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Radiological Outcomes Of Ligamentotaxis By Gradual Distraction And Soft Tissue Operation In Cases Of Recurrent And Resistant Club Foot

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Abstract

Introduction: Clubfoot, sometimes referred to as congenital talipes equinovarus (CTEV), is a complicated malformation that manifests as cavus, adductus, varus, and equinus of the foot. About 1 in 1000 live babies are affected, and if left untreated, it can cause severe functional impairment and irregularities in gait.
Aims: To evaluate the radiological outcomes of ligamentotaxis using gradual distraction combined with soft tissue procedures in cases of recurrent and resistant clubfoot, and to assess the effectiveness of this approach in achieving correction of deformity.
Materials & Methods: The study was a prospective interventional observational study conducted in the Orthopaedics Department of IPGME&R and SSKM Hospital, Kolkata, over a 20-month period from September 2022 to May 2024, including a total of 20 patients.
Result: In our study, post-operative radiological assessment showed significant correction in lateral view angles: talo-calcaneal increased from 14.91 ± 4.88 to 32.77 ± 4.45, while tibio-calcaneal and calcaneal pitch angles decreased from 111.11 ± 7.61 to 71.86 ± 8.7 and 35.06 ± 3.19 to 19.72 ± 4.17, respectively ($P < 0.0001$).
Conclusion: We came to the conclusion that the majority of patients had recurrent and resistant clubfoot, were between the ages of 24 and 30 months, were more likely to be male, and had involvement on the right side. Effective three-dimensional correction of the deformity was demonstrated by radiological results, which indicated a considerable rise in talo-calcaneal angles (AP and lateral views) and a decrease in talo-first metatarsal, tibio-calcaneal, and calcaneal pitch angles after surgery.

Keywords: Ligamentotaxis, Recurrent clubfoot, Gradual distraction, Soft tissue release and Calcaneal pitch.

INTRODUCTION

Clubfoot, sometimes referred to as congenital talipes equinovarus (CTEV), is a complicated malformation that manifests as cavus, adductus, varus, and equinus of the foot. About 1 in 1000 live babies are affected, and if left untreated, it can cause severe functional impairment and abnormalities in gait [1,2]. A subset of individuals come with recurrent, ignored, or resistant abnormalities that do not respond to standard conservative or surgical therapies, despite the fact that the Ponseti approach has transformed the early therapy of idiopathic clubfoot with great short- and long-term results [3,4]. While neglected cases are abnormalities that are left untreated after infancy, leading to hard soft tissue contractures and altered bony architecture, recurrent clubfoot usually results from non-compliance or inadequate bracing [5]. Deformities that do not improve with repeated manipulations or soft tissue releases are referred to as resistant clubfoot, and they frequently call for more involved operations [6,7]. A thorough strategy that takes into account the osseous and soft tissue aspects of the deformity is necessary for the management of these difficult situations. In this situation, ligamentotaxis with external fixation for gradual correction has proven to be a useful method [8]. Ligamentotaxis, which promotes bone and joint alignment without requiring lengthy open releases, enables the gradual stretching of constricted ligaments and tendons. It is based on the notion of tissue remodeling under controlled mechanical stresses. Differential distraction is made possible by systems like Joshi's External Stabilization

System (JESS), which offer accurate, incremental treatment based on the rigidity and severity of the deformity. This technique is especially appropriate for recurring or resistant abnormalities because it lowers the risk of neurovascular damage and permits simultaneous treatment in numerous planes. Ligamentotaxis is frequently used in conjunction with adjunctive soft tissue techniques, such as percutaneous Achilles tendon lengthening, posterior tibial tendon release, and plantar fascia release, to accomplish total correction. Selective soft tissue release combined with progressive distraction maximizes functional results and reduces the need for severe surgical exposure, which raises the possibility of skin problems, stiffness, or scarring. Study aims to evaluate the radiological outcomes of ligamentotaxis using gradual distraction combined with soft tissue procedures in cases of recurrent and resistant clubfoot, and to assess the effectiveness of this approach in achieving correction of deformity.

MATERIALS AND METHODS

Type of Study: Prospective interventional observational study.
Place of Study: Orthopaedics department of IPGME&R and SSKM Hospital, Kolkata
Study Duration: From September 2022 to May 2024
Sample Size: 20 patients
Inclusion Criteria:

- Patients diagnosed with recurrent or resistant congenital clubfoot.
- Age between 18 months and 5 years.
- Patients with rigid deformities not responding to previous conservative or surgical treatments.
- Patients whose caregivers consented to participate in the study and follow-up.
- Patients suitable for ligamentotaxis with gradual distraction and soft tissue procedures based on clinical and radiological assessment.

Exclusion Criteria:

- Patients with syndromic, neuromuscular, or idiopathic clubfoot associated with other congenital anomalies.
- Age below 18 months or above 5 years.
- Patients with active infection or skin lesions at the foot or leg.
- Patients unfit for surgery or anaesthesia due to systemic illnesses.
- Patients with inadequate follow-up or those who do not consent to participate.

Study Variables:

- Age (months)
- Sex
- Laterality of involvement
- Type of clubfoot
- Talo-calcaneal angle
- Talo-first metatarsal angle

Statistical Analysis:
Data Were Entered Into Excel And Analyzed Using SPSS And Graphpad Prism. Numerical Variables Were Summarized Using Means And Standard Deviations, While Categorical Variables Were Described With Counts And Percentages. Two-Sample T-Tests Were Used To Compare Independent Groups, While Paired T-Tests Accounted For Correlations In Paired Data. Chi-Square Tests (Including Fisher's Exact Test For Small Sample Sizes) Were Used For Categorical Data Comparisons. P-Values ≤ 0.05 Were Considered Statistically Significant.

RESULT

Table: 1. Age Distribution

Age group (Months)	No of patients	Percentage	Mean & SD	p-value
24 – 30 months	18	90	27.50 ±2.76	< .00001
31 – 34 months	2	10		
Total	20	100		

Table: 2. Sex Distribution

Sex	No of patients	Percentage	M : F ratio	p-value
Male	12	60	1.5:1	.00466
Female	8	40		
Total	20	100		

Table: 3. Side involvement

Sex	No of patients	Percentage	p-value
Right	11	55	.15854
Left	9	45	
Total	20	100	

Table: 4. Comparison between Pre and Post-operative Radiological investigations (angles) AP View and Lateral views

		Pre-operative		Post-operative		P- Value
		Mean	SD	Mean	SD	
Radiological investigations (angles) AP View	**Talo- calcaneal**	18.98	4.28	30.48	3.71	<0.0001
	Talo-first metatarsal	25.73	6.92	3.43	3.8	<0.0001
Radiological investigations (angles) Lateral views	**Talo-calcaneal**	14.91	4.88	32.77	4.45	<0.0001
	Tibio- calcaneal	111.11	7.61	71.86	8.7	<0.0001
	Calcaneal- pitch	35.06	3.19	19.72	4.17	<0.0001

Figure: 1. Comparison between Pre and Post-operative Radiological investigations (angles) AP View

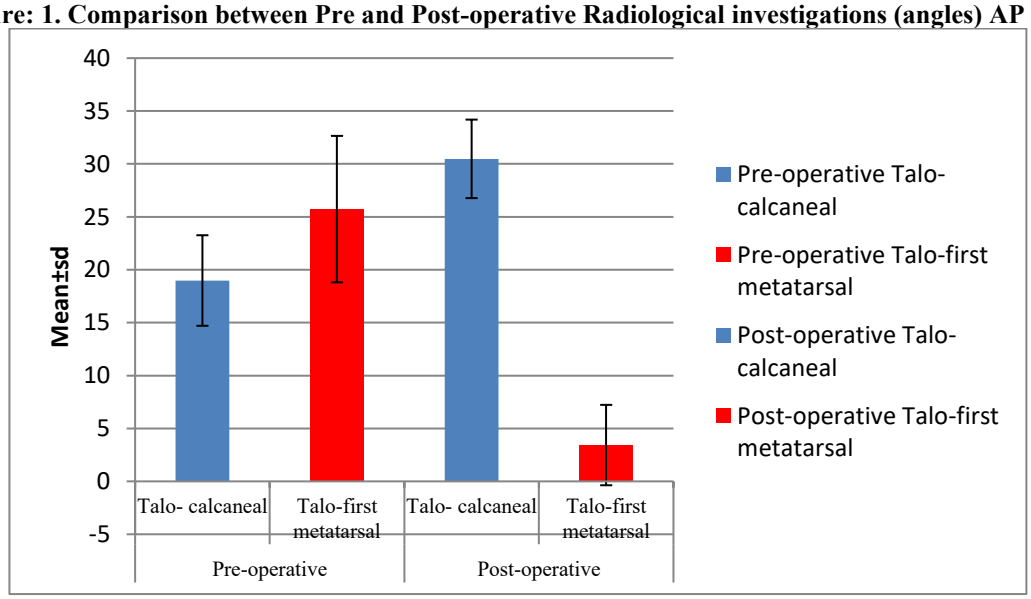
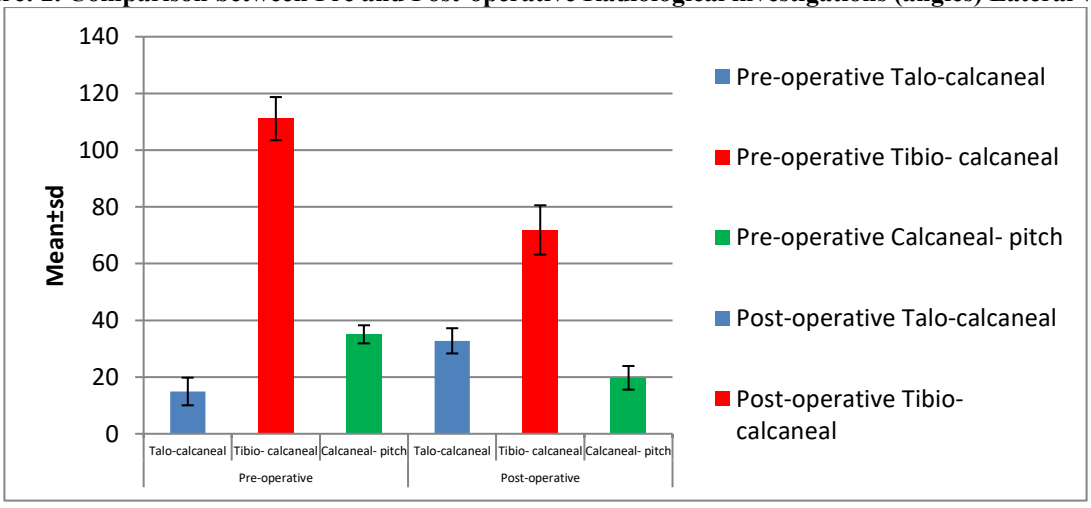


Figure: 2. Comparison between Pre and Post-operative Radiological investigations (angles) Lateral views



In this study, out of a total of 20 patients, 18 (90%) were in the 24–30 months age group, while 2 (10%) were between 31–34 months. The mean age of the study population was 27.50 ± 2.76 months. The difference in age distribution between the groups was statistically significant ($p < 0.00001$). Out of 20 patients, 12 (60%) were males and 8 (40%) were females, with a male-to-female ratio of 1.5:1. The difference in sex distribution was found to be statistically significant ($p = 0.00466$). In this study, 11 patients (55%) involved the right side and 9 patients (45%) involved the left side. The difference in laterality was not statistically significant ($p = 0.15854$). In our study, the mean talo-calcaneal angle (AP view) was higher in the post-operative group (30.48 ± 3.71) compared to the pre-operative group (18.98 ± 4.28), while the mean talo-first metatarsal angle (AP view) was lower post-operatively (3.43 ± 3.80) compared to pre-operatively (25.73 ± 6.92). Both differences were statistically significant ($P < 0.0001$). In our study, the mean talo-calcaneal angle (lateral view) was higher in the post-operative group (32.77 ± 4.45) compared to the pre-operative group (14.91 ± 4.88). Similarly, the mean tibio-calcaneal angle decreased from 111.11 ± 7.61 pre-operatively to 71.86 ± 8.7 post-operatively, and the mean calcaneal pitch angle decreased from 35.06 ± 3.19 to 19.72 ± 4.17 post-operatively. All differences were statistically significant ($P < 0.0001$).

DISCUSSION

In our study, out of 20 patients most of the patients were 24 – 30 months old [18 (90.0%)] which was statistically significant ($p< .00001$) and the mean Age of patients was [27.50±2.76] in similar study by Heer J et al. [9] (2021), which reported that the mean age of patients undergoing treatment for neglected, recurrent, or resistant clubfoot was 4.79 years (approximately 57.5 months). This suggests that while early intervention is ideal, a significant number of cases requiring ligamentotaxis treatment present at older ages.

We found that, male population was higher [12(60.0%)] than the female population [8(40.0%)]. Male: Female ratio was 1.5:1 but this was not statistically significant ($p=.00466$).In other study by Tileston K et al. [10] (2022) reported that 60.2% of clubfoot patients were male, with a male-to-female ratio of 1.51:1.

We observed that, most number of patients had right side sex involvement [11 (55.0%)] it was statistically significant ($p=.15854$).In similar study İğrek S et al. [11] (2022) reported that in unilateral clubfoot cases, the right foot was more frequently affected, with 61.5% of patients having right-sided involvement

In similar study by Ishii Y et al.[12] (2021) highlighted the significance of baseline bone mineral density (BMD) and bone turnover in patients undergoing total knee arthroplasty, suggesting that preoperative BMD assessments can inform surgical planning and postoperative care.

We observed that the mean talo-calcaneal angle AP was higher in the post-operative group (30.48 ± 3.71) compared to the pre-operative group (18.98 ± 4.28). This difference was statistically significant ($P < 0.0001$). In other study by Yasin MS et al [13] (2025) found that significant improvements in talo-calcaneal angles following calcaneal osteotomy for flexible flatfoot correction.

We found that the mean talo-first metatarsal angle AP was lower in the post-operative group (3.43 ± 3.80) compared to the pre-operative group (25.73 ± 6.92). This difference was statistically significant ($P < 0.0001$). In similar study by Yontar NS et al.[14] (2016) observed that significant reductions in talo-first metatarsal angles following surgical correction of flexible flatfoot deformi

We showed that the mean talo-calcaneal angle Lateral views was higher in the post-operative group (32.77 ± 4.45) compared to the pre-operative group (14.91 ± 4.88). This difference was statistically significant ($P < 0.0001$). In other study by Kim S et al [15] (2024) found that significant improvements in lateral talo-calcaneal angles following calcaneal osteotomy for flexible flatfoot correction.

We observed that the mean tibio-calcaneal angle Lateral views was lower in the post-operative group (71.86 ± 8.7) compared to the pre-operative group (111.11 ± 7.61). This difference was statistically significant ($P < 0.0001$).

We found that the mean calcaneal pitch angle Lateral views was lower in the post-operative group (19.72 ± 4.17) compared to the pre-operative group (35.06 ± 3.19). This difference was statistically significant ($P < 0.0001$).

CONCLUSION

We concluded that the majority of patients with recurrent and resistant clubfoot were between the ages of 24 and 30 months, had a higher percentage of males, and had involvement on the right side. Effective three-dimensional correction of the deformity was demonstrated by radiological results, which indicated a considerable rise in talo-calcaneal angles (AP and lateral views) and a decrease in talo-first metatarsal, tibio-calcaneal, and calcaneal pitch angles after surgery. According to these results, ligamentotaxis with progressive distraction and selective soft tissue release is a safe and efficient way to treat complex clubfoot abnormalities, improve radiological results, and restore the foot's functional alignment.

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