) and compared with 15 age-matched healthy controls. According to their results, the ROM of the ankle joint complex on the affected side was smaller than on the contralateral side and in healthy persons. Smaller dorsiflexion was associated with lower quality of life. They concluded that lateral column lengthening osteotomy could cause limitations in the tibiotalar joint (12). We did not quantify the sagittal ankle ROM in our patients. However, none of the patients had evident clinical limitations in sagittal ankle ROM.

Altogether, the present study reveals that modification of Mosca's lateral calcaneal lengthening through the advancement of the tibialis posterior on its original bone could be regarded as a safe and effective method for the treatment of pes planous and pes planovalgus. However, our study was not without limitations. First of all, we did not use a clinical score to measure the functional outcome of the patients. Second, we used a combination of pes planus and pes planovagus patients. This could be regarded as a source of heterogeneity. Therefore, future complementary studies are required to confirm the results of this study.

Conclusion

Mosca's lateral column lengthening with the advancement of the tibialis posterior on navicular bone significantly improves the radiographic measures of pediatric pes planus and pes planovalgus patients. The rate of complication is considerably low following this procedure. Therefore it could be suggested as a safe and effective method for the treatment of pediatric pes planus and pes planovalgus.

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Ethical issues

This article was approved by the ethical committee of Iran university of medical sciences under the code of : IR.IUMS.FMD.REC.1400.283

Conflict of Interests

The authors declare that they have no competing interests.

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