

Original Research Article

Calcaneal lengthening osteotomy for treatment of idiopathic flexible flat foot in children

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ABSTRACT

Background: The modified Evans osteotomy technique of calcaneal osteotomy was reported to be effective in correction of flexible flat foot in restoring foot alignment.

Methods: The modified Evans technique of calcaneal lengthening osteotomy was used in treatment of 18 feet of 12 patients. The mean follow-up period was 24 months (18-42). The etiology was idiopathic flexible flat foot deformity in all patients. Preoperative conservative therapy was tried in all patients. For clinical evaluation a modified point scoring system containing 32 points for patients' assessment with added 4 points for radiological evaluation the total of score became 36 points.

Results: According to the modified points scoring system the results were satisfactory in 16 feet (88.9%) and unsatisfactory in two feet (11.1%) at the final follow up All osteotomies were united within a mean time of 11 months (range 9-14 months). All 6 angles were measured at the end of the follow up and assessed as points added to the 32 points score. The score in 14 feet (77.7%) were (4) having the 6 angles within normal values. The values from 4 angles were within normal values and take score 3 in 3 feet (16.5%). In one foot (5.5%), 3 angles felt in normal range with score 2.

Conclusions: Calcaneal lengthening osteotomy for symptomatic flexible flat foot is effective in correction of the deformity and pain relief.

Keywords: Flexible, Flat foot, Calcaneal, Lengthening, Osteotomy

INTRODUCTION

The term flat foot defined as a deformity composed of flattening of the medial arch of the foot with heel valgus either in pediatric, adolescent or adults. The deformity may be rigid, which commonly congenital, or flexible which is usually acquired.¹ The pathology of flatfoot may be an isolated pathology or a part from a disorder like neurologic and muscular diseases (as poliomyelitis, cerebral palsy, myelomeningocele), generalized ligamentous laxity, genetic or collagen disorders.² The main complaints of the patients are pain accompanied by skin ulcerations, difficult shoe wear and serious problems in walking. The galls of treatment was utilized to solve this previous problems.³⁻⁵ After failure

of conservative methods to solve the problem, surgical methods are indicated.

The advantages of surgical procedures are restoring the foot alignment, relieving pain and skin. Surgical procedures in flexible flat foot vary from soft tissue to bony osteotomies, extra-articular arthrodesis of the subtalar joint, and triple arthrodesis.^{2,3,6,7} Arthrodesis is largely discouraged in children because of the problems associated with these techniques.⁶⁻⁹ One of the effective techniques is the calcaneal lengthening osteotomy. Evans in 1975 is the first to describe and modified by Mosca in 1995.^{6,10} In this prospective the clinical and radiological results of eighteen patients with flexible flat foot (FFF) treated

using modified Evans calcaneal osteotomy technique were evaluated in a mean follow up of 24 months (range 18-36).

METHODS

Through the period from June 2010 to June 2013, eighteen feet in 12 patients were presented by FFF. Six patients were operated on for both sides, the right side was operated in 4 patients and left in 2 patients. There were 8 males, and 4 females. Calcaneal lengthening operation was performed using modified Evans osteotomy technique in all feet. The mean age at time of operation was 8.5 years (range 4.5-11 years). The mean duration of follow-up was 24 months (range 18-42 months). The mean age at the end of follow-up was 12.5 years (range 7.5-14.5 years). In bilateral cases the operation was done in two stages with 6 months interval. All cases were idiopathic in etiology. All patients received conservative treatment as orthosis and before the operation.

Surgical technique

All operations were done under general anesthesia in supine position and under pneumatic tourniquet. Over the sinus tarsi, a lateral longitudinal incision from 3-4 cm. With careful dissection the inferior extensor retinaculum was incised from the superolateral calcaneal border. Special care was carried out to preserve the sural nerve and peroneal nerve superficial branches. Next step was elevation of fleshy fibers of extensor digitorum brevis and the contents of sinus tarsi. The tendons of peroneus longus and brevis were released to be easily retracted.



Figure 1: The operative technique A) preoperative photo of the foot clinically; B) intraoperative photo after doing the calcaneal osteotomy; C) intraoperative photo after impacting the graft into the osteotomy site; D) intraoperative photo of the foot after correction and K- wire fixation; E) X-ray 4months postoperative after removal of K- wires and bony union of the osteotomy with incorporation of the graft; F) the foot clinically after correction.

Under image intensifier the calcaneocuboid joint was identified and the site of osteotomy was determined between the medial and anterior facets of the calcaneus was identified. After release of the periosteum over the calcaneus the osteotomy began from about 1.5 cm proximal to the calcaneocuboid joint and directed obliquely from proximal laterally to distal medially. This obliquity was done to correct the valgus and distraction for lengthening of the lateral column. While using a laminar spreader to open the osteotomy site, the size of the graft was measured and the trapezoidal tricortical graft was harvested from the iliac crest through a separate incision. The reduction of the talo-navicular and subtalar joints was evaluated clinically and radiologically before any fixation.

The graft is impacted from lateral to medial while distracting to open the osteotomy site. Two K- wires were used, one to fix lateral column through calcaneocuboid, and the other through the talo-navicular to fix the medial column. The K- wires were bended long outside the skin for easy removal after healing. A long leg cast was applied after skin closure for 2 weeks postoperative. After removal of stitches by 2 weeks the cast was changed for another 4 weeks. The K- wires were removed after 6 weeks postoperative in outpatient clinic and a walking cast was applied for 4 weeks. For clinical evaluation a modified point scoring system containing 32 points for patients' assessment. When added 4 points for radiological evaluation the total of score became 36 points as given in Table 1.

The patients have 30-36 points are of excellent results, 25-29 points for good, 20-24 for fair, and less than 20 points for poor results. Collectively, the excellent and good results were classified as satisfactory and fair and poor results were classified as unsatisfactory. For radiological evaluation, the postoperative films (anteroposterior and lateral weight-bearing radiographs of the foot) were compared to the preoperative films for each patient measuring the angles used for assessment of the deformity and correction which are: the talohorizontal (TH), talometatarsal (TMT), calcaneal pitch (CP) and talocalcaneal (TC) angles in lateral view and TMT and TC angles in anteroposterior view as in Table 2.

RESULTS

Clinically as given in Table 2 the modified points scoring system the results were satisfactory in 16 feet (88.9%) and unsatisfactory in two feet (11.1%) at the final follow up. As regards the pain, 14 feet (77.7%) were asymptomatic and 4 feet (22.3 %) had occasional pain during activity. There was collapse of the medial arch in 2 feet (11.1%). Heel posture was mild varus in 3 feet (16.6%), moderate valgus in one foot (5.5%). Talar head prominence was mild in 3 feet (16.5%). The range of motion of ankle joint was (93%) of normal in 15 feet (83.5%), and 88% of normal in three feet (16.5%). Range of motion of subtalar joints was limited by 30% of

normal in 6 feet (33.3%), and in 12 feet the limitation was less than 15% from normal (23%). Radiologically as shown in Table 2 and 3 all osteotomies were united

within a mean time of 11 months (range 9-14 months). All 6 angles were measured at the end of the follow up and assessed as points added to the 32 points score.

Table 1: The point scoring system.

Parameters	4 points	3 points	2 points	1 points
Clinical				
A. Subjectively				
1. Pain	No pain	Occasional pain	Pain with strenuous activity	Pain
2. Activity	Normal	Mild reduction	Unable to do heavy work	Difficulty of walking
B. Objectively				
1. Medial arch	Normal	Decreased	absent	convex
2. Heel posture	Normal	Mild valgus or varus	Moderate valgus or varus	Severe valgus or varus
3. Forefoot	Normal	Mild abduction or adduction	Moderate abduction or adduction	Severe abduction or adduction
4. Prominence of talar head	None	Mild	Moderate	severe
5. Range of motion a. ankle joint b. subtalar and mid tarsal joints	Good range of motion Good range of motion	Slight limitation Limited sutalar and mobil idtarsal joints	Stiff in neutral position limitation of the subtalar and midtarsal joints	Deformity in equinus or dorsi-flexion stiffness of the whole tarsus
6. Radiological	5 angles or more fell within normal range	Only 4 angles fell within normal range	3 angles fell within normal range	Less than 3 angles fell within normal range

Table 2: The clinical point system for all feet.

Foot no	Subjective		Objective						Total clinical score	Radiological score	Total score
	Pain	Activity	Medial arch	Heel posture	Fore foot	Prominence talar head	Range of motion				
							Ankle joint	Subtala			
1	4	3	4	4	3	4	4	3	28	3	31
2	3	4	4	4	4	4	4	3	30	3	33
3	4	3	4	3	4	4	4	4	30	3	33
4	4	4	4	4	4	4	4	4	32	3	35
5	4	4	4	4	4	4	4	3	31	3	34
6	3	3	3	4	4	4	4	4	30	3	33
7	4	4	4	4	4	4	4	4	32	3	35
8	4	4	4	4	3	4	4	3	29	3	32
9	4	4	4	4	4	3	4	4	32	3	35
10	4	4	4	4	4	4	4	3	31	3	34
11	4	4	4	4	4	4	4	4	32	3	35
12	3	3	3	3	3	4	4	4	26	2	28
13	4	4	4	4	4	3	4	4	32	3	35
14	4	4	4	4	4	4	4	4	32	3	35
15	4	4	4	4	4	4	4	4	32	3	35
16	4	3	3	3	4	4	4	4	29	3	32
17	4	4	4	4	3	3	4	4	30	3	33
18	3	3	4	4	4	4	4	4	31	3	34

Table 3: The preoperative and postoperative angles of the foot after surgical correction compared to normal range.

Angle	Normal range	Preoperative angles		Postoperative angles	
		Range	Mean	Range	Mean
Lateral view					
TMT	BVG (-4)-(-4)	25-45	35.5	(-5)-(-9)	2.4
TH	15-37	28-60	45.5	5-30	17.5
CP	15-30	(-6)-(-15)	9.5	10-25	18.5
TC	25-55	35-60	50	10-40	28
AP view					
TMT	(-15)-(-10)	15-30	22	(-10)-(-10)	0
TC	15-35	20-52	36	10-45	30

TMT- Tarsometatarsal angle; TH- Talo horizontal angle; CP- Calcaneal pitch angle, TC- Talocalcaneal angle.

The score in 14 feet (77.7%) were (4) having the 6 angles within normal values. The values from 4 angles were within normal values and take score 3 in 3 feet (16.5%). In one foot (5.5%), 3 angles felt in normal range with score 2.

DISCUSSION

Flexible flat foot (FFF) is a deformity represented with supination of forefoot in relation to hind foot, shorter lateral column to the medial column, inappropriate talonavicular joint alignment as seen in Figure 2.



Figure 2: Clinical and radiological description of the deformity preoperative.

Many treatment options are utilized and vary from simple orthosis to triple arthrodesis.^{1,3,11} When conservative methods failed to control pain and shoe wear the surgical treatment is indicated. Many options like soft tissue procedures, calcaneal osteotomy, subtalar and triple arthrodesis. These techniques have short term good results. Calcaneal displacement osteotomies are successfully correcting hind foot valgus but insufficient for severe cases. The limited arthrodesis is widely reviewed in the literature and correction without arthrodesis is better in long term results.^{12,13}

In this study the results of calcaneal lengthening osteotomy in 18 feet of 12 patients with idiopathic FFF deformity are evaluated. The hind and mid-foot were clinically corrected in all cases with reformation of medial longitudinal arc. The recommendation of Evans is that the ideal age group for this technique was between 8 and 12 years old. The mean age of our patients at time of operation was 8.5 years (range 4.5-11 years). Evans claimed that full correction cannot achieved with this technique especially in the patients with poliomyelitis. In our study the aetiology in all cases was idiopathic deformity. The amount of correction is related to the size of the graft. In this study, the correction position was obtained and stabilized with K-wire fixation until union. Intraoperative radiology was used to assess the correction before fixation in all cases.

Davitt et al evaluated plantar pressure contribution and contact surface after calcaneal lengthening operation in children and adolescents and certifying the clinical correction they showed that contact surface in both hind foot and forefoot and maximum mean pressure decreased in the medial side but increased in the lateral side and also that medial longitudinal arc was formed with all of the plantar pressure parameters that they have used.¹⁴

Ragab et al in a cadaveric study, they claimed that calcaneal lengthening osteotomy was an effective method for correction of FFF deformity in short term results, but they did not report on long term results.¹⁵

Phillips⁷ in 1983 reviewed the cases that were operated by Phillips.¹⁶ The results were good in 15, fair in 3 and poor in 3 patients, but their evaluation of cases was based on the subjective parameters like clinical appearance, patient satisfaction, and relief of symptoms. The radiological evaluation did not use the angular parameters for correction, but classified as complete correction and acceptable partial correction. They reported that poor results in 3 cases were due to progressive deformities with aetiologies but there was no information about these aetiologies.

Yoo et al evaluated 92 feet of 69 cases and classified the clinical results by assessing pain improvement, and callus.¹⁷ They reported the reformation of medial longitudinal arch, correction of the forefoot abduction and hind foot valgus. They evaluated standing lateral radiographies, and the results were poor when the talocalcaneal angle is less than 35 degrees, talus-first metatarsal angle was greater than 25 degrees and calcaneal slope angle was less than 5 degrees.

In this work, clinical evaluation was made according to a modified point scoring system containing 32 points for patients' assessment, and added 4 points for radiological evaluation to get a total of score of 36 points as shown in Table 1. For radiological evaluation, we used the talohorizontal (TH), talometatarsal (TMT), calcaneal pitch (CP) and talocalcaneal (TC) angles in lateral view and TMT and TC angles in anteroposterior view as in Table 2. The overall results were satisfactory in 16 feet (88.9%) and unsatisfactory in two feet (11.1%) at the final follow up. 14 feet (77.7 %) were asymptomatic and 4 feet (22.3%) had occasional pain during activity. There was collapse of the medial arch in 2 feet (11.1%). mild heel varus in 3 feet (16.6%), moderate valgus in one foot (5.5%). Talar head prominence was mild in 3 feet (16.5%).

In this study we used the modifications of Mosca on skin incision, direction of the osteotomy, shape of the graft, application of internal fixation. Mosca [-] also used allografts in 24 of 31 patients and he reported no problems in osteotomy site bone union. In all of our cases a tricortical autograft from iliac crest was used.

CONCLUSION

Calcaneal lengthening osteotomy in symptomatic FFF is a successful technique and can provide clinical and radiological correction of the deformity in hind foot and forefoot. It is possible to gain complete reduction in the flexible cases. The calcaneal lengthening osteotomy is technically easy to be performed, with low risk of neurovascular injury. The limitation of the study is the short term follow up period as the changes in subtalar joint may take a long time to occur. One of the advantages of this technique is that other procedures can be performed later on unlike arthrodesis which is a terminal operation.

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