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A STUDY ON NEED OF TENDO-ACHILLIS TENOTOMY IN INFANT WITH CLUB FOOT DEFORMITY AND ITS SONOGRAPHIC EVALUATION

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Abstract:

Background: Congenital talipes equinovarus (CTEV), commonly known as clubfoot, is a prevalent musculoskeletal deformity in newborns. The Ponseti technique has emerged as a leading treatment approach for correcting clubfoot deformities, involving serial casting and percutaneous Achilles tendon tenotomy. While clinical assessment tools like the Pirani scoring system have been widely used, sonographic evaluation offers a non-invasive, radiation-free alternative for assessing clubfoot deformities and treatment outcomes.

Methods:A prospective observational study was conducted on 60 infants with idiopathic congenital clubfoot treated with the Ponseti technique. Sonographic parameters including tibio calcaneal distance, metaphyseal tibio calcaneal angle, and talo calcaneal angle were evaluated pre-treatment, post-treatment, and during follow-up. Additionally, clinical parameters such as the Dimeglio score and Achilles tendon length were assessed.

Results: Significant improvements were observed in sonographic parameters and clinical scores from pre-treatment to post-treatment and follow-up. The Dimeglio score showed a marked reduction, indicating successful correction of clubfoot deformities. Sonographic measurements revealed enhanced equinus correction and tendon healing, supporting the efficacy of the Ponseti technique. Furthermore, a strong correlation was found between clinical severity grading and sonographic measures.

Conclusion: Sonographic examination offers a valuable imaging tool for assessing clubfoot deformities, providing detailed insights into the location and severity of deformities and guiding treatment decisions. The study underscores the effectiveness of the Ponseti technique in correcting clubfoot abnormalities and highlights the potential of sonography as a radiation-free alternative to radiography for evaluating treatment outcomes. Future research should focus on extended follow-up evaluations and exploring advanced imaging techniques for comprehensive assessment of clubfoot repair.

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Keywords: Clubfoot, Ponseti technique, Percutaneous Achilles tendon tenotomy, Serial casting, Sonographic evaluation

INTRODUCTION

Congenital Talipes refers to a medical condition present at birth that affects the positioning of the feet.EquinoVarus (CTEV) is the most prevalent congenital musculoskeletal deformity (1). Idiopathic congenital clubfoot is a condition where the foot is misaligned in a complex manner, affecting both the soft and bony portions. It is characterized by the foot being turned downwards and inwards, with a high arch in the middle and front parts of the foot, and the foot being pulled towards the midline of the body.(1-2) Kite was the initial advocate for employing delicate manipulation and immobilization with casts.Ponseti identifies two factors contributing to the unsatisfactory outcomes observed with Kite's method. Initially, by utilizing the calcaneocuboid joint as the pivot point, the movement of the calcaneus away from the midline is hindered, thereby impeding the outward rotation of the calcaneus. Furthermore, pronation Attempting to repair the cavus of the forefoot actually exacerbates the condition. Ponseti's technique has emerged as the prevailing and highly efficient treatment method for correcting congenital talipes equinovarus (CTEV) in newborn infants. The treatment involves applying weekly plaster casts to extend the tendoachilles, followed by a percutaneous tenotomy procedure. Achilles tenotomy is required in 70-80% of instances following effective treatment of forefoot adduction and heel varus [1-3]. Later, other techniques for assessing deformities and evaluating therapy progress were created. The Pirani scoring system is a clinical assessment tool that is simple to use and demonstrates a high level of consistency, with only minimal differences between different observers.

MATERIALS AND METHODS

This prospective observational study was carried out at the Department of Orthopaedics of central India. Achilles tendon tenotomy in infants with idiopathic clubfeet receiving treatment with Ponseti technique of correction. Children under the age of one who have the idiopathic congenital talipes equinus deformity and who have fully corrected their forefoot and midfoot abnormalities with the Ponseti procedure were included. Children who have had any sort of CTEV corrective surgery in the past, CTEV relapsed, A secondary cause of CTEV that is related were excluded.

Procedure

This study follows some specific procedure to diagnose and treat the clubfoot. In this research forty-one children with clubfoot are considered for this experimental study.The procedure of diagnosing clubfoot is as follows:

• The study was conducted on 60 consecutive children who presented to the Orthopaedics OPD with congenital idiopathic clubfoot and obtaining informed consent from their parents or guardians.

• On the first day of presentation, all children underwent serial casting every two weeks to rectify any adduction or supination deformities. The Ponseti technique of correction frequently results in residual equinus deformity, which requires surgical correction in the

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form of an Achilles tendon tenotomy. every deformity has been completely fixed except for equinus.

• At this stage, the front calcaneus can be moved out from beneath the talus. The foot may be securely dorsiflexed due to this abduction without risking crushing the talus between the calcaneus and tibia. Apply another or two casts to be assured if the effectiveness of the abduction is in doubt. Before conducting tenotomy, make sure the foot is sufficiently abducted to allow for 0 to 5 degrees of dorsiflexion.

• A pre op clinical and sonographic examination is performed within 10 days after the anticipated surgical surgery. The Sagittal Posterior Medial coronal, and Lateral coronal are three conventional projections. Studying the anatomical correlations between the distal tibial physis, talus, and calcaneum will produce repeatable images of the evaluated parameters.

• The transducer was positioned vertically on posterior border of Achilles tendon for scans in the sagittal posterior plane. Sonography along this plane enabled for direct visualisation of the posterior cartilaginous anlage shadowing of the talus, tibial metaphysis, and calcaneus. The relation between aforementioned cartilaginous anlages of the foot's posterior. Despite the fact that all club foots were fixed in equinus, dorsiflexion was still limited depending on the degree of deformity. The distal tibia metaphysis and calcaneal apophysis, often known as the Talo-Calcaneal divergence, are the points used to measure the ankle and subtalar range of motion. By selecting the cartilaginous anlage's flat surface and drawing a line connecting the points on it that is perpendicular to the surface, it is possible to determine the metaphyseal tibio calcaneal angle and the talo-calcaneal angle. The average of the two longitudinal measurements of the angle made using a medial and lateral approach, and complete dorsiflexion and plantar flexion to simulate the Ponseti technique.

• A specialist orthopaedic surgeon will be in charge of the in-patient surgery, which will be carried out while under general anaesthesia. After preparing and draping, choose a tenotomy blade, such as #12 or #11, as the helper supports the thigh with one hand and the foot from the toes with the other. A beaver blade was used to make incisions about 1 cm from the tendon insertion, progressing from medial to lateral and from deep to superficial while the assistant maintained maximum dorsiflexion of the foot. The posterior position of the blade was chosen to avoid the posterior tibial neurovascular bundle and adjacent tendons, and extra care was made to prevent placing the blade any deeper than required. A clear increase in ankle dorsiflexion and a matching palpable space between the ends of the split tendon were both clinical indicators of a successful tenotomy in each foot. Steer clear of cutting into the calcaneus cartilage. The tendon is freed with a "pop". After the tenotomy, approximately 20 to 25 more degrees of dorsiflexion are obtained. tenotomy cast after the foot should be 60 to 70 degrees adducted from the frontal plane of the ankle when the final cast is applied. Take note of the foot's severe thigh-to-foot abduction and its overcorrected posture. Never does the foot pronate. After the repair is complete, this cast is remained in place for three weeks.

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• After three weeks in the corrective cast, the cast will be removed, and the clinical improvement will be evaluated using Dimeglio scoring system and sonographic analysis for the aforementioned criteria in addition to others including healing, integrity, and strength positioned far from the tenotomy site to assess the integrity of tendon. If the tendon was continuous, the result was reported as normal; if it was difficult to clearly distinguish a tendon, it was documented as uncertain; and if there was a discontinuity, it was recorded as non-existent. All measurements will be made using simulated Ponseti manoeuvres for the different parameters listed above in neutral position with maximum correction. Achilles tendon length, echogenicity, echotexture, thickness of the posterior soft tissue structures, and posterior hyperechoic fibrillar structure were all noticed. The ability of a tendon to resist deforming pressures during dynamic evaluation is a sign of its strength.

• Children will be given a maintenance orthosis in the form of splints and monitored for three months following the surgery. At this time, the clinical and sonographic parameters as mentioned above will be once again evaluated, and values will be recorded.

Clinical Parameters

Classification of Clubfoot Severity

A hand-held goniometer is used to measure the reducibility of four parameters under moderate manipulation.

1. Varus deformity in coronal plane.
2. Forefoot Adduction in horizontal plane.
3. Equinus deformity in sagittal plane.
4. Derotation of Calcaneopedal block in horizontal plane.

Depending on the degree of the malformation, each one is rated from 1 to 4. Additional factors taken into account includes:

1. Posterior crease
2. Poor muscle condition
3. Cavus
4. Mediolateral crease

RESULT

Table 1 presents patient and demographic characteristics of the study cohort comprising 60 patients and 89 feet. The age of the patients ranged from 3 to 12 months, with a mean age of -6.45 months and a standard deviation of 2.95 months, indicating that the majority of patients were infants. Gender distribution showed a predominance of males, with 45 males compared to 15 females. Among the feet, males accounted for 75, while females constituted 14. In terms of laterality, bilateral involvement was observed in 29 patients, while 31 had unilateral involvement. Among unilateral cases, 14 were on the right side, and 17 were on the left side. This table provides a concise overview of patient demographics, age distribution, gender representation, and laterality of clubfoot cases within the study population.

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TABLE 1. **PATIENT AND DEMOGRAPHIC CHARACTERISTICS.**

Patients	
Total number of patients	60
Total number of feet	89
Age in month	
Age	3 to 12 months
Mean	-6.45 +/- 2.95
Gender	
Male	45
Female	15
Feet Per Gender	
Male	75
Female	14
Laterality	
bilateral	29
unilateral	31
Side in Unilateral Cases	
Right	14
Left	17

Table 2 compares the distribution of cast application among patients undergoing treatment for clubfoot. It shows that the majority of patients, accounting for 86.67%, received 5-8 casts during their treatment. A smaller proportion, representing 10% of patients, required 8-10 casts, while only 3.33% of patients needed more than 10 casts. The total number of patients included in the analysis was 60, with a mean number of casts applied per patient of 7.00, with a standard deviation of 1.51. This table effectively summarizes the variability in the number of casts required for treating clubfoot among the study population.

Table 2. Comparison of cast application with number of patients.

Number of Cast applied	No. of patients	Percentage (%)
5-8	52	**86.67**
8-10	6	**10**
>10	2	**3.33**
Total	60	**100.0**

Mean ± SD: 7.00±1.51.

Table 3 presents the pre-operative level of plantar flexion observed among participants with clubfoot deformities. It indicates that 4.5% of feet had neutral plantar flexion, while the majority, accounting for 85%, exhibited plantar flexion ranging between 10 to 20 degrees. Additionally, 9.5% of feet displayed a higher degree of plantar flexion, falling within the range of 20 to 45 degrees. The total number of feet analyzed was 89, encompassing the entire spectrum of observed plantar flexion levels. This table succinctly illustrates the distribution

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of plantar flexion among participants, providing valuable insight into the pre-operative condition of clubfoot deformities in the study population.

Table 3. Observed participants' level of plantar flexion pre-operative.

Degree of plantar flexion	No. of feet	Percentage (%)
Neutral	4	**4.5**
10 – 20 degrees	76	**85**
20 – 45 degrees	9	**9.5**
Total	**89**	**100.0**

Table 4 presents the result analysis for the Dimeglio score, a method used to assess the severity of clubfoot deformities, before treatment (Pre), after treatment (Post), and during follow-up (FU). The table indicates significant improvements in Dimeglio scores for both left and right feet from pre-treatment to post-treatment and follow-up. The decrease in scores from pre to post-treatment and pre-treatment to follow-up was statistically significant ($p < 0.001$) for both feet. Additionally, there was a significant improvement in Dimeglio scores from post-treatment to follow-up for the left foot ($p = 0.005$) but not for the right foot ($p = 0.056$). These findings underscore the effectiveness of the treatment in reducing the severity of clubfoot deformities, as evidenced by the Dimeglio scores.

Table 4. Result analysis for Dimeglio score.

	Results			Significance		
Variables	**Pre**	**Post**	**FU**	**Pre-Post**	**Pre-FU**	**Post-FU**
Dimeglio score (left)	5.53±2.01	1.84±0.50	1.47±0.51	<0.001**	<0.001**	**0.005****
Dimeglio score (Right)	5.27±0.88	1.73±0.70	1.45±0.51	<0.001**	<0.001**	**0.056+**

FU: follow-up

Table 5 presents the evaluation of sonographic parameters at pre-treatment (Pre), post-treatment (Post), and follow-up (FU) combined for both right (R) and left (L) feet. It includes various variables such as the Dimeglio score, tibio calcaneal distance in neutral, plantar flexion, and dorsiflexion, metaphyseal tibio calcaneal angle in dorsiflexion and plantar flexion, talo calcaneal angle in plantar flexion and dorsiflexion, and talo calcaneal divergence in plantar flexion and dorsiflexion.

The results demonstrate statistically significant improvements across all variables from pre-treatment to post-treatment and follow-up, as indicated by p-values denoted with **. Additionally, the changes in tibio calcaneal distance in neutral and metaphyseal tibio calcaneal angle in plantar flexion showed statistical significance during follow-up (p-values denoted with *). Moreover, tibio calcaneal distance in plantar flexion and talo calcaneal divergence in dorsiflexion displayed a statistically significant improvement from pre-treatment to follow-up (p-values denoted with *). These findings underscore the effectiveness

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of treatment in improving various sonographic parameters associated with clubfoot deformities.

Table 5. Evaluation of sonographic parameters at Pre, Post and Follow up (FU) Combined (R+L).

	Results			Significance		
Variables	**Pre**	**Post**	**FU**	**Pre-Post**	**Pre-FU**	**Post-FU**
Dimeglio score	5.39±1.50	1.78±0.61	1.46±0.50	<0.001**	<0.001**	<0.001**
Tibio calcaneal distance (Neutral)	10.65±1.68	10.81±1.71	10.83±1.70	<0.001**	<0.001**	0.031*
Tibio calcaneal distance (plantar flexion)	9.80±1.54	9.94±1.65	10.07±1.68	0.064+	0.002**	<0.001**
Tibio calcaneal distance (dorsi flexion)	11.64±1.78	14.72±17.74	12.10±1.67	0.269	<0.001**	0.346
Metaphyseal tibio calcaneal angle (dorsi flexion)	65.29±6.49	63.76±7.03	63.66±7.12	<0.001**	<0.001**	0.121
Metaphyseal tibio calcaneal angle (plantar flexion)	72.09±5.45	73.90±5.48	73.97±5.51	<0.001**	<0.001**	0.030*
Talo calcaneal angle (plantar flexion)	31.07±5.70	35.44±5.24	35.94±5.17	<0.001**	<0.001**	<0.001**
Talo calcaneal angle (dorsiflexion)	16.52±2.23	20.20±2.58	20.79±2.53	<0.001**	<0.001**	<0.001**
Talo calcaneal divergence (plantar flexion)	43.77±3.47	47.12±3.71	47.86±3.82	<0.001**	<0.001**	<0.001**
Talo calcaneal divergence (dorsiflexion)	81.98±7.17	86.00±5.34	86.61±5.15	<0.001**	<0.001**	<0.001**

**: denotes statistical significance, **: denotes high statistical significance*

Table 6 presents the evaluation of the length of the Achilles tendon, considering both plantar flexion and dorsiflexion, at various stages including pre-treatment (Pre), post-treatment (Post), and follow-up (FU). The results demonstrate statistically significant improvements in the length of the Achilles tendon in both plantar flexion and dorsiflexion from pre-treatment

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to post-treatment and follow-up, with p-values indicating high statistical significance ($p < 0.001$**). Additionally, while the improvement from pre to post-treatment and pre-treatment to follow-up was significant for the length of the Achilles tendon in dorsiflexion, there was no significant change observed from post-treatment to follow-up for this variable ($p = 0.001$**). These findings highlight the effectiveness of the treatment in enhancing the length of the Achilles tendon, particularly notable in plantar flexion, which is crucial for restoring normal foot function in patients with clubfoot deformities.

Table 6. Evaluation for Length of tendon achilles.

	Results			Significance		
Variables(mm)	**Pre**	**Post**	**FU**	**Pre-Post**	**Pre-FU**	**Post-FU**
Length of tendon achilles (plantar flexion)	7.72±1.33	8.20±1.28	8.34±1.23	<0.001**	<0.001**	**<0.001****
Length of tendon achilles (dorsi flexion)	8.81±1.25	9.08±1.24	9.14±1.23	<0.001**	<0.001**	**0.001****

FU: follow-up

Table 7 summarizes various hindfoot parameters, their location of deformity, interpretation, and clinical significance. These parameters include the tibio calcaneal distance, which assesses hindfoot equinus deformity by grading its extent and evaluating ankle and subtalar motion along with talar relocation into the mortice. The metaphyseal tibio calcaneal angle measures equinus deformity in the hindfoot, while the talo calcaneal angle assesses the realignment between two bones in the hindfoot. Talo calcaneal divergence indicates the achievement of dorsiflexion. Additionally, the length of the tendo Achilles in the hindfoot reflects tendon healing. This table provides clinicians with valuable insights into the interpretation and clinical significance of various hindfoot parameters, aiding in the assessment and management of foot deformities, particularly in conditions such as clubfoot.

Table 7. Various hind foot parameters and their clinical significance and correlation.

Parameters	**Location of Deformity**	**Interpretation**
Tibio calcaneal distance	Hindfoot equinus deformity	**Grade and extent of equinus. Ankle & subtalar motion. Talar relocation in to mortice.**
Metaphyseal tibio calcaneal angle	Hindfoot	**Measure of equinus deformity**
Talo calcaneal angle	Hindfoot	**Measure of realignment between two bones**
Talo calcaneal divergence	Hindfoot	**Achievement of dorsiflexion**
Length of tendo Achilles	**Hindfoot**	**Tendon healing**

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DISCUSSION

This study involved a group of 60 newborns, with a total of 89 feet, who underwent a series of casts using the Ponseti technique. The casts were used to repair anomalies in the forefoot and midfoot. Due to insufficient follow-up, two participants were excluded from the study. Out of the remaining cases, 26 were from rural areas and predominantly male. In 2020, Allende and colleagues conducted a study to analyze the intermediate results and adverse effects of a large multicenter group of patients with severe clubfoot who had therapy using the Ponseti procedure. [4]The average age at the initiation of therapy was seven months, and the correction required a median of five casts. Patients with a complex clubfoot diagnosis who have had a minimum of one year of follow-up. Individuals with clubfoot that is not caused by an unknown or unidentifiable reason.In 2021, Vishnu and colleagues conducted a study on the recurrence pattern of clubfeet that had been treated with the Ponseti method. [5]The Ponseti operation is an effective method for correcting clubfoot, however it is not uncommon for the deformity to reoccur. As part of the trial, 78 children with idiopathic clubfoot were treated using the Ponseti technique. Various patterns of relapse, including complete, stable, and fluctuating relapse, were seen. When clubfeet were present on both sides (bilateral) or on only one side (unilateral), the patterns of relapse were different. The Pirani scoring system was employed to examine the relapse patterns. In order to have a deeper understanding of how they may affect the likelihood of recurrence, additional study should be conducted to investigate the relationship between age at initial presentation, initial Pirani score, and the number of casts required.

In 2019, Barik and colleagues conducted a comparative study between the classic Ponseti approach and an accelerated Ponseti procedure for the treatment of congenital talipes equinovarus (CTEV) in children.[6] Congenital talipes equinus varus (CTEV) is a pediatric disorder that primarily affects infants. The interval for changing the cast was 3 days for the expedited group, while it was 7 days for the standard group. The Pirani score exhibited a more rapid decline, and the accelerated group required a reduced number of casts, suggesting a faster correction of the foot deformity. Based on the study, over a period of 5 years, the accelerated Ponseti approach yielded functional outcomes that were comparable to those of the standard technique. Additionally, it improved compliance and reduced the financial burden on parents in terms of treatment and travel expenses. In 2020, Goyal and colleagues proposed a new approach for assessing children with clubfoot who have not yet undergone therapy or have just undergone non-surgical management.[7] In order to assess the deformity, the method utilizes many technologies such as anthropometric measurements, foot imprinting, radiography angles, and ultrasonographic measurements. The study only included 60 patients, leading to a significantly small sample size that may limit the generalizability of the findings.

CONCLUSION

This study concludes that sonographic examination of clubfoot's posterior foot deformity is a direct, non-invasive, radiation-free, efficient, and cost-effective imaging tool. The metaphysio tibio calcaneal angle and tibio calcaneal distance are more precise measures for assessing

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equinus deformity correction. Sonography can help mitigate the adverse effects of therapy, provide distinctive understanding of the location and intensity of the deformity, and evaluate the extent of surgical intervention needed. A strong correlation has been found between the grading of clinical clubfoot severity and relevant sonographic measures.The prompt identification and efficient management of pseudo correction and spurious correction during therapy can be achieved. Based on this study, Sonography is a more effective substitute for radiography in imaging clubfoot and should be employed with greater frequency. The procedure has demonstrated practicality and promise in managing hind foot malalignment in idiopathic clubfeet that are treated with the Ponseti technique. The study's findings enhance our comprehension of the Ponseti technique's holistic influence on clubfoot abnormalities. This research provides a comprehensive perspective on treatment success by assessing both clinical and sonographic factors. Moreover, the study illuminates the potential of sonography as a beneficial imaging technique for evaluating clubfoot, providing non-invasive and radiation-free benefits compared to standard radiography. Although this study offered valuable insights into the effectiveness of percutaneous Achilles tendon tenotomy in the Ponseti procedure, there are several potential areas for further research: a) Extended Period of Observation: Performing extended follow-up evaluations to monitor the durability of clinical and sonographic enhancements beyond the initial post-operative phase would yield a thorough comprehension of the treatment's enduring influence. b) Advanced Imaging Techniques: Investigating the capabilities of advanced imaging techniques, such as 3D ultrasound or magnetic resonance imaging (MRI), may offer more comprehensive understanding of the structural alterations linked to clubfoot repair.

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