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Subtalar Joint Arthroerisis in Management of Pediatric Flexible Flatfoot

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ABSTRACT

Background: Flexible Flat Foot [FFF] in children is a frequent abnormality. Although its benign nature, sometimes a significant pain and discomfort is sufficient enough to consider surgery for alleviating symptoms. Subtalar arthroereisis is becoming more popular as a treatment for FFF symptoms.

Aim of the work: To assess the feasibility of subtalar joint screw arthroereisis procedure in the treatment of FFF in children and assess its related outcomes.

Patients and methods: This prospective interventional study, where a total of 10 patients [20 feet] presented with bilateral flexible flatfeet were enrolled in our study. Patients were treated with Subtalar joint Screw Arthroereisis. The American Orthopedic Foot & Ankle Society [AOFAS] score was employed to assess preoperative status and postoperative healing of ankle and hindfoot function. The three main components are pain, function, and alignment.

Results: The mean preoperative AOFAS score was 52.5 ± 13.5 [range, 23 – 75]. At 3-month and 6-month follow-up, the average AOFAS score was 85 ± 11.3 [range, 65 – 95], and 87 ± 7.8 [range, 70 – 96], respectively. Fourteen [70%] feet had good functional scores, and six [30%] feet had excellent scores.

Conclusion: Subtalar joint screw arthroereisis technique was safe and effective in the treatment of flexible flatfoot in children. It was minimally invasive procedure associated with low operative time, good clinical and radiologic outcome and low complication rate.

Keywords: Subtalar Joint; Arthroerisis; Flexible; Flatfoot

INTRODUCTION

Several children and many adults have Flexible Flat Feet [FFF], a common foot form. Because there is no comprehensive diagnosis, correct categorization, or specific radiological criteria for defining a flat foot, the prevalence of flatfoot is not well understood [1].

In adult population, pes planus foot type exists about 10–25% [2]. Most children's arches naturally raise over the first ten years of life. There has been no proof that any external circumstances or equipment may induce a vertical arch in a child's foot. Contrary to ordinary flexible flatfoot, flexible flatfoot with a short Achilles tendon is recognized to result in pain and incapacity in some adults and teenagers [1].

An anatomical variant mimicking flatfoot, caused by infantile adipose cushion formation concentrated on the medial region of the foot, can be detected in 90% of children under the age of two. Additionally, toddlers who begin to walk may do so with flat feet. They actually make an effort to move with both feet completely on the floor in order to keep a balanced posture. As a result, they change the direction of their weight-bearing axis, that might lead to a flatfoot attitude, to the first or second tarsal metatarsal joint [2]. Most children's normal longitudinal arches begin to form between the ages of 3 and 5 years old and in only 4% of them flatfoot persists after 10 years of age [2].

Management of FFF is found to be very confusing. Recommendations range from aggressive surgical correction of severe FFF as young as two years of age to no treatment, avoiding even shoe modifications or inserts. Obviously, the recommendations of most orthopedic surgeons are somewhere in between these extremes [3].

The range of available treatments includes arthrodesis and the use of an orthosis. Conservative measures such as corrective shoes, arc supports and heel wedges should be tried first. If these conservative measures fail to relieve the patient's symptoms—most notably the discomfort they experience while engaging in daily activities—then surgical treatments should be carried out. However, because the illness is benign in nature, it is recommended to reconsider performing surgery, particularly in unexplained situations [4].

Arthroereisis is a procedure for managing FFF through implanting screws into the sinus tarsi. Subtalar arthroereisis involves inserting a device into the sinus tarsi to treat the mid-foot abduction and hind-foot valgus that are seen in FFF. Through better positioning of the talus in relation to the calcaneus and navicular, the subtalar joint is prevented from eversion that is too great [5]. Since arthroereisis is thought to be a minimally invasive operation and spares the joints, it is becoming more and more popular; however, there are divergent views regarding the procedure's efficacy and safety [6].

The objectives of the study are to assess the feasibility of subtalar joint screw arthroereisis technique in the treatment of flexible flatfoot in children and assess its related outcomes

PATIENTS AND METHODS

A prospective interventional study was conducted for flexible flatfoot in children admitted in the Department of Orthopedic surgery, Al-Azhar university Hospital in Damietta in the period between January 2021 and October 2022, Patients were treated with. Subtalar joint Screw Arthroereisis

Inclusion criteria: Children from 3 to 13 years, painful passively correctable pesplanovalgus [PP] and no significant inflammation of the subtalar calcaneocuboid andtalonavicular joints.

Exclusion criteria: osteoporosis of the calcanenus, severe degeneration of the subtalar, talonavicular orcalcaneocuboid joints, posterior tibial tendon malfunction, paralysis of the distal muscles of lower limbs, advanced trophic cutaneous changes and common limitations to surgery, including poor circulation, a sick or debilitated patient, and an ongoing illness.

Operative considerations: Surgery is recommended, according to the consensus of experts, if conservative measures have failed and the kid's problems have not been relieved. However, doctors shouldn't be persuaded to perform surgery because the patient's parents want their child to have a straight foot. Simple foot adjustment and pain relief are the only objectives of surgery. Despite the vast range of clinical manifestations, from mild to severe flatfeet with a multitude of planal dominance contributions, accomplishing these aims may be difficult, operative realignment may be tricky.

Clinical Evaluations: Personal data**:** Demographic data including age, gender, weight, and height were collected.

History: complain of the patient: Pain in the foot and leg especially with long standing and walking, difficulty in walking, running or jumping and easy fatigability, unsightly appearance of the foot and shoe wear and distortion, previous conservative treatment. previous surgery for correction of this deformity, similar condition of flat foot in family **-** Clinical assessment included evaluation of deformity reducibility using bilateral and single heel

Examination: Comprehensive examination of the musculoskeletal system was included in the clinical evaluation of a child with flatfeet in additional to the particular foot and ankle evaluation.

General examination: The purpose of the general examination is to evaluate the lower extremities' torsional and angular deviations as well as their walking gait.

Local examination of the foot: Side affected Rt or Lt or bilateral, Flexibility of the deformity**,** collapse of the medial longitudinal arch, hind foot valgus, prominence of the talar head, tightness of Achilles tendon and assess related problems

Radiological assessment: A standardized radiographic exam was used under the direction of a qualified radiologist to ensure radiographs of excellent quality and placement. The patient is assessed radiologically using the following views.

X-ray, lateral view of the foot: Lines are drawn along the longitudinal axes of the calcaneus, talus, and first metatarsal. Assess the lateral talometatrasal angle and the calcenal pitch angle.

X-ray, anteroposterior view of the foot: Radiological analysis is performed with weight bearing AP view and assesses the talonavicular coverage angle

Surgical Procedure

To guarantee that the child remains motionless during the treatment, general anaesthesia was used. Along the tension lines of the relaxed skin, one cm incision is made over the sinus tarsi. The tissue is spread to the level of the sinus tarsi using a hemostat. The guide wire is then percutaneously inserted laterally to medially throughout the floor of the sinus tarsi in the direction of medial posterior proximal to lateral anterior distal [the direction of the sinus tarsi]. To prevent the guidewire from bulling back during trials, the guide pin is moved to the medial side and the guidewire is clamped on the medial side with a hemostat [figure 1].

Trial implants [non-absorbable impacted implant screw] are put after sizing guidance. The intention is to reduce over-eversion [approximately 5 degrees of eversion from neutral] [figure 2].

With AP pictures, the implant's location can be confirmed to be 1 to 1.5 cm medially from the lateral edge of the calcaneus. Laterally, the implant should be visible planted on the floor of the sinus tarsi. Bilateral arthroereisis can be carried out if the opposite foot has any abnormality [figure 3].

Figure [1]: The guide pin

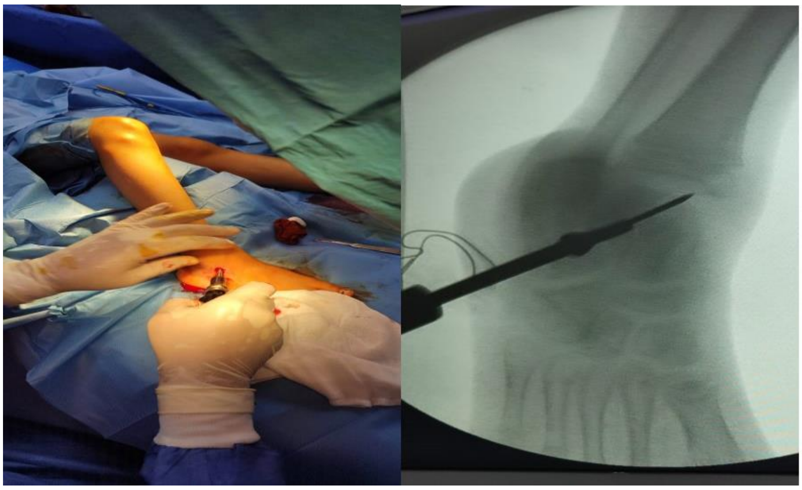


Figure [2]: Sizing guides

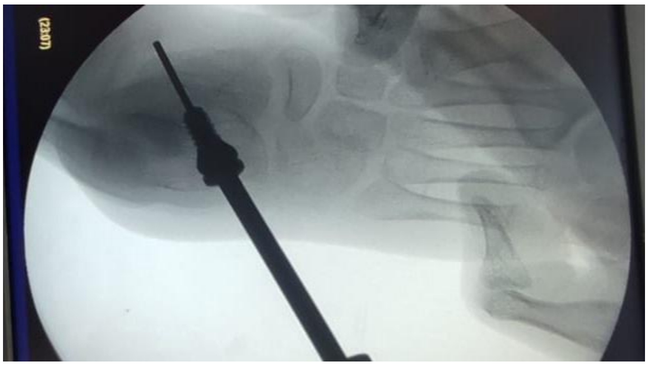


Figure [3]: The implant

Dorsiflexion of the foot is carried out with the knee extended following surgical repair. When dorsiflexion is restricted, the Achilles tendon must be lengthened subcutaneously till the foot may be dorsiflexed 10 degrees and maintained by blow knee cast.

Postoperative assessment: Immediate PO care arthroerisis procedure was conducted as one-day surgery where patients were discharged after complete recovery of anesthesia well molded arch supports were prescribed if necessary. Pain was re-evaluated for severity using NRS score and its relation to movement and weight bearing at 3-weeks and 3-months after surgery. Radiological assessment using plain film for evaluation of PO Meary's angle after removal of stitches and 6-months after surgery. A mid-calf line was drawn on the dorsum of the leg for evaluation of the determined preoperative angle. Bilateral and single heel rise test were performed after stitch removal. Time of removal screw

Follow up: After 3 weak, 3 months and 6 months we collect data about postoperative pain scoring and Meay's angle of studied patients compared to preoperative data.

Pain was evaluated using a numerical rating scale [NRS], through evaluation of the child complains to the parents of foot pain, the child's reluctance to play and increases gradually and the child's gait is impaired to avoid pain and the parents notice it.

Ethical considerations: The details of the operation technique and complications will be explained to the patient & an informed written consent will be obtained in addition, approval by the institution review board in Al-Azhar University, Damietta faculty of medicine were obtained before initiating this study.

Statistical Analysis: SPSS Version 22.0 was used to calculate the description of means, standard deviation, and proportion for numerical variables and frequency and percentage for categorical variables [IBM Corp, Armonk, NY]. Data were found to follow a normal distribution using Shapiro-wilk test. A general linear model [repeated measures ANOVA] and post-hoc analysis was used to compare results at different follow-up intervals. P value less than 0.05 was considered to declare statistical significance.

RESULTS

Pre-operative demographic data, including age, gender, weight, height, and body mass index [BMI] are summarized in Table [1]. The mean age at the time of surgery was 8.3 ± 2.5 years, ranging from 3 to 13 years old. Patients were classified into three age groups: less than 5 [n = 2], between 5 and 10 [n = 4], and more than 10 [n = 4].

All patients were discharged after full recovery of anesthesia within a time range of 3 – 6 hours. All patients were given broad-spectrum antibiotic injection twice daily for three days. Moreover, oral analgesics and anti-inflammatory drugs were given for the week postoperatively. All wounds healed totally without complications after a mean duration of 15.5 ± 3.3 days [range, 12 – 21 days]. The mean time till screw removal was 26 ± 6.5 [table 2].

The mean preoperative NRS for pain was 6.2 ± 1.5. At 3-week follow-up, the pain score declined to a mean of 2.8 ± 1.2 [range, 2 – 5]. At 3-month and 6-month follow-up, the average pain score was 1.9 ± 0.7 [range, 1 – 4] and 1.5 ± 0.3 [range, 1 – 3], respectively [figure 4].

There was a significant difference in functional scores preoperatively and at different follow-up intervals [repeated measure ANOVA, P = .001]. By running a post-hoc test, there was significant improvement in functional scores from preoperatively to 3-month follow-up [Bonferroni post-hoc test, P = .004]. No statistically significant difference between 3-month and 6-month follow-up in the AOFAS scores was found [Bonferroni post-hoc test, P = 0.186] [tables 3].

In our study three radiological parameters were assessed, including the lateral talar-first metatarsal angel [Meary's angle], calcaneal pitch angle, talonavicular coverage angle. The mean preoperative Meary's angle was -24.5 ± 11.2 degrees. At 3-week follow-up, the angle increased to a mean of -5.9 ± 5.2 degrees. At 3-month and 6-month follow-up, the average Meary's angle was -5.7 ± 5.5 and -5.5 ± 6.1 degrees, respectively [figure 5].

Two patients [20%] complained of the presence of pain in the sinus tarsi one side due to tissue straining and implant irritation. One dislocation instance [10%], which was brought on by a fall six weeks after surgery and required nonsurgical therapy, required an additional two weeks before the patient could begin bearing pressure. She experienced no complaints and had recovered all daily tasks at the last follow-up [figure 6].

Table [1]: Demographic characteristics [n = 10 patients, 20 feet]

Parameter		Value
Age, years	Mean ± SD Range	8.3 ± 2.5 3 – 13
Gender	Male Female	4 [40%] 6 [60%]
Weight, kg	Mean ± SD Range	31.5 ± 4.2 14 – 45
Height, cm	Mean ± SD Range	120 ± 15 95 – 155
BMI, kg/m^2	Mean ± SD Range	21.5 ± 1.3 15.5 – 18.7
Follow-up Duration, months	Mean ± SD Range	7.6 ± 1.2 6 – 9

Table [2]: Operative Characteristics [n = 10 patients, 20 feet]

Parameter		Value
Operative Time, minute/foot	Mean ± SD Range	16 ± 4.5 13 – 26
Time till Discharge, hours	Mean ± SD Range	4.4 ± 1.2 3 – 6
Time till Wound Healing, days	Mean ± SD Range	15.5 ± 3.3 12 – 21
Time till Screw Removal, months	Mean ± SD Range	26 ± 6.5 21 – 36

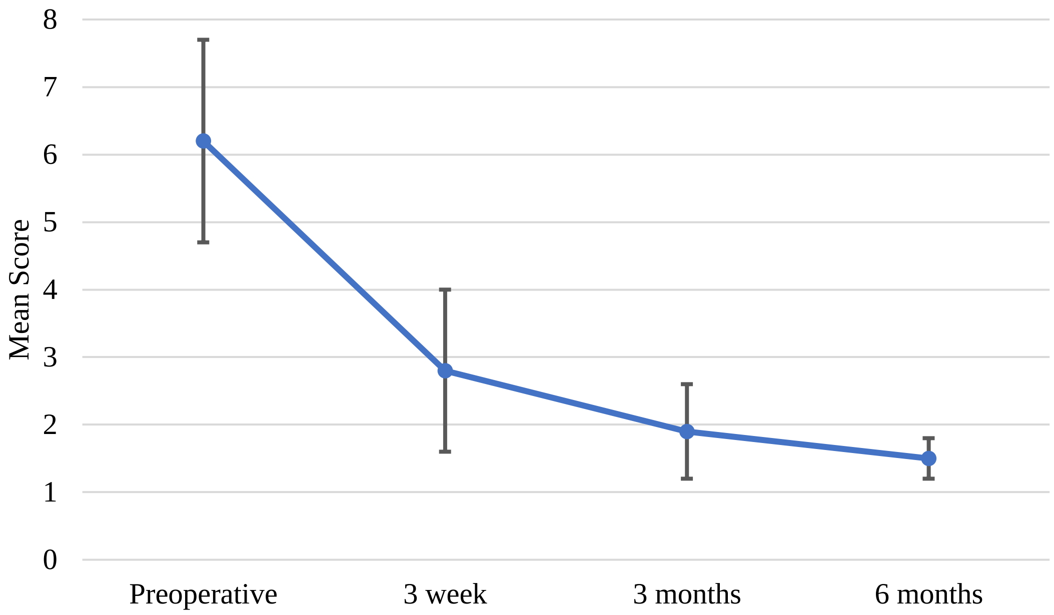


Figure [4]: NRS for Pain

Table [3]: Clinical Outcomes [n = 10 patients, 20 feet]

		Preoperative	3 weeks	3 months	6 months	P value*
NRS	Mean ± SD Range	6.2 ± 1.5 4 – 8	2.8 ± 1.2 2 – 5	1.9 ± 0.7 1 – 4	1.5 ± 0.3 1 – 3	**0.021**
AOFAS Score	Mean ± SD Range	52.5 ± 13.5 23 – 75	- -	85 ± 11.3 65 – 95	87 ± 7.8 70 – 96	**0.001**

NRS: numeric rating scale; AOFAS: American Orthopedic Foot & Ankle Society. * Repeated measure ANOVA

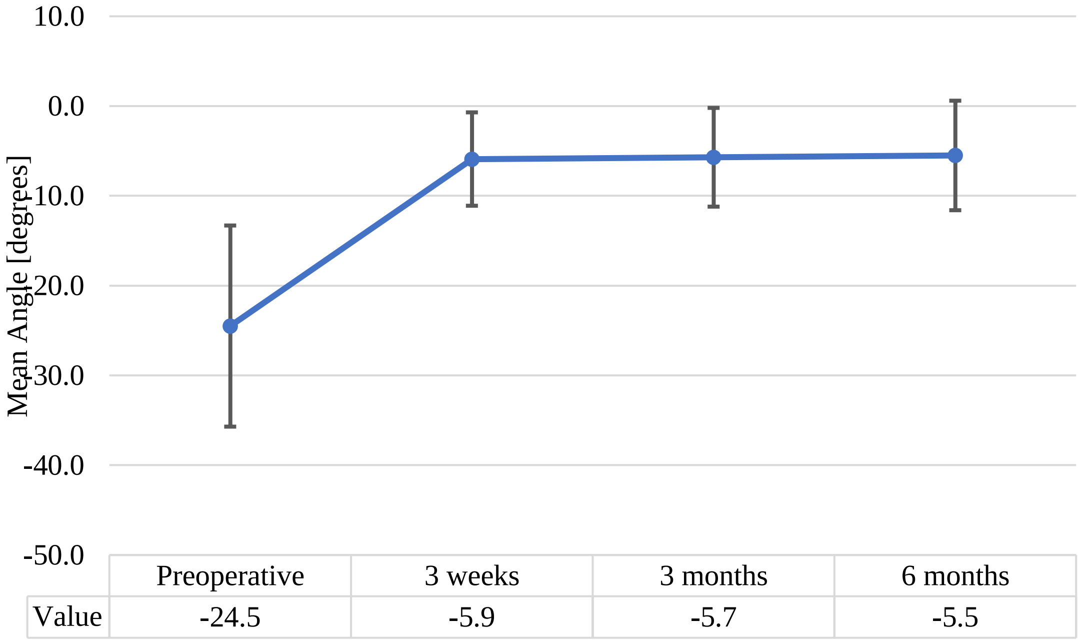


Figure [5]: Meary's Angle

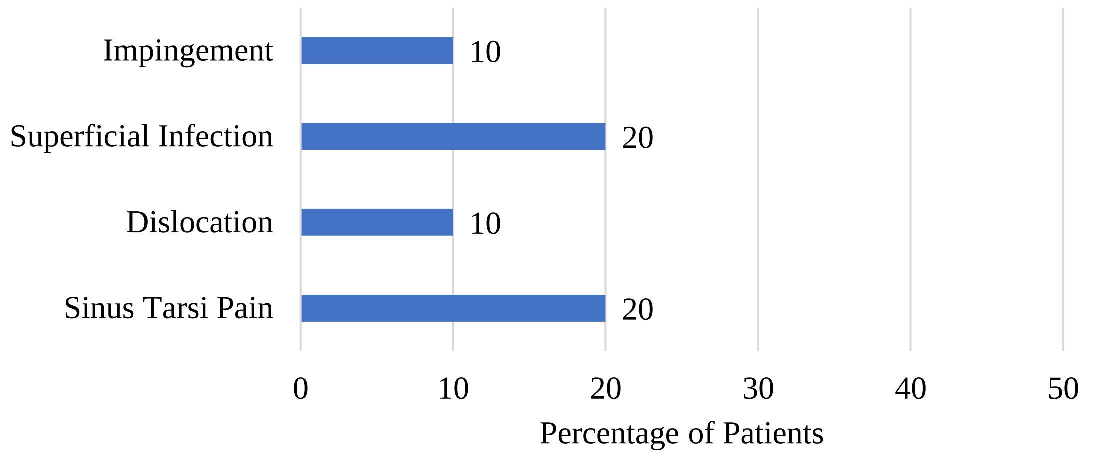
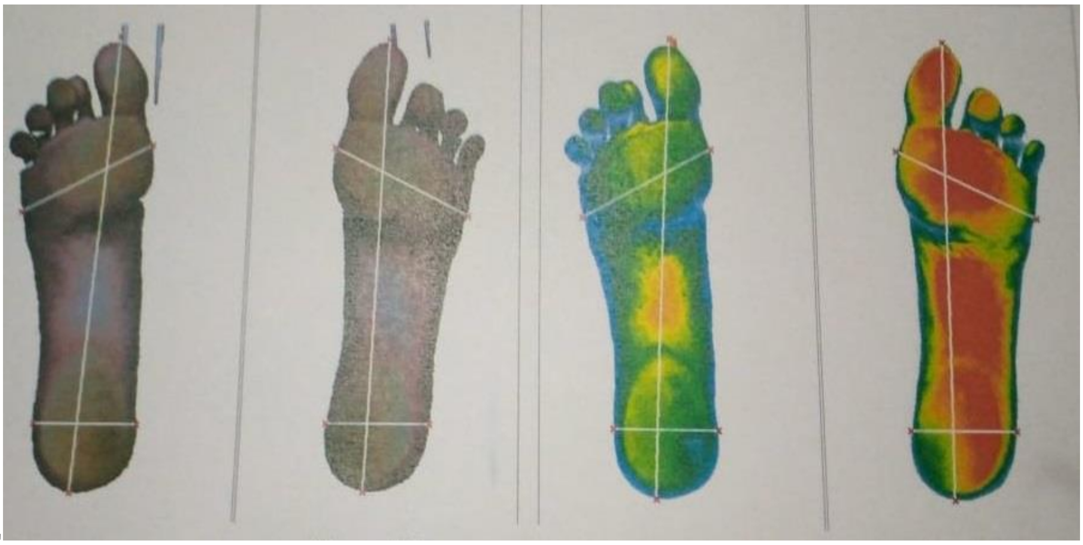


Figure [6]: Postoperative Complications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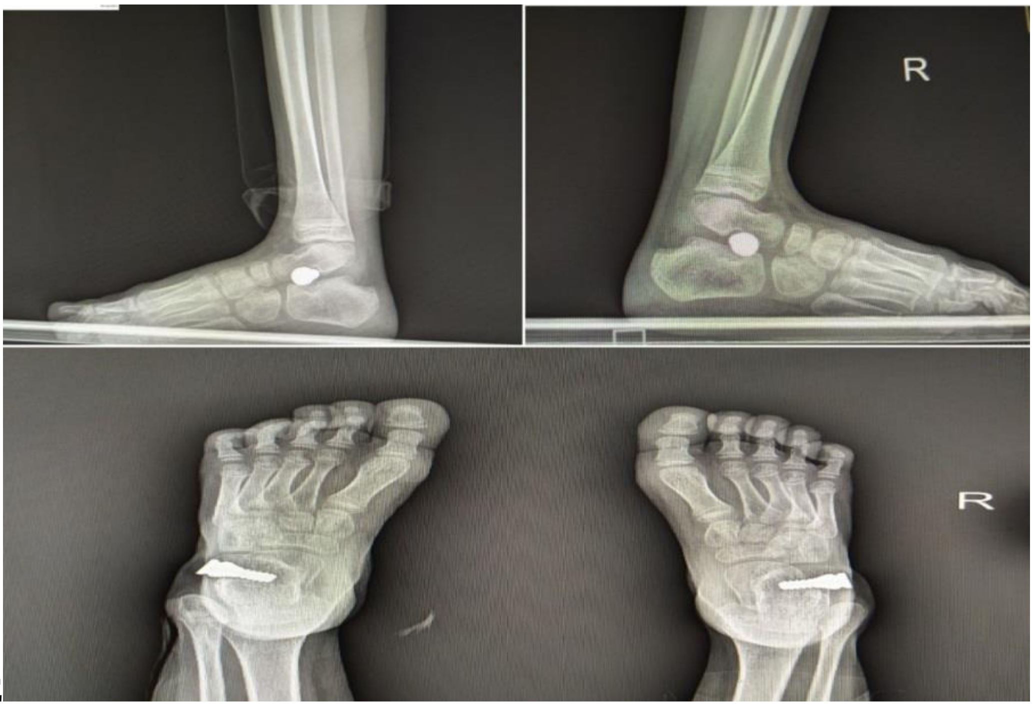

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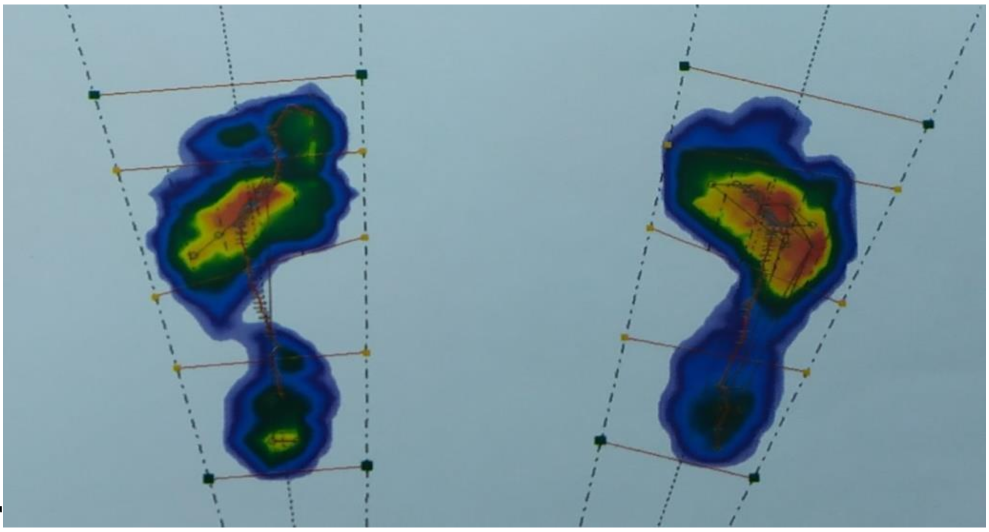
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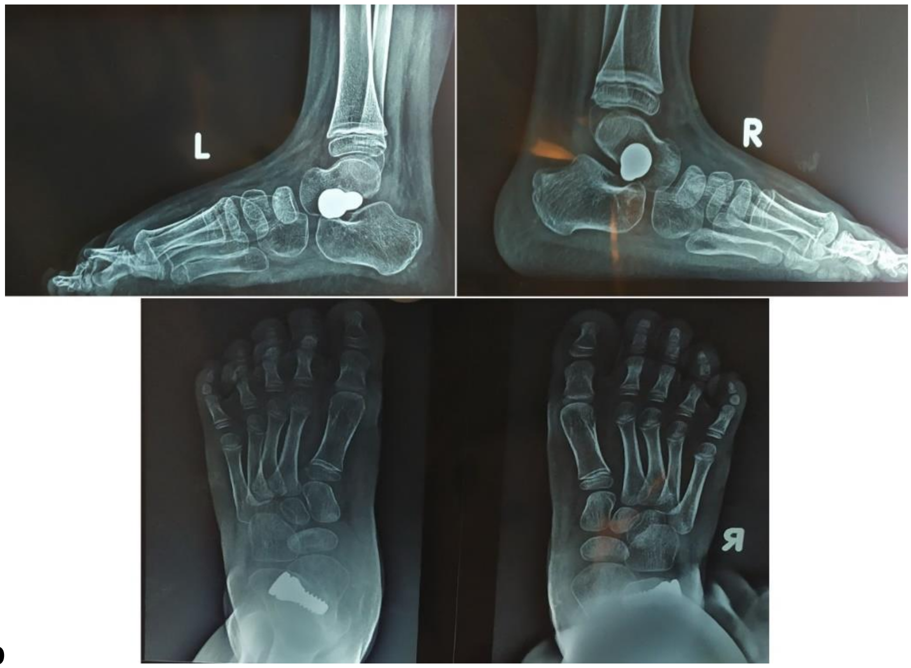
Figure [7]: Female patient 9 years old with FFF. A: Pre-operative; B: Pre-operative x-ray; C: Pre-operative foot print; D: six months postoperative; E: X-ray after 6 months; F: Foot print after 6 months


A

B


C



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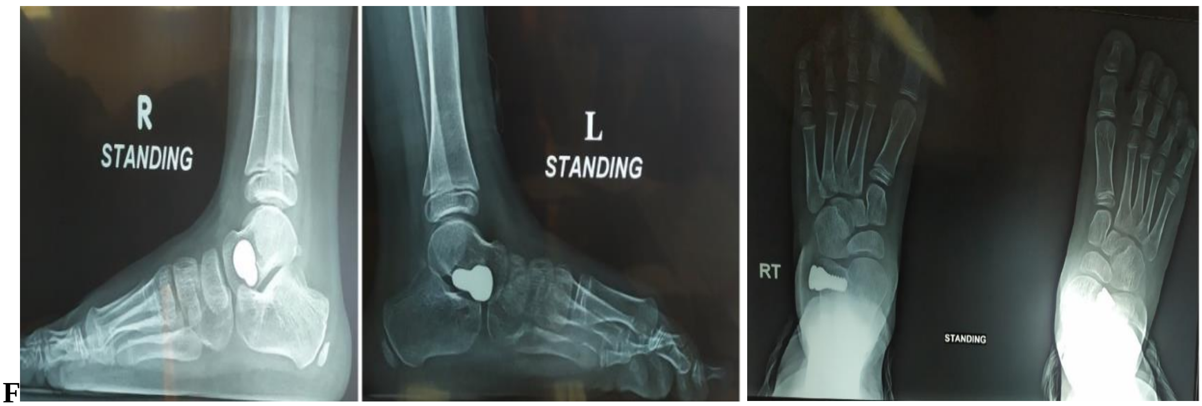

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G

H

Figure [8]: Female patient 4 years' old with flatfoot; A: Pre-operative, B: Pre-operative x-ray, C: Six months postoperative; D: X-ray after 6 months; E: After 1 year; F: X-ray after 1 year; G: After removal; H: X-ray after removal

DISCUSSION

Benefits of SSA are brief surgical times, little invasiveness, small expenses, few complication rates and a positive clinical outcome [6].

As regard Demographic Characteristics among the studied group, we found that the mean age at the time of surgery was 8.3 ± 2.5 years, ranging from 3 to 13 years old, six [60%] patients were females, whereas four [40%] were males. The mean weight was 31.5 ± 4.2 kg, ranging from 14 to 45 kg. The mean height was 120 ± 15 cm, ranging from 95 to 155 cm. The average BMI was 21.5 ± 1.3, ranging from 15.5 to 18.7 kg/m2.

In line with the present study **El Gazzar *et al*.** [7] sought to determine whether the subtalar extra-articular screw arthroereisis technique was helpful at treating children with FFF. The study enrolled 12 feet of eight children with FFF, the mean age was 10.5 years [5-16], five boys and three girls.

Also, **Elmarghany *et al*.** [8] sought to assess the subtalar extra-articular screw arthroereisis [SESA] physically and radiographically in children with FFF. The study included 84 feet of 42 patients. In this study, there were 16 women [38%] and 26 men [62%]. The range of ages at operation was [9.92 years on average]; [7–15 years].

Regarding the Operative Data, we found that all surgeries were conducted uneventfully within a mean operative time for correction of the affected side of 16 ± 4.5 minutes [range, 13 – 26 minutes]. No patient showed abnormal screw position on intraoperative x-ray. All patients were discharged after full recovery of anesthesia within a time range of 3 – 6 hours; mean was 4.4 ± 1.2 hours. All patients were given broad-spectrum antibiotic injection twice daily for three days. Additionally, oral analgesics and anti-inflammatory drugs were given for the week postoperatively. All wounds healed completely without complications after a mean duration of 15.5 ± 3.3 days [range, 12 – 21 days]. The mean time till screw removal was 26 ± 6.5 [range, 21 – 36 months]. The study by, **Elmarghany *et al*.** [8] reported that the mean operative time was 20 min.

In comparable results **Vogt *et al*.** [9] reported that SESA implants were explanted after a mean time of 28.8 months [range 18–111].

Furthermore, **Zahid *et al*. [10]** reported that for SESA treatment Weight-bearing was permitted after two days and sports activity was permitted after three months without the need of a cast immobilisation.

At 3-month follow-up, further statistically significant improvement was reported [Bonferroni post-hoc test, P = .043]. No statistically significant difference between 3-month and 6-month follow-up in the pain level was found [Bonferroni post-hoc test, P = .074].

This result was supported by **El Gazzar [7]** who reported that the reatment resulted in a significant improvement in visual analog of pain scale postoperatively.

Also, **Elmarghany *et al*. [8]** reported that 42 patients with a painful FFF malformation who underwent Subtalar Extra-Articular Screw Arthroereisis [SESA] displayed significant clinical benefit at quick follow-up, including absence of or significantly reduced pain, increased capacity for physical activity, decreased fatigue, and enhanced radiographic results.

As well, **De Pellegrin *et al*. [11]** reported that there was significant improvement of pain at 3 months postoperatively compared to pre-operative pain score.

The present study showed that there was a statistically significant difference in functional scores preoperatively and at different follow-up intervals [Repeated measure ANOVA, P = 0.001]. By running a post-hoc test, there was a statistically significant improvement in functional scores from preoperatively to 3-month follow-up [Bonferroni post-hoc test, P = 0.004]. No statistically significant difference between 3-month and 6-month follow-up in the AOFAS scores was found [Bonferroni post-hoc test, P = 0.186].

In agreement with our results **El Gazzar [7]** reported that there were significant improvements in the American Orthopedic Foot and Ankle Society scale postoperatively.

The present study was supported by **Elmarghany *et al*. [8]** who found that the post-operative AOFAS score was 97.4±2.3 [range, 94 to 100], whereas the mean AOFAS preoperative value was 68.7±5.7 [Range, 58 to 78]. Significant improvement was achieved [P-value < 0.000]. Both the objective and the subjective components of the AOFAS score showed this improvement. The great majority of patients reported experiencing little or no pain. The majority of patients' maximal walking distances significantly increased as a result.

As regard Radiological Outcomes, in our study three radiological parameters were assessed, including the lateral talar-first metatarsal angel [Meary's angle], calcaneal pitch angle, talonavicular coverage angle.

We found that the mean preoperative Meary's angle was -24.5 ± 11.2 degrees. At 3-week follow-up, the angle increased to a mean of -5.9 ± 5.2 degrees. At 3-month and 6-month follow-up, the average Meary's angle was -5.7 ± 5.5 and -5.5 ± 6.1 degrees, respectively.

This was supported by **El Gazzar [7]** who reported that there was significant improvement in radiographic measurements.

Also, **Elmarghany *et al*. [8]** reported that The Costa-Bartani angle values for the pre- and post-SESA weight bearing X-ray angles were 149° ± 6° and 127° ± 8°, respectively; the lateral T-1stMT angle numbers were 43° ± 8° and 25° ± 6°; and the calcaneal pitch angle values were 26° ± 7° and 8° ± 3°, in both. There was significant improvement in all radiographic measures.

As well, **De Pellegrin *et al*. [11]** reported that the Costa-Bartani angle was measured at 146° ± 7° and 129° ± 5°, respectively, while the talar inclination angle was measured at 43° ± 8°, and 25° ± 6°, respectively [p 0.001]. The calcaneal pitch was measured at 11° ± 6°, and 14° ± 5°, respectively.

Regarding Complications, we found that 2 patients [20%] complained of the presence of pain in the sinus tarsi one side due to tissue straining and implant irritation. There was one [10%] dislocation case, which was caused by a fall six weeks after surgery, underwent nonoperative treatment and took two more weeks to start weight-bearing.

However, **Elmarghany *et al*. [8]** reported that the rate of complications is quite low [0.07%]. Only 3 patients had a slight problem, but one of our patients [0.02%] had had deformity repair since she had generalized ligamentous laxity as a complaint. One of our patients [0.02%] had a buried screw as a result of the distant cortex being drilled. One [0.02%] required removal due to synovitis around the screw head.

Limitations: the main limitation of the study is the small number of patients, also, the relative short duration of follow up is another limiting factor.

Conclusion: Subtalar joint screw arthroereisis technique was safe and effective in the treatment of flexible flatfoot in children. It was minimally invasive procedure associated with low operative time, good clinical and radiologic outcome and low complication rate.

Conflict of Interest and Financial Disclosure: None

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