

Lateral Calcaneal Lengthening Osteotomy in Management Symptomatic Flexible Flat Foot.

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ABSTRACT

Background: Flexible flatfoot is a physiological variation of normality that does not need correction unless it becomes symptomatic¹. The objective of this study was to assess the value of Lateral Calcaneal lengthening osteotomy in Symptomatic flexible Flat foot in children and adolescents to improve structural alignment while maintaining hind foot motion, which may further protect the function of adjacent motion segments. We performed this procedure on 36 feet of 22 patients where Achilles tendon lengthening is also done. Postoperative follow-up showed significant improvement in both clinical and radiological parameters and ankle foot score. **Methods:** In a prospective study conducted in abo aresh, Cairo University or orthopedic department in zagzaig University Hospital, 36 feet of 22 patients were operated for symptomatic flexible Flat foot from January 2010 and February 2014. All the cases were treated as per protocol. There were 12 female (54.5%) and 10 males (45.5%). Mean operation age was 10 years 4 months, range from 7 years 6 months to 17 years 2 months. There were 14 bilateral cases (63.6%) and 8 unilateral cases (36.4%). The average follow up duration was 18.7 months (SD 80.5) (ranging from 6 to 37 months). Inclusion criteria included painful, passively correctable pes planovalgus (No symptomatic arthritis in the subtalar, calcaneocuboid and talonavicular joints.). Exclusion criteria included fixed pesplanovalgus, osteoporosis of the calcaneum, advanced degenerative arthritis of the subtalar, talonavicular or calcaneocuboid joints, Paralytic condition affecting foot and ankle Severe bone metabolism disorder (e.g., poorly controlled insulin-dependent diabetes mellitus with neuropathy), severe trophic skin disorders and Standard contraindications to any surgery such as poor circulation, unhealthy or compromised patient and concurrent infection. The diagnosis of functional flexible flatfoot was established by clinical and radiographic examination. Clinical diagnosis was based on increased valgus position at rest and during tiptoe standing test as well as restriction of dorsiflexion of the ankle joint in neutral varus/valgus position. All patients are assessed clinical and American Academy of Orthopedic Surgeons (AOFAS) foot and ankle core score. - All patients underwent American Orthopedic Foot and Ankle Society (AOFAS) hindfoot/ankle scoring preoperatively, 3 months after the second foot surgery, and at the time of maximal follow-up. **Results:** Out of 36 feet of 22 patients who were operated for symptomatic flexible Flat foot showed significant correction (P <0.001) in all parameters clinically postoperatively. The pain which was the main indication for the surgery was eliminated in all patients. In the follow-up period, there were no difficulties in wearing shoes. Postoperative 20 patients showed excellent results (18–16 points), and 13 patient show good result (15–13 points) And 3 patient show fair results (12–10 points) And no patient show poor result (< 10 points). The average AOFAS preoperative score was 68.7±5.7 (Range: 58 to 78). A 3-month postoperative AOFAS score was determined for all 36 patients after the second foot surgery. The average score was 86.5±3.4 (Range, 82 to 92). 1 patient showed Incision dehiscence which improved on daily dressing. 1 patient show Mild sural neuritis improved dramatically by physiotherapy and local steroid injection. 1 patient Subluxed talonavicular joint on postoperative which corrected by k-wire pass across medial cuneiform, navicular, talus, on final follow up the graft incorporated well with well covered talonavicular. 2 patients, a graft minimally dislocated after surgery, but then healed uneventfully. In both cases, there is bony prominence. 1 of these 2 patients also exhibited some loss of forefoot adduction correction. At follow-up, moderate pain was present at the lateral ankle and subtalar joint, and the result was rated as fair. **Conclusion:** Lateral calcaneal lengthening osteotomy with tendon achilis lengthening is relatively simple, effective procedure in treating flexible flatfoot in pediatric age. The objective of the technique was achieved. Good alignment and improvement in sagittal and hind foot motion was observed. Such an improvement in AOFAS score has been previously reported.

Keywords: Flatfoot, flexible, painful, Calcaneal lengthening osteotomy

INTRODUCTION

Flexible flatfoot is a normal foot shape that is present in most infants and many adults. The arch elevates spontaneously in most children during the first decade of life.^[1] There is no evidence that a longitudinal arch can be created in a child's foot by any external forces or devices.^[2] Flexible flatfoot with a short Achilles tendon, in contrast to simple flexible flatfoot, is known to cause pain and disability in some adolescents and adults.^[3] Joint-preserving, deformity-correcting surgery is indicated in flexible flatfoot with short Achilles tendons when conservative measurements fail to relieve pain under the head of the plantar flexed talus or in the sinus tarsi area.^[4] 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.^[1,2]

MATERIALS AND METHODS

In a prospective study conducted in abo aresh, Cairo University or orthopedic department in zagazig University Hospital, 36 feet of 22 patients were operated for symptomatic flexible Flat foot from January 2010 and February 2014. The aim of the work is evaluation of the short term results of calcaneal lengthening osteotomy in the treatment of symptomatic flexible flatfoot.

All the cases were treated as per protocol. There were 12 female (54.5%) and 10 males (45.5%). Mean operation age was 10 years 4 months, range from 7 years 6 months to 17 years 2 months. There were 14 bilateral cases (63.6%) and 8 unilateral cases (36.4%). The average follow up duration was 18.7 months (SD 80.5) (ranging from 6 to 37 months). Inclusion criteria included painful, passively correctable pes planovalgus (No symptomatic arthritis in the subtalar, calcaneocuboid and talonavicular joints.). Exclusion criteria included fixed pesplanovalgus, osteoporosis of the calcaneum, advanced degenerative arthritis of the subtalar, talonavicular or calcaneocuboid joints, Paralytic condition affecting foot and ankle Severe bone metabolism disorder (e.g., poorly controlled insulin-dependent diabetes mellitus with neuropathy), Severe trophic skin disorders and Standard contraindications to any surgery such as poor circulation, unhealthy or compromised patient and concurrent infection. The

diagnosis of functional flexible flatfoot was established by clinical and radiographic examination. Clinical diagnosis was based on increased valgus position at rest and during tiptoe standing test as well as restriction of dorsiflexion of the ankle joint in neutral varus/valgus position. All patients are assessed clinical and American Academy of Orthopedic Surgeons (AOFAS) foot and ankle core score. - All patients underwent American Orthopedic Foot and Ankle Society (AOFAS) hindfoot/ankle scoring preoperatively, 3 months after the second foot surgery, and at the time of maximal follow-up.

Surgical technique

The patient was placed supine on the operating table with a bump Placed beneath the ipsilateral buttock to medially rotate the foot. A Pneumatic thigh tourniquet was typically used for hemostasis. An oblique or a curvilinear incision was placed distal to the sinus tarsi and 1 to 1.5 cm proximal to the calcaneocuboid joint. This approach usually avoids the dorsal cutaneous nerves and provides access to the lateral wall of the anterior portion of the calcaneum, although care must be taken to protect the peroneal tendons and the sural nerve. An image intensifier was sometimes used to confirm the osteotomy location prior to execution .Once satisfied with the location, periosteum was incised in a vertical fashion, and an elevator was used to dissect periosteum from the lateral wall of the calcaneum.

Periarticular dissection was limited to avoid destabilization of the distal segment. A sagittal saw blade was oriented perpendicular to the lateral surface of the calcaneum and perpendicular to the weight-bearing surface to initiate the osteotomy in a lateral-to-medial direction, and a handheld osteotome was typically used to complete the cut without violating the medial osseous hinge and soft tissue structures.

A lamina spreader, or a mini distractor, was then used to manipulate and distract the osteotomy to the desired length to achieve restoration of arch height.

The precise degree of correction was determined intraoperatively with fluoroscopy in conjunction with direct visualization of the sagittal, frontal, and transverse plane orientations of the foot, and the autogenous bone graft (fibular) wedge was sized to fit the corrected alignment.

The graft was fashioned into a triangular, with its cortical base measuring 7 to 10 mm in width. The cortical base was oriented lateral and apex medial, and then attempted into its final position. The graft remained secure with 2 k-wires for fixation. After completion of any adjunct surgical procedures and application of a surgical dressing, a short-leg, non-weight-bearing cast was done, and serial radiographs were obtained to determine the status of graft incorporation.

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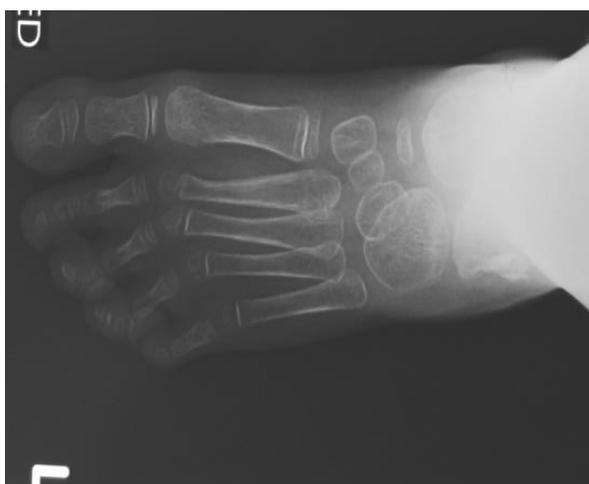


Figure 1: (a) Standing AP view RT feet; showing medial deviation of the talus in relation to the navicular and first metatarsal. (b) Standing lateral view RT feet: showing evident collapse of the arch.

Figure 1 show 8 years old , x-ray of right foot and ankle. After 2 weeks, postoperatively the cast was changed with removal of stitches. Figure 2 show Postoperative first day show graft in AP and lateral view. 1 month later the cast was removed for removal of the K-wires and another below knee non-weight bearing cast was done with the ankle in neutral position, and this was for another 4-6 weeks.

After removal of plaster, a medical shoe was used in which the medial part is elevated to maintain the correction produced and prevent recurrence, for at least months after surgery. The tendon Achilles lengthening procedure was performed for all patients, as the ankle was dorsiflexed when the knee was in full extension, and the peroneus brevis tendon lengthening done in 4 feet.

Methods of evaluation

The diagnosis of functional flexible flatfoot was established by clinical and radiographic examination. Clinical diagnosis was based on increased valgus position at rest and during tiptoe

standing test as well as restriction of dorsiflexion of the ankle joint in neutral varus/valgus position. All patients are assessed clinical and American Academy of Orthopedic Surgeons (AOFAS) foot and ankle core score.



Figure 2: Postoperative first day show graft in AP and lateral view.



Figure: anterior -posterior and lateral x-ray view of right foot and ankle the bone graft well incorporated into calcaneus with restoration of medial foot arch.

1-Clinical evaluation

Was made by assessment of the forefoot alignment in the transverse and frontal planes, hindfoot alignment in the sagittal and frontal planes, and severity of pain, ability to walk on the heel, and the appearance of the medial longitudinal arc preoperatively. In addition, improvement in standing and walking and family satisfaction was evaluated during the last visit. Results were classified as excellent, good, fair, and poor as in [Table 1].

18–16 points, excellent; 15–13 points, good; 12–10 points, fair ;< 10 points, poor.

2- All patients underwent American Orthopedic Foot and Ankle Society (AOFAS) hindfoot/ankle scoring preoperatively, 3 months after the second foot surgery, and at the time of maximal follow-up [Figure 3].



Figure 3: Final follow up 2years show graft was taken and the medial arch was restored.

RESULTS

In the period between January 2009 and February 2012, a prospective study was conducted involving 36 feet of 22 patients who underwent lateral calcaneal lengthening due to symptomatic flexible PPV. All patients were operated upon either in abo aresh, Cairo University or orthopedic department in zagzaig University Hospital. There were 12 female (54.5%) And 10 males (45.5%). [Figure 1]. Mean operation age was 10 years 4 months, range from 7 years 6 months to 17 years 2 months (SD3.0) [Figure 2]. There were 14 bilateral cases (63.6%),

And 8 unilateral cases (36.4%) [Figure 3]. The average follow up duration was 18.7 months (SD 80.5) (ranging from 6 to 37 months).

Table 1: Clinical evaluation criteria

| 0 point | 1point | 2points | Parameters |
|------------------------------|---------------------------|------------|---------------------------------------|
| >10valgus | 5–10valgus | 0–5 valgus | Hindfoot alignment (frontal plane) |
| Obvious equines | Mild equines | Neutral | Hindfoot alignment (sagittal plane) |
| >5°abduction/adduction | <5° abduction/adduction | Neutral | Forefoot alignment (transverse plane) |
| Obvious supination/pronation | Mild supination/pronation | Neutral | Forefoot alignment (frontal plane) |
| severe | Mild | None | Pain |
| Non ambulatory | Ambulated with crutches | Ambulatory | Ability of walking on the heel |
| None | Moderate | Good | Improvement in standing and walking |
| Obvious planus/cavus | Mild planus/cavus | Attained | Medial long arc reconstruction |
| Not satisfied | Moderate | Good | Family satisfaction |

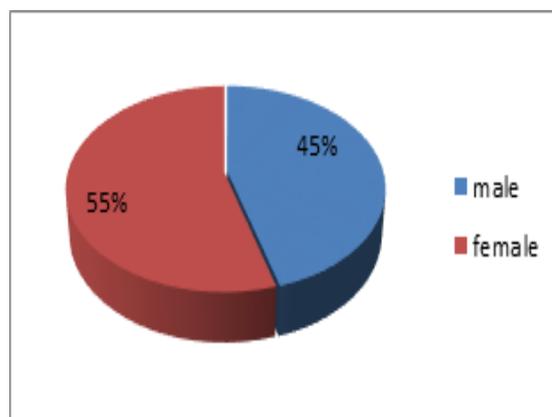


Figure 1: Sex distribution among the studied group

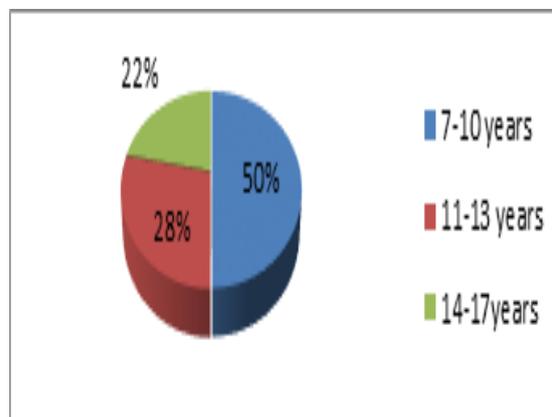


Figure 2: Age distribution among the studied group at the time of surgery.

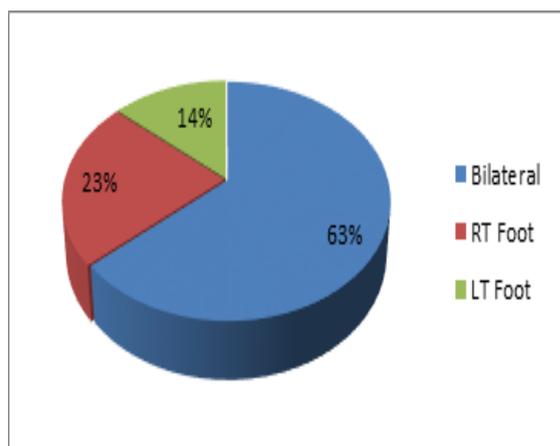


Figure 3: Side distribution among the studied group

According to the clinical evaluation criteria mentioned above in table , in the preoperative there are 21 feet were fair and 13 feet were clinically poor , 1 female patient were clinically good in both foot and had no neuromuscular problems; the pain was persistent and irritating for both the child and the parents, and therefore the surgery was performed.

Clinical results are shown in Table preoperatively, and during the last visit showed significant correction (P <0.001) in all parameters postoperatively. The pain which was the main indication for the surgery was eliminated in all patients. In the follow-up period, we had not encountered difficulties in wearing shoes.

Postoperative 20 patients showed excellent results (18–16 points), and 13 patient show good result (15–13 points) And 3 patient show fair results (12–10 points) and no patient show poor result (< 10 points).

1 patient with fair clinical score had severe preoperative pain, which is diminished postoperative, the arch is grade 3 (severe), there is no arch and the medial border of the foot is convex preoperative but become grade 2 (moderate), the arch is absent but the medial border of the foot is straight, Heel alignment preoperative was sever 16 degree postoperative become 13 degree.

The average AOFAS preoperative score was 68.7±5.7 (Range, 58 to 78). The most common reasons for lower scores included pain, limitations of daily and recreational activities, limited walking distances, difficulty on uneven , and obvious functional gait abnormalities. A 3-month postoperative AOFAS score was determined for all 36 patients after the second foot surgery. The average score was 86.5±3.4 (Range, 82 to 92).

1 patient Show Incision dehiscence which improved on daily dressing. 1 patient show mild sural neuritis improved dramatically by physiotherapy and local steroid injection. 1 patient Subluxed talonavicular joint on postoperative which corrected by k-wire pass across medial cuneiform, navicular, talus, on final follow up the

graft incorporated well with well covered talonavicular. 2 patients, a graft minimally dislocated after surgery, but then healed uneventfully. In both cases, there is bony prominence. 1 of these 2 patients also exhibited some loss of forefoot adduction correction. At follow-up, moderate pain was present at the lateral ankle and subtalar joint, and the result was rated as fair.

DISCUSSION

Flexible flatfoot is common condition in children and adults. The natural history of flexible flatfoot has been described. The longitudinal arch develops spontaneously during childhood and inserts or shoe modifications do not have any effect on the development of the arch.^[5-9] Ideally, the deformity should be corrected in young children, before it becomes fixed and adaptive osseous changes have occurred. The operative technique should not interfere with subsequent growth of the foot.

On reviewing the literature, the goals of many techniques proposed for surgical treatment of FFF in children were raising the medial arch and correcting heel valgus and forefoot abduction.^[10]

Surgical procedures can be categorized as a bony interference in the form of osteotomy or arthrodesis or a soft tissue correction in the form of tendon transfer or lengthening.^[11-13] There is general agreement that a surgical procedure for correction of symptomatic flat foot in a growing child should not rely on soft tissue tightening alone and should not fuse joints.^[14,15] Koutsogiannis et al described a Calcaneal medial sliding osteotomy to correct the valgus deformity of the hindfoot and restore the normal angle between the long axis of the calcaneum and the floor.^[16] Rathjen and Mubarak used a sliding-closing medial calcaneal osteotomy, a plantar closing wedge osteotomy of the medial cuneiform and an opening wedge osteotomy of the cuboid.^[17]

Table 2: AOFAS hindfoot scoring.

| Patient Number | Preoperative | Three-Month Postoperative | Maximum Follow-up |
|----------------|--------------|---------------------------|-------------------|
| 1 | 70 | 84 | 100 |
| 2 | 76 | 84 | 94 |
| 3 | 64 | 88 | 94 |
| 4 | 68 | 84 | 94 |
| 5 | 58 | 86 | 96 |
| 6 | 76 | 88 | 96 |
| 7 | 62 | 90 | 100 |
| 8 | 74 | 86 | 96 |
| 10 | 68 | 88 | 96 |
| 11 | 72 | 84 | 94 |
| 12 | 70 | 90 | 100 |
| 13 | 78 | 90 | 100 |
| 14 | 64 | 82 | 96 |
| 15 | 76 | 90 | 96 |
| 16 | 68 | 88 | 94 |
| 17 | 66 | 88 | 100 |
| 18 | 70 | 90 | 94 |
| 19 | 74 | 88 | 94 |

| | | | |
|----|----|----|-----|
| 20 | 68 | 92 | 96 |
| 21 | 72 | 92 | 94 |
| 22 | 64 | 88 | 96 |
| 23 | 58 | 82 | 94 |
| 24 | 66 | 84 | 96 |
| 25 | 72 | 88 | 100 |
| 26 | 64 | 82 | 96 |
| 27 | 58 | 78 | 94 |
| 28 | 74 | 90 | 100 |
| 29 | 76 | 86 | 96 |
| 30 | 62 | 88 | 94 |
| 31 | 70 | 84 | 96 |
| 32 | 70 | 88 | 96 |
| 33 | 58 | 78 | 94 |
| 34 | 68 | 86 | 100 |
| 35 | 70 | 88 | 96 |
| 36 | 74 | 86 | 94 |

a Range, 58 to 78; b Range, 82 to 92; c Range, 94 to 100.

In this study a simple bony technique Lateral calcaneal lengthening osteotomy to restore the medial longitudinal arch and to correct forefoot abduction, allowing minimizing the strain and to reach a successful function of the medial ligament and correct all the components of the deformity of FFF in one sitting. Accompanied by lengthening of tendon Achilles. Isolated calcaneal displacement osteotomies are successful in correcting hindfoot valgus but in severe cases they are not sufficient to restore medial longitudinal arc.^[18] Problems associated with limited arthrodesis in literature are widely reviewed and a common opinion to correct children foot deformities without application of arthrodesis is constituted 7, 16, and 17, 19-23. a potential disadvantage of osteotomy is that it increases calcaneocuboid pressure that correlates with a higher risk of arthrosis or arthritis of foot.

Cooper et al suggested that risk of arthrosis in calcaneocuboid joint due to decreased pressure in the joint was a disadvantage for Evans osteotomy.^[24] But in a cadaver study no relation between calcaneal lengthening and decreased calcaneocuboid joint pressure was found.^[25] In another cadaver study it was reported that graft size should be limited by 6 mm, and grafts with a size more than 6 mm had no additional correction effect, and that bigger grafts caused pain in the lateral side of the foot by the strain effect over long plantar ligament.^[26]

In this current analysis, after follow-up, no patients related calcaneocuboid pain on palpation and attempted range of motion of this joint. There was also no radiographic evidence of degenerative arthritis at this joint level in any of the 22 patients, based on review of plain films obtained at the time of latest follow-up.

Davitt et al,^[27] 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 hindfoot 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 Good result is supposed to occur in a properly selected patient, if the technique is done meticulously with adherence to the details of the operative steps and good postoperative care and follow up

CONCLUSION

According to these results, we can conclude that Lateral calcaneal lengthening osteotomy with tendon achilis lengthening is relatively simple, effective procedure in treating flexible flatfoot in pediatric age. The objective of the technique was achieved. Good alignment and improvement in sagittal and hind foot motion was observed. Such an improvement in AOFAS score has been previously reported.

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