

Calcaneal Lateral Column Lengthening Osteotomy for Symptomatic Flexible Flatfoot

Emad Elsayed Mohamed Abdelhadi, El Sayed El Etewy Soudy, Ashraf Abd ELDayem Mohammed, Ahmed Hesham Lotfy*, Ahmed Mohammed Nahla

Department of Orthopedic Surgery, Faculty of Medicine, Zagazig University, Egypt.

*Corresponding author: Ahmed Hesham Lotfy, Mobile: (+2) 01027140067, Email: dr_zh90@yahoo.com

ABSTRACT

Background: Existing methods of foot type classification based on foot morphology could be put into one of the 4 categories, including visual non-quantitative inspection, anthropometric values, footprint parameters and radiographic evaluation. **Objective:** The aim of the present study was to evaluate the clinical and functional outcome after calcaneal lateral column lengthening osteotomy in patients with symptomatic flexible flatfoot.

Patient and Methods: This is clinical trial (pre-post intervention) included 18 patient with symptomatic flexible flatfoot who were admitted to Zagazig Orthopedic Department, with mean follow up period of 13.6±2.7 months.

Results: Age was 9.05±1.89 with minimum 6 and maximum 13 years, and as regard sex distribution male were majority with 66.7%. There was significant improvement regarding talocalcaneal angle at anterior view from pre to 3, 6 and 12 months as it decreased from 46.94±5.19 to 29.66±2.86 at 3 months to 26.55±3.45 at 6 months and to 24.55±3.97 at 12 months. There was significant improvement regarding talocalcaneal angle at lateral view from pre to 3 months and also to 6 and 12 months. **Conclusion:** The advantages of calcaneal lengthening osteotomy are as follows: it is technically easy to be applied, has a low risk of neurovascular injury and low loss of blood. In addition, it allows other procedures to be applied in the future contrary to arthrodesis. If arthrodesis is required later in these feet, it will be far easier to do because of the corrected alignment of the foot.

Keywords: Calcaneal Lateral Column, Flexible Flatfoot, Osteotomy.

INTRODUCTION

Flatfoot is a complex disorder, with diverse symptoms and degrees of deformity and disability. There are several types of flatfoot, all of which have partial or total loss of normal arches of foot. Other characteristics present in most types include toe drift, in which the toes and front part of the foot pointed outward. The heel tilts toward the outside and the ankle appears to turn in. A tight tendon Achilles, which causes the heel to lift off the ground earlier when walking and may make the problem worse and hammertoes, may develop as a result of a flatfoot. About 30% of people have a flatfoot. For every person who has a flatfoot, one in ten probably has symptoms from it. Despite being a frequent affection, the flexible valgus flatfoot does not show objective diagnostic criteria ⁽¹⁾.

Most children are born with flatfoot, but the medial plantar arch mainly develops between two and six years of age ⁽²⁾. However, some individuals do not show any spontaneous correction. The therapeutic approach of symptomatic flatfoot in children may be conservative with prescription of analgesics, anti-inflammatories, physiotherapy and orthoses ⁽³⁾. However, there is no scientific evidence that these measures act to correct the deformity ⁽⁴⁾. There are two major types of flatfeet as follows: flexible flatfeet (FFF) and rigid flatfeet. FFF begins in childhood and continued into adulthood and usually affects both feet. It is the most common type. The term flexible is defined as a medial longitudinal arch of the foot that collapses in various degrees when standing and returns to normal

if the foot is not weight bearing ⁽⁵⁾.

Surgical treatment is indicated for older children with symptomatic flexible flatfeet in which there are interference in daily life physical activities ⁽⁶⁾. Among the various surgical treatments, calcaneal lateral column lengthening osteotomy is widely used for the flexible flatfoot treatment. **Evans** conceived the technique in 1959, but it was published only in 1975. He believed that the lateral column of the valgus flatfoot was shorter than the medial column. Thus, the purpose of the surgery is to equalize the length of the lateral and medial columns, which leads to the correction of the forefoot abduction and, consequently, of the talonavicular subluxation ⁽⁷⁾. Initially, Evans used autologous tibial graft, without implants to achieve correction. Mosca modified the technique by performing a more obliquely oriented calcaneal osteotomy, not in parallel to the calcaneocuboid joint. Mosca used a tricortical graft, obtained from the iliac crest and fixed with Steinmann pins. Currently, the allogenic bone graft is widely used for calcaneal lateral column lengthening, with good results in terms of graft healing ⁽⁸⁾.

The aim of the present study was to evaluate the clinical and functional outcome after calceneal lateral column lengthening osteotomy in patients with symptomatic flexible flatfoot.

PATIENTS AND METHODS

The comprehensive sample size was 18 cases. Assuming that the rate of administration of patient with



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flexible flatfoot to Zagazig Orthopedic Department was three cases per month.

Inclusion criteria: Patients with symptomatic flexible flatfoot. Resistant to conservative measures and surgically fit patients.

Exclusion criteria: Patients with insufficient or lost follow-up data, infection, paralysis and rigid flatfoot.

Preoperative assessment:

1- Clinical Evaluation:

The history included the age of onset, pain location, intensity, and alleviating/aggravating factors. Trauma or recurrent ankle sprains were specifically questioned. A comprehensive general examination of each patient performed and related signs to flat feet noticed as generalized laxity, coronal and rotational lower limb malalignment. For all patients the foot and ankle examined with the patient standing and sitting. The patient's gait, range of motion, flattening of the longitudinal arch, abduction of the forefoot (too many toes), heel valgus, tightness of tendon Achilles. Tip toe position (double heel rise), for the associated varus of the heel and supination of the foot.

2- Radiological evaluation:

Weight bearing antero-posterior (AP), lateral, and oblique views of the foot were obtained. Weight-bearing views were taken to the ankle joint to determine more proximal deformity and possible instability. Pre- and postoperative angles were measured and results were compared, these angles are: Talonavicular coverage angle, lateral talar first metatarsal angle and Calcaneal pitch angle.

3- Laboratory investigations:

Preoperative CBC, PT, PTT and INR, liver and renal function tests were done. All the patients received a single dose of prophylactic antibiotic first generation cephalosporin 50 mg/kg within one hour before tourniquet inflation.

Ethical approval:

The study was approved by the Ethical Committee of Zagazig Faculty of Medicine. Written consent was signed from parents after simplifying all technique, rehabilitation, complications, this consent included that they were aware of complications and accepting osteoarthritis of ankle joint, residual deformity, residual pain, infection and all these may occur after surgery. All given data were used for the current medical research only. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Operative procedure:

The surgical technique used was basically the same as that reported by Evans⁽⁷⁾: The patient, under general anesthesia with a thigh tourniquet, was placed in the

supine position with a sandbag under the ipsilateral buttock to aid access to the lateral side of the foot. The patient was prepared from the iliac crest to the toes. This technique is through a longitudinal incision on the lateral aspect of the calcaneal neck. The peroneal tendons are identified and retracted plantarly. Two Hohmann retractors are placed around the calcaneal neck and the osteotomy is made at 10–15mm posterior to the calcaneocuboid joint with a power saw. A Hintermann distractor is then used to fine-tune the amount of lengthening required. A wedge-shaped tricortical iliac crest allograft was then inserted into the osteotomy site. Fixation is not necessary but may be performed using a plate and screws, K wires or staples. The degree of correction was checked clinically and with fluoroscopy. AP, oblique and lateral views of the foot were done to check the degree of correction and to be sure about K-w position after its advancement. The incision was closed and a well-padded short-leg non-weight-bearing cast was applied.

Postoperative follow up:

Phase 1: First two weeks

- Antero-posterior and lateral X- rays for the operated foot was done on the same day of operation.
- Protection of the surgical site, both skin incision and bony healing, prophylactic antibiotics (3rd generation cephalosporins). At the end of 2nd week sutures were removed and the bivalved cast changed to complete one.
- Pain management included use of NSAID for pain modulation only when needed
- Absolute non weight bearing for the 1st 6 weeks postoperatively had been done. Patient and family were instructed for safe transfer of the patient and about postoperative precautions and home exercise program, Passive, active assistive and active range of motion of the hips and knees started as early as tolerated.

Phase 2: From the 2nd-week to the 8th- week postoperatively:

- At 6th week pins and cast were removed, protective weight bearing as tolerated by the patients was allowed. Follow up X- ray by the end of the 6th week was done. From the 6th week to the 6th month postoperative patients used medial longitudinal arch support.
- Return to preoperative function and activity as tolerated by the patients as early as possible was tried.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 15 for Windows® (SPSS Inc, Chicago, IL, USA). Qualitative data were presented as number and percent. Quantitative data were tested for normality by Kolmogorov-Smirnov test. Normally distributed data were presented as mean \pm standard deviation (SD), median, and range. $P < 0.05$ was considered to be statistically significant.

RESULT

The majority of patients were males (Table 1).

Table (1): Age and sex of the studied group

		Age	
Mean± SD		9.05±1.89	
Median (Range)		9.0 (6-13)	
		N	%
Sex	Male	12	66.7
	Female	6	33.3
	Total	18	100.0

There was significant improvement as regard AOFAS from pre to 3 months and also to 6 months and also to 12 months (Table 2).

Table (2): American Orthopedic Foot and Ankle Society (AOFAS) score at different times of follow up

	Mean	SD	Paired t	P
AOFAS pre	51.9444	7.88500	13.857	<0.01**
AOFAS_3M	78.8889	5.01631		
AOFAS pre	51.9444	7.88500	20.455	<0.01**
AOFAS_6M	90.5556	4.50127		
AOFAS pre	51.9444	7.88500	20.398	<0.01**
AOFAS_12M	94.1667	4.61774		

** : Highly significant difference

There was significant improvement as regard talocalcaneal angle at anterior view from pre to 3 months and also to 6 months and also to 12 months (Table 3).

Table (3): Radiological assessment (Talocalcaneal angle) at different times of follow up from anterior view

	Mean	SD	Paired t	P
A_Talocalcaneal angle pre	46.9444	5.19584	12.282	<0.01**
A_Talocalcaneal_angle_3M	29.6667	2.86972		
A_Talocalcaneal angle pre	46.9444	5.19584	12.851	<0.01**
A_Talocalcaneal_angle_6M	26.5556	3.45087		
A_Talocalcaneal angle pre	46.9444	5.19584	13.844	<0.01**
A_Talocalcaneal_angle_12M	24.5556	3.97377		

** : Highly significant difference

There was significant improvement regarding talocalcaneal angle at lateral view from pre to 3 months and also to 6 months and also to 12 months (Table 4).

Table (4): Radiological assessment (Talocalcaneal angle) at different times of follow up from lateral view

	Mean	SD	Paired t	P
L_Talocalcaneal_angle_pre	53.0000	4.28403	10.882	<0.01**
L_Talocalcaneal_angle_3M	40.0556	4.10842		
L_Talocalcaneal_angle_pre	53.0000	4.28403	12.468	<0.01**
L_Talocalcaneal_angle_6M	35.7222	4.98003		
L_Talocalcaneal_angle_pre	53.0000	4.28403	13.184	<0.01**
L_Talocalcaneal_angle_12M	33.6667	5.80061		

** : Highly significant difference

DISCUSSION

Flatfoot is a complex foot deformity that is commonly seen in clinical practice. It is characterized by a combination of a collapse of the medial longitudinal arch, foot abduction and hind-foot valgus.

Flatfoot is subdivided into three types: flexible flatfoot (FFF), FFF with a short Achilles tendon and rigid flatfoot most commonly associated with tarsal coalitions. In a FFF, the longitudinal arch can be created by dorsiflexing the great toe and on toe-standing,

because of the 'windlass action' of the plantar fascia. FFF is a normal foot shape that is present in most infants and many adults, and the longitudinal arch elevates in most children spontaneously within the first decade of life ⁽⁹⁾.

Despite being a frequent affection, the flexible valgus flatfoot does not show objective diagnostic criteria. It is characterized by the loss or inversion of the medial longitudinal plantar arch associated with valgus hindfoot and supination of the forefoot ⁽¹⁰⁾. Flexible flatfoot occurs when there is subtalar joint and foot mobility, so that the deformity can be reversed by maneuvers standing on the tiptoes or at the lateral border of the foot, or simply not bearing weight ⁽¹¹⁾.

Most children are born with flatfoot, but the medial plantar arch mainly develops between two and six years of age. However, some individuals do not show any spontaneous correction ⁽¹²⁾.

There is broad consensus that an asymptomatic patient with FFF needs no specific treatment. Shoe inserts have been proven to be ineffective in correction of the deformity, but it may relieve symptoms in some cases. Therefore, in symptomatic patients who are unresponsive to conservative measures, surgery is often considered ⁽¹³⁾.

The therapeutic approach of symptomatic flatfoot in children may be conservative with prescription of analgesics, anti-inflammatories, physiotherapy, adequate footwear, and orthoses. However, there is no scientific evidence that these measures act to correct the deformity, maybe they are only palliative ⁽¹⁴⁾. Surgical treatment is indicated for older children with symptomatic flexible flatfeet in which there is interference in daily life physical activities or gross deformities that interferes with footwear ⁽¹⁵⁾.

Among the various surgical treatments, calcaneal lateral column lengthening osteotomy is widely used for the flexible flatfoot treatment. Evans ⁽⁷⁾ conceived the technique and believed that the lateral column of the valgus flatfoot was shorter than the medial column. Thus, the purpose of the surgery is to equalize the length of the lateral and medial columns, which leads to the correction of the forefoot abduction and, consequently, of the talonavicular subluxation. Osteotomy is the fundamental and central procedure of choice. In almost all cases, Achilles tendon lengthening is required. In some cases, rigid supination deformity of the forefoot is present, requiring identification and concurrent treatment ⁽¹⁶⁾.

The aim of our study was to evaluate the calcaneal lateral column lengthening osteotomy for treatment of symptomatic flexible flatfoot deformity. Our retrospective study included 18 symptomatic FFF patients undergone calcaneal lateral column lengthening osteotomy in Zagazig University Hospitals, with mean follow up period equal 13.6±2.7 months.

Regarding demographic data, age was (9.05±1.89 SD) with minimum 6 and maximum 13 years, regarding sex distribution male were majority with 66.7%.

In a study by Askary *et al.* ⁽¹⁷⁾, to figure out prevalence of flat foot between male and female primary school students. They concluded that, the data showed that the overall prevalence of flat foot was 74% out of which 23% were mild, 34% were moderate and 17% were severe. The prevalence of flat foot in girl and boy students were 75.2% and 72.6% respectively, but this difference was not significant. Moreover, no significant relationship was observed between the prevalence of flat foot and age.

Also in contrary to our results, in a study done by Robb and Brunner ⁽¹⁸⁾, a total population of 1132 students in Babol were 11.6% for males and 12.1% for females. Another result from Nigeria⁽¹²⁾, reported higher percentage prevalence among females than in males. In both researches mentioned above, females had higher percentage prevalence than males, which is in disagreement with the result of the current study. The incidence of severe flat foot is higher in females too. One explanation for the higher incidence of flat foot in females could be the greater laxity of their joints.

The clinical rating system published by the American Orthopedic Foot and Ankle Society (AOFAS), the AOFAS Ankle-Hindfoot Scale, is one of the mostly used assessment tool in foot surgery. This clinical rating system, developed by Kitaoka *et al.* ⁽¹⁹⁾, combines subjective scores of pain and function provided by the patient and objective scores based on the physician's physical examination (i.e., gait, sagittal motion, hindfoot motion, ankle-hindfoot stability and alignment of the ankle-hindfoot). The questionnaire includes nine items that can be divided into three subscales (pain, function and alignment). Each of the nine items is scored, accumulating to a total score ranging from 0 points (indicating severe pain and impairment) to 100 points (no symptoms or impairment) ⁽²⁰⁾. The AOFAS-DLV is a valid, reliable and responsive instrument for follow up measuring symptoms and disability in patients who undergo ankle and foot surgery⁽²¹⁾.

In our study, regarding American Orthopedic Foot and Ankle Society score at different times of follow up periods, there was significant improvement as regard AOFAS from pre to 3 months and also to 6 months and also to 12 months as it increased from 51.94±7.88 to 78.88±5.01 at 3 months to 90.55±4.5 at 6 months and to 94.16±4.61 at 12 months. The results of this study explained the effectiveness of lateral column lengthening as a surgical approach to alleviate pain and deformity resulting from flexible flat foot in children leading to increase their activities at the end of treatment. In the study of Hegazy *et al.* ⁽²²⁾, to evaluate the role of calcaneal lengthening for correction of symptomatic flexible flat foot in children, the mean functional American Orthopedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot score had improved from 43.45 (31-55) preoperatively to 85.52 (68-92) postoperatively at last follow up (P value < 0.001) using paired t-test as a significance test for evaluation of pre

and postoperative AOFAS score. In the study of **Baghdadi et al.** (23), they evaluated 30 operated feet of 20 patients who underwent calcaneal lengthening osteotomy, the average age was 10.4 ± 0.9 years. Patients were evaluated according to AOFAS score and radiographic indexes. The mean follow up duration was 23.1 ± 9.9 months. AOFAS score at the final follow up had improved significantly compared to preoperative score (37 to 88, $P < 0.0001$).

Regarding radiological assessment (Talocalcaneal angle) at different times of follow up from anterior and lateral views. There was significant improvement as regard talocalcaneal angle at anterior view from pre to 3 months and also to 6 months and also to 12 months as it decreased from 46.94 ± 5.19 to 29.66 ± 2.86 at 3 months to 26.55 ± 3.45 at 6 months and to 24.55 ± 3.97 at 12 months. There was also significant improvement as regard talocalcaneal angle at lateral view from pre to 3 months and also to 6 months and also to 12 months as it decreased from 53.0 ± 4.28 to 40.05 ± 4.1 at 3 months to 35.72 ± 4.98 at 6 months and to 33.66 ± 5.8 at 12 months. In the study of **Hegazy et al.** (22) they reported radiological improvement of the mean of the lateral talometatarsal angle from 26.9° preoperative to 3.96° at last follow up and an improvement of the mean of the AP- talonavicular angle from 32° preoperative to 7.21° at last follow up (P value < 0.05).

CONCLUSION

The advantages of calcaneal lengthening osteotomy are as follows: it is technically easy to be applied, has a low risk of neurovascular injury and low loss of blood. In addition, it allows other procedures to be applied in the future contrary to arthrodesis. If arthrodesis is required later in these feet, it will be far easier to do because of the corrected alignment of the foot. However, future long-term studies may be needed to detect any deleterious effects on the subtalar joint caused by the osteotomy.

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