

# Results of Calcaneo-Stop procedure for idiopathic flexible pes planovalgus in children

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## Abstract

### Introduction

Pes planus is a flattening of the medial foot arch. Flexible flatfoot is characterized by a normal medial arch during non-weight bearing and an absence of the medial arch with valgus heel during weight bearing. The operative treatment of the flexible calcaneovalgus can be divided into three main groups: reconstruction, arthrodesis and arthroereisis. Valgus position of the heel with hyperpronation is the main cause of idiopathic flexible pes planovalgus in children. One of the successful operations is to correct heel valgus by implanting different elements in the sinus tarsi. The aim of this study was to evaluate the clinical and radiological results of percutaneous arthroereisis with the use of a screw through the sinus tarsi into the calcaneus.

### Patients and Methods

From July, 2013 to July, 2016, twenty eight patients with idiopathic flexible pes planovalgus were treated with Calcaneo-stop operation. The patients were between the ages of 7 and 13 years. Surgery was attempted after failure of these conservative measures. All cases were followed up for minimum of 24 months (range: 24-38 months). In all cases a 6.5-mm cancellous screw was used for subtalar arthroereisis.

### Results

The mean age was  $11.2 \pm 2.5$  years. There were 22 girls and 6 boys. Preoperative mean AOFAS score increased significantly from 56.76 (range: 48-73) to 95.29 (range: 90-100;  $p < 0.001$ ). All patients achieved VAS 80-95 points after one year of follow up. There were no signs of inflammation from local reaction to a foreign body. The median preoperative talo-first metatarsal angle of Meary was 159 degrees (minimum 144 degrees and maximum 178 degrees) and the median postoperative talo-first metatarsal angle was 180 degrees (minimum 168 degrees and maximum 190 degrees). It was significantly improved postoperatively ( $p < 0.0001$ ).

### Conclusion

Calcaneo-stop operation is a valid and effective option for treatment of idiopathic pes planovalgus in children below 15 years old with little intra and postoperative complications.

## Introduction

Pes planovalgus is a progressive foot deformity in which there is a flat medial arch with medial rotation of talus and adduction of forefoot. There is two different types of pes planovalgus. The flexible type has a normal arch with non weight bearing and flattening of medial arch with hindfoot valgus during weight bearing. [1-3]

Some authors claim that paediatric flatfoot may be a basis for numerous painful deformities in the adulthood, and they recommend early treatment. [4-6] Majority of the flexible flatfoot show an advance following foot exercises, or usage of medial arch supporting the insoles or the orthopaedic shoes. However, in some cases with severe hindfoot valgus, conservative treatment often fails. [7, 8]

The surgical treatment of the flexible flatfoot can be divided into three main groups: reconstruction of the deformity, triple arthrodesis and subtalar arthroereisis. Soft tissue reconstruction is rarely used alone. Bony procedures may give excellent results, however, the long-term results are still questioned. [9, 10] Triple arthrodesis remains the salvage method for failed primary procedures. The subtalar arthroereisis is the most commonly used procedure with numerous techniques. [10]

Valgus heel with hyperpronation is the main cause of idiopathic flexible flatfoot in children. This position leads to planter and medial deviation of the talus. So the main target in treatment is to correct the heel valgus with the resultant hyperpronation. One of the successful operations is to correct heel valgus by implanting different implants inside the sinus tarsi. [11-13]

The calcaneo-stop procedure achieves limitation of the subtalar joint pronation through proprioceptive mechanism rather than a mechanical block. [5]

Chambers used a bone mass to fill the sinus tarsi to limit eversion of the calcaneus.[14] LeLievre introduced the term of arthroereisis. He used free bone graft inside the sinus tarsi. [11] Smith and Millar used a polyethylene screw in the sinus tarsi (STA peg). [15] Verheyden used a spacer in the sinus tarsi. [16]

Calcaneo-stop method with cancellous screw insertion into sinus tarsi for subtalar arthroereisis is a valid procedure for this multiplanar deformity. Maintenance of correction of the deformity is achieved via a proprioceptive mechanism. [17]

The purpose of this prospective study was to evaluate the clinical and radiological results of planovalgus cases treated by percutaneous arthroereisis with the use of a screw through the sinus tarsi into the calcaneus.

## Patients and Methods

From July, 2013 to July, 2016, twenty eight patients were treated for idiopathic flexible pes planovalgus using Calcaneo-stop operation. The patients were between the ages of 7 and 13 years. Only four cases had unilateral correction.

The inclusion criteria included all patients with pes planovalgus with medial protrusion of the talar head and complete absence of the longitudinal arch; Meary's angle of 170 degrees or less; and valgus heel.

Patients were age > 13 years or < 7 years were excluded from the study. This is because before 7 years there is no solid bone tissue for screw purchase. Also the foot would improve with conservative treatment. Children over 13 years of age also were excluded due to completed foot bone growth. Children with neuromuscular diseases, post traumatic or congenital pes planovalgus were excluded from the study. (Figures 1,2)

All cases were submitted to conservative therapy first in form of physical exercises and orthosis for six months. Surgery was done after failure of all conservative measures. Parents were counselled about the recurrence of the deformity after screw removal. All cases were followed up for minimum of 24 months (range: 24-38 months).

In all cases a 6.5-mm cancellous screw was used for subtalar arthroereisis. A small 10 mm longitudinal skin incision in front of the lateral malleolus at the level of the sinus tarsi was used. The skin and underlying ligament were incised. The heel was taken into maximum varus to open the sinus tarsi. 3.2 mm drill bit was used to make a tunnel for the screw.

A cancellous screw of approximately 30-mm in length was inserted into the calcaneus. The screw trajectory was 35° in the sagittal and 45° in the coronal planes. During the implantation, the foot was held in inversion, and the screw smoothly into the calcaneus. After screw insertion, the longitudinal arch of the foot spontaneously reconstituted. The nonthreaded portion of the screw was not seated into the calcaneus allowing a 'calcaneo-stop' abutment to maintain the corrected hindfoot position.



**Figure 1:** preoperative photos showing hindfoot valgus with hyperpronation of the foot.



**Figure 2:** preoperative weight bearing xrays showing complete loss of medial arch.



**Figure 3:** intraoperative photo showing minimally invasive insertion approach over sinus tarsi.



**Figure 4:** intraoperative fluoroscopic image showing direction of drilling of the screw through sinus tarsi.



**Figure 5:** intraoperative flusocsopic image showing the direction of the screw



**Figure 6:** postoperative Xrays showing calcaneal stop screw inserted into anterior process of the calcaneus



**Figure 7:** postoperative photo showing complete correction of hindfoot valgus

No cast immobilization was necessary, and on the second postoperative day complete weight bearing was possible if there was no pain. If the patient complained of a painful foot, a gradual weight bearing was initiated. Moulded arch supports were prescribed when necessary. Sports allowed when pain was ended.

## Results

The data were statistically analyzed with the statistical software package of SPSS ver 20. The level of  $p < 0.05$  was considered statistically significant. Data are expressed as mean  $\pm$  standard deviation (SD). Statistical analyses were performed using the descriptive statistic and nonparametric method.

The mean age was  $11.2 \pm 2.5$  years. There were 22 girls and 6 boys. All screws were removed after 24 months. An informed consent was obtained from all parents whom children were submitted to the study.

The results were obtained six months and one year after surgery. Patients were screened for the correction of the foot arch; position of heel valgus; pain with weight bearing; changes in radiographic measurements after operation especially improvement in Meary's angle. Also ability to do activities of daily living and sports activities.

Preoperative AOFAS score improved significantly from 56.76 (range: 48-73) to 95.29 (range: 90-100;  $p < 0.001$ ). All patients and their parents stated that they were satisfied with surgery results. Pain was evaluated using VAS score. All patients had 80-95 points after one year of follow up.

There were no signs of inflammation from local reaction to a foreign body.

The median preoperative Meary's angle was 159 degrees (minimum 144 degrees and maximum 178 degrees) and the median postoperative angle was 180 degrees (minimum 168 degrees and maximum 190 degrees). It was significantly improved postoperatively ( $p < 0.0001$ ).

Also, radiographic analysis revealed significant improvements in calcaneal inclination ( $p < 0.005$ ), and talohorizontal angles ( $p < 0.002$ ) in lateral radiographs, and talo-first metatarsal ( $p < 0.001$ ) and talonavicular coverage angles ( $p < 0.007$ ) in AP radiographs. Although improvement was seen in lateral talocalcaneal and AP talocalcaneal angles, difference was not statistically significant.

In all cases the heel valgus was corrected. The median preoperative valgus heel position was 16 degrees (range: 9-18 degree). The median postoperative heel valgus was 2 degrees (range: 0-4 degrees). The correction was statistically significant with  $p$  value  $< 0.001$ . No cases reported loss of correction after removal of the screw neither loss of arch height.

There was one case with overcorrection and patient was readmitted to sunken the screw more inside calcaneus. There were no cases of screw breakage. There was no cases of infection of nerve injury. There were no screw loosening reported till end of the follow up.

Six children reported pain with prolonged walking. They were managed with NSAIDs and local treatments. Pain disappeared after six months postoperatively.

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## Discussion

Flexible pes planovalgus is a common condition in the childhood. If the deformity limits activities of daily living and sports participation, treatment deems necessary. When conservative therapy fails, a surgical correction should be considered. Subtalar arthrodesis is one of the most common procedures done for flexible flatfoot with a variety of implants inserted within subtalar joint. [6]

Subtalar arthrodesis is a valid effective operation for treatment of idiopathic flatfoot in symptomatic children using a block to calcaneal eversion in a minimally invasive way. The surgery is reasonably straightforward without expensive instrumentation. [18] It has less morbidity as well as a shorter postoperative course. It is a fast, minimally invasive, effec-

tive, and economical method for operative treatment of this condition.[4]

R. Alvarez [19] first described the technique of subtalar screw arthroereisis. [19] Maintenance of the correction is entirely achieved through a proprioceptive mechanism. [6, 17, 20, 21]

The screw can be inserted into the of talus[9], or into the calcaneus; [10] with no difference in results between both techniques.

Jerosch [10] found a significant improvement of heel valgus (from  $12.2^\circ$  to  $5.2^\circ$ ) and increase in the Meary's angle ( $162^\circ$ – $174^\circ$ ) following the 21 calcaneo-stop procedures.[10]

Giannini [6] used reabsorbable poly-L-lactic acid (PLLA) implant in 21 patients, aged from eight to 15 years. The Meary's angle increased from  $164^\circ$  to  $174^\circ$ , while the calcenovalgus decreased from  $11.4^\circ$  to  $5.8^\circ$ . [6]

Roth et al [21] operated calceno-stop procedure on 94 feet with 5 years follow up. They used a scale for patient satisfaction from 1 to 10. The results were divided into excellent, good, and poor. Eighty-six (91.49%) had excellent and good results, and eight (9%) had poor results. They reported improvement of the Meary's angle of  $17.10 \pm 5.51$  degrees. Screw breakage occurred in nine cases.[21]

Kellermann et al performed 43 calcaneo-stop procedures on 25 patients. Their mean age was 10 years. Patients were follow-up for a mean of 9.7 months (3–19 m). Patient satisfaction was excellent for 33 feet of 19 children, good for eight feet of five children, and poor for either feet of one child. The mean rest heel valgus decreased from  $13.4^\circ$  to  $2.8^\circ$  post operatively. The Meary's angle improved from  $160.2^\circ$  to  $175.9^\circ$ . [20]

The limitation of this study were the short follow up, lack of control group and the small sample size. Also, the lack of footprint measurements in this study which gives more data about outcome of this procedures as described by many papers in the literature.

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## Conclusion

The calcaneo-stop procedure is a simple and reliable method for the correction of severe pes planus in paediatric pes planovalgus by aligning the talus and the calcaneus into normal position and maintaining the situation through proprioceptive stimuli arising from the sinus tarsi.

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