

Short Term Outcomes of Cuboid Closing Wedge Osteotomy with Percutaneous Soft Tissue Release in Resistant and Relapsed Cases of Clubfoot - A Prospective Study of Forty-four Feet

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Abstract

Background: Recurrences and relapses are formidable aspects of clubfoot management. Most cases present with stiff, nonreducible feet which do not respond to conservative treatment. To treat these difficult cases, a procedure that addresses both soft tissue and bony restraints, provides sustained correction with minimal complications would be ideal. This prospective study was carried to evaluate the outcome of cuboid osteotomy with percutaneous soft tissue release as an effective procedure in difficult clubfeet in children younger than five years.

Material and Methods: The study cohort consisted of 44 feet in 29 children in whom the forefoot adduction and midfoot cavus relapsed or persisted after Ponseti method of casting or previous surgeries. In addition to clinical evaluation by modified Pirani scoring, comprehensive radiological evaluation was performed before after the surgery. Patients underwent a percutaneous five-point release of the posteromedial soft tissues followed by a mini-open lateral closing wedge cuboid osteotomy and fixation with K-wires. Patients were followed up for mean of 29 months (23-58 months).

Results: Mean age at the time of surgery was 42 months (8-59 months). In all cases Pirani score improved by minimum of two points, reaching full correction in 88% (n=37). Straightening of the lateral border of the foot was achieved in 91% feet (n=40). Marked improvements were also seen in radiological parameters viz. talus-1st MT angle in AP (by 20.5°, p<0.001), calcaneum-5th MT angle in AP (by 18.6°, p<0.001), talus-1st MT angle in lateral views (by 14.5°, p<0.001) and calcaneum-1st MT angle in lateral views (by 12.2°, p<0.001). There was no recurrence of the deformity. Only one case had superficial wound dehiscence which healed in one week with regular care.

Discussion and Conclusion: Percutaneous release of postero-medial soft tissues coupled with lateral column shortening has consistently provided instant, sustained correction in our study. Relative ease, safety and low rates of complications or recurrences make the procedure an attractive option for managing difficult clubfeet especially in those younger than five years.

Keywords: Clubfoot, Cuboid Osteotomy, Percutaneous Release.

Introduction

Clubfoot is the commonest congenital musculoskeletal disorder. With 1,50,000 children born with it each year, the global burden of the disease is tremendous because of its consequent disability with financial loss and social stigma if left untreated [1]. Fortunately, with the advent of the Ponseti Technique, the management of clubfoot has become effective, affordable and easy to accomplish [2]. However, the very cause of

the disease being multifactorial, ranging from collagen abnormalities to neuromuscular disorders, all clubfeet do not respond uniformly to Ponseti protocol of serial casting, tenotomy and bracing. Some feet may initially show response, yet relapse as soon as the treatment is completed. A relapsed clubfoot is defined as any foot requiring further intervention following successful correction with the Ponseti technique. [3]. A foot is considered resistant

conservative treatment [4].

Ponseti himself said that regardless of the mode of treatment, the clubfoot has a strong tendency to relapse especially some feet which Ponseti labelled as "severe and stiff with small calf size" [5]. Relapse rate in Ponseti method has been variously stated to range from 5 to 41% [6]. These relapsed clubfeet pose unique difficulties. Soft tissues adapt to the increasing body mass of the growing child and effect of weight bearing. Gradually bony changes take place including overgrowth of the lateral column of the foot. In such a stiff deformed foot, only casting is not likely to be entirely effective.

Various surgical procedures have been described for correction of deformities. Each technique has its own advantages and drawbacks.

Soft tissue releases have been described for clubfeet. They can bring the clubfoot to acceptable alignment so long as bony architecture maintains some degree of conformity. When columnar disparity occurs

when the deformity shows no evidence of further improvement after three months of adequate

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Table- I: Change in Clinical & Radiological Parameters

Parameters	Initial (Sd)	Final (Sd)	Mean improvement (Sd)	P Value
Pirani score	2.7 (± 0.6)	0.3 (± 0.3)	2.4 (± 1.2)	<0.001
Talus 1st MT angle in AP (TFMA-AP)	25.2 (± 13.4)	4.7 (± 5.2)	20.5 (± 13.5)	<0.001
Calcaneum 5th MT angle (CFMA-AP)	21.7 (± 11.7)	3.1 (± 4.6)	18.6 (± 13.4)	<0.001
Talus 1st MT angle in Lat (TFMA-L)	22.9 (± 13.9)	8.4 (± 7.2)	14.5 (± 11.4)	<0.001
Calcaneus 1st MT angle in Lat (CFMA-L)	28 (± 13.1)	15.8 (± 8.9)	12.2 (± 10.1)	<0.001

due to lateral overgrowth, which becomes clinically evident as forefoot adduction, midtarsal osteotomies are required. Combined procedure of lengthening of the medial column and shortening the lateral column would seem to be the optimum treatment. However, operating on both sides of the foot and forcing correction by stretching of the medial side puts contracted medial soft tissues at risk of dehiscence.

Hence we proposed that a percutaneous posteromedial soft tissue release would avoid wound related complications frequently associated with an open dissection and when combined with a trans-cuboid lateral column shortening osteotomy will bring about the full correction of all the deformities. So, with the primary objective of evaluation of outcome of the procedure we carried out the prospective study.

Material and Method

Twenty nine consecutive children younger than five years with resistant or relapsed clubfoot were enrolled for the study. A total of forty four feet in these 29 subjects were thus included in the study. Inclusion criteria consisted of: presence of forefoot adduction or mid foot cavus deformities have recurred due to any reason after full correction, or b) deformities were not corrected by any conservative treatment by Ponseti technique or operative techniques. Such previous intervention on the study cohort consisted of Ponseti casting & tenotomy (n=19), operative techniques, which consisted of soft tissue release (n=12), JESS fixation (n=2),

bony procedures (n=2) and tibialis anterior transfer (n=2). We also included 7 feet of neglected cases which were not treated previously by any of the methods. These feet were clinically evaluated using the Pirani Scoring. A comprehensive radiological evaluation was performed before and after the surgery. This consisted of talus-first metatarsal angle (TFMA-AP) and calcaneum-fifth metatarsal angle (CFMA-AP) in standing AP views and talus-first metatarsal angle (TFMA-L) and calcaneum-first metatarsal angle (CFMA-L) in weight-bearing lateral radiographs.

The patients were operated under general anaesthesia with a caudal block for postoperative pain control. We used tourniquet for a blood less field during dissection. The first stage consisted of percutaneous "Five Point Release" of the tight posteromedial structures. These structures which impede correction are namely the Tendo Achilles, tibialis posterior, plantar fascia, abductor hallucis, and the long toe flexors. This was followed by a transverse incision along the dorsolateral aspect of the foot, centring over the cuboid. The extensor digitorum brevis was separated from its origin on the lateral side of the calcaneus and retracted towards the top of the foot, thus giving exposure of the cuboid, anterior portion of the calcaneus, and the neck of the talus. Two K wires were passed through the cuboid to assess the amount of wedge to be resected. The proximal K wire was perpendicular to the axis of the hindfoot and the distal one perpendicular to that of the

forefoot. A dorsolaterally based wedge from the cuboid was resected using the K wires as the guide. When the gap was closed, the k wires essentially became parallel and the normal axis of the foot was achieved. The closure of the lateral cuboid wedge was also accompanied by the rotation of the forefoot, which corrected adduction and supination. The osteotomy site was secured with two k wires passing through the osteotomy site. Wound was closed and the limb was kept in an above knee plaster slab for initial two weeks. At two weeks sutures were removed and below knee plaster was applied and kept for subsequent four weeks. At six weeks, K wires were removed as the osteotomy site had healed by then. Gait training and progressive full weight bearing with ankle foot orthoses were encouraged. Orthoses were gradually weaned off and patients continued with regular footwear. For radiological evaluation, serial radiographs starting from six weeks postoperative and every three months thereafter were taken to assess the same parameters as that of the preoperative evaluation. Patients were followed up for a mean period of 29 months (23-58 months)

Along with Pirani Score, pain or difficulty in walking if any, were noted. Ease of wearing normal foot wear was assessed. Parents' satisfaction with the appearance and function of the foot was also evaluated.

For statistical analysis was performed using Chi Square test, paired t test & Student t tests. Statistical significance was set at 99% confidence interval (p=0.01).

Observation and Results

Amongst the study cohort, there were twenty one boys eight girls. Mean age at the time of surgery was 42 months (range 8-59 months). Fifteen cases were bilateral and the rest unilateral.

Pirani score in all cases improved by minimum of two points, the mean improvement being 2.4 ± 1.2 points which was statistically significant ($p < 0.001$) (Table 1). Full correction was achieved in 88% cases. Straightening of the lateral border of the foot was achieved in 91% feet ($n=40$). Marked improvements were also seen in radiological parameters viz. talus-1st MT angle in AP (by a mean of $20.5^\circ \pm 13.5$, $p < 0.001$), calcaneum-5th MT angle in AP (by $18.6^\circ \pm 13.4$, $p < 0.001$), talus-1st MT angle in lateral views (by $14.5^\circ \pm 11.4$, $p < 0.001$) and calcaneum-1st MT angle in lateral views (by $12.2^\circ \pm 10.1$, $p < 0.001$). There was no recurrence of the deformity. All patients were able to bear weight on a painless plantigrade feet and could use regular shoes.

Complications

None of the patients suffered from any major complications like infection, loss of fixation, displacement of the osteotomy or non-union at the osteotomy site. Only one case had superficial wound dehiscence which healed in one week with regular care. One case had residual equinus deformity of 10° which was found to be due to flat topped talus, unrelated to the surgery.

Discussion

The ultimate goal of treatment of a clubfoot is to achieve a functional, pain-free plantigrade foot with good mobility. However in recurrent or resistant cases, achieving this goal becomes progressively challenging. The effectiveness of Ponseti method diminishes with increasing age of the child. [7]. Penny has described how the effect of weight bearing exaggerates the existing equinus, varus and cavus deformities eventually rendering it non-reducible. [8]. This happens because the lateral column of the foot (calcaneus plus cuboid) elongates more than the medial one (talus, navicular, and cuneiform) and in that process the bones lose their natural reciprocal conformity. [9,10] After finding the obvious limitations of conservative methods to treat relapsed and resistant clubfeet, many surgeons devised

soft-tissue release procedures [11,12]. But it was found that although STR can be used to correct some cases of resistant clubfoot [12-14], in patients with bony deformity and columnar disparity, it can at most, provide only partial correction. Extensive STRs may have short-term complications, and as much as 47% of patients may undergo additional surgery [15,16].

Bony procedures have the ability to restore the normal foot alignment through equalisation of the columnar length and thus provide a definitive solution to resistant deformities. This involves shortening the lateral column and/or lengthening of the medial column. Combination of these midfoot osteotomies and soft tissue releases can correct the hindfoot deformities also. This is possible by elongation of medial flexors, invertors and by direct reduction of the navicular bone over the head of the talus. [17]

The complex deformities of the foot can be corrected by number of ways. Shortening the lateral column by resecting wedge of bone from the midtarsal region is effective in aligning the foot. Bone can be removed by resecting distal part of calcaneum (Lichtblau procedure), cuboid enucleation or by a formal dorsolaterally based wedge subtraction osteotomy of cuboid. Conversely, the medial column can be lengthened by opening wedge osteotomy of the medial cuneiform bone. These two procedures can be combined together whereby the wedge removed from the cuboid is grafted into the distracted osteotomy gap of the medial cuneiform.

Whatever procedure is performed, the resultant foot should be plantigrade, articular surfaces should be preserved to prevent further stiffness and the growth potential of the bone should be left undisturbed. In addition the procedure should provide one-time correction so that no further surgeries are required later in life. Medial cuneiform opening osteotomies are more appropriate for children older than four years as the ossific nucleus does not appear till then and the bone remains soft, leading to higher incidence of graft extrusion and reoperation rates [18]. According to Gordon et al. [19], this procedure should be reserved for patients aged 5 years or older because the medial osteotomy is technically difficult in a small, partially ossified cuneiform. Lourenco et al. [20] treated 39 feet with a closing who

achieved good results with this dual column osteotomy. He stressed the importance of a well formed medial cuneiform ossification centre for which appears when the child is at least four years old.

Another difficulty with acute lengthening of the medial column is that the procedure is likely to stretch the skin and soft tissues which have so long remained contracted, to an extent beyond their elastic limit. Results from the arteriography study by Greider et al. [21] in children with clubfoot showed there is only one major vessel supplying the foot: the posterior tibial artery. While performing surgery on the medial side the vessel may get injured unless protected. Also, undue stretching of the medial side at attempt to correct a severely deformed foot may result in segmental thrombosis of the artery. This can seriously affect the outcome of the surgery. Following the correction of severe deformities, problems with skin closure can also occur [18].

Much of these potential difficulties can be avoided if posteromedial releases are performed using percutaneous technique to make the foot more mobile and then performing a formal lateral closing wedge osteotomy to accomplish columnar alignment. No patient in our study suffered from any medial soft tissue related problems. The present study reflects that correction of deformities can be achieved by percutaneous releases even without opening the critical medial aspect of the foot.

At the end of the study period, all our patients walked with a painless plantigrade and supple foot. There was no recurrence or persistence of deformity and hence none of the cases had to undergo surgery. Ninety-one percent feet achieved a straight lateral border. In the rest nine percent cases, the calcaneus-5th metatarsal angle was less than 10 degrees and hence were acceptable in appearance and function.

In the series published by Loza where double column osteotomy was performed, the mean post-operative radiographic angles were: talus first metatarsal angle in AP view (TFMA-AP) -7° (-10° to 25°), Calcaneus Fifth Metatarsal angle in AP view (CFMA-AP) was 9° (10° – 20°), lateral talo-first metatarsal angle (TFMA-L) was 11° (0° – 29°) [22]. The corresponding values of the parameters in our study were: TFMA-AP was 4.7° (-5° – 17°), CFMA-AP was 3.1° (-8° – 18°), TFMA-L was 8.5° (-2° – 28°),

which are comparable to that of Loza et al. It means that even with a single column osteotomy with a selective medial release, a correction comparable to double column osteotomy can be achieved.

Arjandas et al performed a retrospective analysis of 14 feet in children younger than five years having a persistent “bean shape” deformity despite treatment by Ponseti method [23]. Each was operated with using a combination of a closing wedge cuboidal osteotomy and trans-midfoot osteotomy without a medial opening wedge osteotomy. At the end of the last follow up (mean 2.6 years) the mean TFMA-AP was 12, CFMA-AP was 10, TFMA-L was 8 and CFMA-L was 13. These figures are comparable to those of our study. Marginally more correction (especially talus-first metatarsal angle in AP view, which reflects extent of adduction deformity), achieved in our study may be the result of Percutaneous medial release

performed by us.

Similar results were also shown by Cesare et al (2012) in their study with 53 neglected rigid non-reducible clubfeet in children 6-9 years in whom, selective medial soft tissue release with lateral closing wedge cuboid osteotomy was performed [17].

The study however had some limitations. It was a study from a single institute. Another shortcoming of the study was short duration of follow up. The long term outcome of the study remains to be assessed. Pohl and Nicol reported one case of recurrence at 2 years [24], Schaefer and Hefti observed a tendency to adduction deformity with longer followup. Hence, following these patients for a longer duration would be more desirable [25].

Conclusion

Thus the procedure of lateral closed wedge osteotomy of the cuboid with medial

percutaneous soft tissue release has shown consistently good overall results in terms of deformity correction, painfree weight bearing and preserving range of movement. Ease of the procedure, short period of convalescence, exceedingly low recurrence rates and complications are the attractive attributes of the procedure which make it ideal for children younger than five years with resistant or recurrent clubfoot.

Clinical Message

The findings of the present study reveal that surgical procedure of percutaneous soft tissue release with lateral closing wedge osteotomy of the cuboid is effective in managing recurrent and relapsed cases of clubfoot, while minimising the complications and rates of recurrence or reoperation. This could be the optimal answer to the entity of difficult clubfoot which has so long been a challenge to the orthopaedic surgeons.

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