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Clinical and Ultrasonographic (USG) assessment and their correlation in clubfoot treated with ponseti cast

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Abstract
Background: Congenital talipes equinovarus (clubfoot) is a common foot deformity in children affecting 1/1000 live births. Pirani scoring system is used mainly for clinical assessment. To correlate the success, reported with Ponseti method an imaging modality is required to quantitate the deformity. Sonography being a radiation free, easily available non-invasive imaging has been investigated for this purpose. The aim of our study is to correlate clinical and sonographic parameters in various grades of clubfoot.
Materials and methods: 53 clubfeet in 34 infants with a mean age of 2.43 ± 1.97 months were examined clinically using Pirani score. Sonographic examination was done in medial, lateral and posterior projection in affected feet. The sonographic parameters measured were: Medial Malleolar Navicular distance (MMN), Calcaneo-cuboid angle (CC angle) and Tibio-calcaneal distance (TC). Treatment was done with Ponseti method of serial manipulation and casting. Weekly assessment was done clinically by Pirani scoring and various Ultrasonographic parameters. Pirani score were correlated with Ultrasonographic parameters.
Results: Out of 53 clubfeet, 19 were bilateral and 15 were unilateral with male: female ratio of 1.8: 1. There was progressive decrease in Pirani score and C-C angle, and progressive increase in MMN distance and T-C distance during treatment. A strong negative correlation was found between mean Pirani score and mean MMN distance, and between mean Pirani score and T-C distance. A strong positive correlation was found between mean Pirani score and C-C angle.
Conclusion: Sonography should be as a supplement to clinical assessment of clubfoot, as it is cheap, easily available and being non-invasive can be repeatedly performed, and can help to determine any spurious correction during course of treatment.

Keywords: Congenital talipes equinus varus, clubfoot, Pirani score, ultrasonography

1. Introduction

Congenital Talipes Equinovarus (CTEV) or Clubfoot is one of the most common congenital deformity in Paediatric Orthopaedics. The reported incidence is one in every thousand live births. About one lakh new cases of clubfoot are added worldwide each year [1, 2]. It has been reported that more than 50% cases are bilateral, with a sex ratio of 2:1 males per females. In unilateral cases, right side has slight more preponderance than left [3]. It is a complex deformity comprising of cavus, forefoot adduction, hind-foot varus and hind foot equinus. Treatment of clubfoot usually starts as soon as possible after birth by Ponseti's method of serial manipulation and casting. As it is easy to manipulate the foot in new-borns and infants.

The assessment of clubfoot during serial manipulation is mainly done clinically with various scoring system. Pirani scoring system has found wider acceptance before, during and after treatment, as it is quick, reliable and easy to memorize [4].

Even after clinical correction the underlying bony anatomy was still altered. So, a need of imaging modality was required to assess underlying bony pathology and deformity correction during treatment. Initially radiography was used to supplement clinical scoring system, but, it was limited by lack of visualization of unossified bones of foot. In addition, radiography did not give any information about soft tissue, cartilaginous structures, and because of radiation exposure cannot be used repeatedly. Sonography is a recently introduced alternative imaging modality for clubfoot assessment. It offers a good assessment of the unossified cartilaginous structures, bones and surrounding soft tissues, and being non-invasive can be used repeatedly.

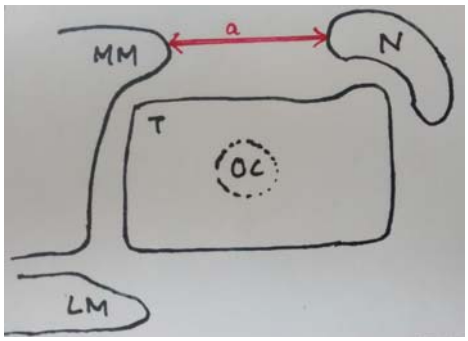
This study was undertaken to assess and correlate, clinical (by Pirani scoring) and Ultrasonographic changes in idiopathic clubfoot during treatment with Ponseti method of serial manipulation and casting.

2. Materials and methods: A prospective study, with a total of 34 infants with 53 (19 bilateral and 15 unilateral) idiopathic clubfeet, who attended the outpatient department of orthopaedics, in our hospital between July 2015 to June 2016 were included in our study, after obtaining ethical committee approval from our institution. All cases were clinically assessed using Pirani scoring system on weekly basis during the Ponseti's treatment.

For Ultrasonographic assessment, all clubfeet were assessed on weekly basis during treatment procedure. It was performed with HD 11 XE PHILIPS Ultrasonography machine with high frequency (5-12 MHz) linear probe. The baby was lying on an examination couch or was placed comfortably on the parent's lap without sedation although we ensured that the baby was quiet or in some instances breast fed during the examination, while the examiner held the ultrasound probe with one hand and the clubfoot in maximally corrected position by the other hand, occasionally with an assistant stabilizing the leg.

Each foot was examined through three standard scanning projections (medial, lateral and posterior).

In *medial projection*, Medial Malleolus and Navicular (MMN) distance (Fig 1,2) was measured, by placing transducer on medial border of foot in maximum corrected position, so that medial malleolus and navicular were in same plane. It is the shortest distance between the medial malleolus and the medial proximal part of the navicular in maximally corrected position of foot. It is represented in maximally abducted position and gives information about the severity of deformity in the talonavicular (TN) complex.

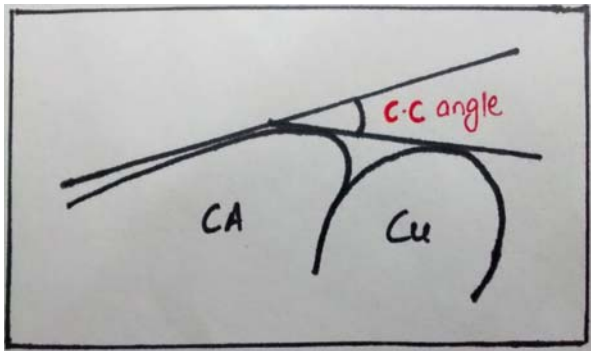


MM medial malleolus; LM lateral malleolus; T talus; N navicular; OC ossification centre of talus;

Fig 1: Diagram depicting osseocartilaginous relationship on medial projection

Fig 2: Medial Malleolar and Navicular (MMN) distance.

In *lateral projection*, Calcaneocuboid (C-C) angle (Fig 3, 4) was measured. It was obtained by positioning the transducer along lateral border of foot parallel to plantar aspect for assessment of C–C relationship. It is the angle formed between the lines tangential to calcaneus and cuboid.

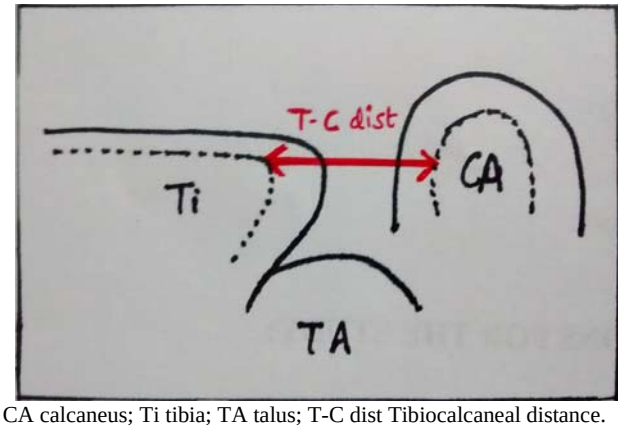


CU cuboid; CA calcaneus; C-C angle- calcaneocuboid angle.

Fig 3: Diagram depicting osseocartilaginous relationship on lateral projection

Fig 4: Calcaneocuboid (C-C) angle.

In *posterior projection*, Tibio-calcaneal (T-C) distance (Fig 5, 6) was measured. It was obtained by placing transducer vertically on the back of foot in midline to assess the tibiocalcaneal (T-C) relationship. It is the distance between distal ossified tibial metaphysis and proximal surface of ossification centre of the calcaneus.



CA calcaneus; Ti tibia; TA talus; T-C dist Tibiocalcaneal distance.

Fig 5: Diagram depicting osseocartilaginous relationship on posterior projection

Fig 6: Tibio-calcaneal (T-C) distance.

Statistical analyses: All analyses were performed using SPSS Statistics Desktop 22.0. The quantitative data were presented as mean ± standard deviation and qualitative data were expressed as a percentage of subjects. The correlation between Pirani score and Ultrasonographic parameters were analysed by Pearson Correlation coefficient and pre-treatment and posttreatment changes were analysed by paired t-test. Statistical significant difference was set as $p < 0.05$.

3. Results

Out of 34 infants with 53 clubfeet, 19 were bilateral and 15 were unilateral. Of unilateral feet, right feet was involved in 10 and left in 5. There were 22 male infants and 12 female infants, with Male to Female ratio of 1.8:1. The mean age was 2.43 ± 1.97 months, ranging from 8 days to 7 months at the time of application of first cast. The maximum number of infants, 24 (78.58 %) were of age less than 3 months.

Out of 53 feet, 43 (81.13 %) were having a score of 5-6. The mean Pirani score was calculated for each visit of all feet (Table 1). Similarly, we calculated mean of each sonographic parameters for each visit (Table 2).

Table 1: Mean Pirani score.

Visit	Mean Pirani score
At 1st Visit	5.12±0.81
At 2nd Visit	4.16±0.94
At 3rd Visit	2.96±1.01
At 4th Visit	1.79±0.94
At 5th Visit	0.90±0.75
At 6th Visit	0.4±0.20

Table 2: Mean MMN distance, Mean C-C angle and Mean T-C distance.

Visit	Mean MMN distance (mm)	Mean C-C angle	Mean T-C distance
At 1st Visit	4.68 ± 0.90	18.47º ± 2.09º	10.35±1.24
At 2nd Visit	5.52 ± 0.88	16.64º ± 2.20º	10.93±1.14
At 3rd Visit	6.35 ± 0.96	14.90º± 2.11º	11.53±1.05
At 4th Visit	7.19 + 0.99	13.33º± 1.90º	12.20±1.10
At 5th Visit	7.99 + 0.98	12.28º ± 1.86º	13.00±1.08
At 6th Visit	8.17± 0.70	11.8º ± 1.57º	13.68±1.40

During the course of treatment, the Pirani score was progressively decreased by Ponseti's method of serial manipulation and casting. On comparison of pre-treatment and post treatment values of Mean Pirani score (Table 3 and Fig 7), during course of treatment, using paired t-test, the t value was -43.32 and the p value was <0.00001. The result was statistically significant at $p \leq 0.05$.

Similarly, during the course of treatment, there was progressive increase in MMN distance and T-C distance, and progressive decrease in C-C angle. On comparison of pre-treatment and post treatment values (Table 3 and Fig 7), during course of treatment, using paired t-test, the t value for mean MMN distance was 38.43, for mean C-C angle was -28.97, and for mean T-C distance was 21.50. The p value for MMN distance was <0.00001, for C-C angle was <0.00001, and for T-C distance was <0.00001.

Table 3: Comparison between pre-treatment and post-treatment clinical and sonographic mean.

Variable	Mean	SD	t value	p value
Pirani score1	5.12	0.81	-43.32	<0.00001
Pirani score2	0.4	0.20		
MMN1	4.68	0.90	38.43	<0.00001
MMN2	8.17	0.70		
CC angle 1	18.47	2.09	-28.94	<0.00001
CC angle 2	11.8	1.57		
TC distance 1	10.35	1.24	21.50	<0.00001
TC distance 2	13.68	1.40		

1- Pre-treatment 2- Post-treatment

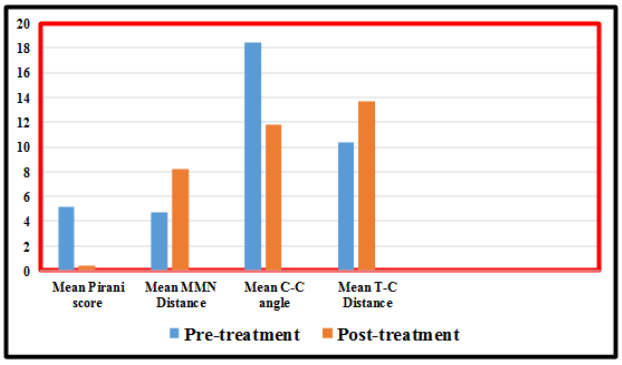


Fig 7: Pre & Post-Treatment Comparison.

We found strong negative correlation between mean Pirani score and mean MMN distance (r value -0.9989 and p value 0.00001) and between mean Pirani Score with T-C distance (r value -0.9877 and p value 0.0002) (Fig 8).

We found strong positive correlation between mean Pirani score and mean C-C angle (Fig 8), with r value 0.996 and p value < 0.00001.

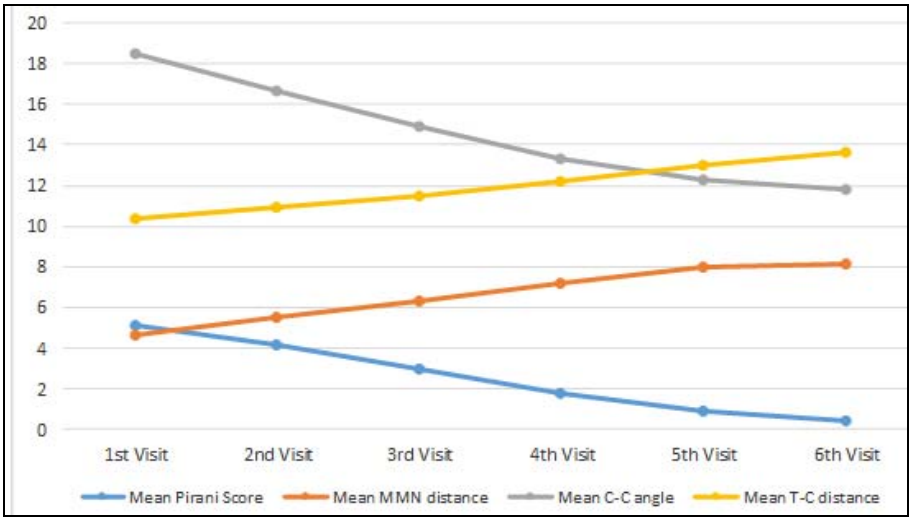


Fig 8: Correlation between Mean Pirani Score with Mean MMN distance, with Mean C-C angle and with Mean T-C distance.

4. Discussion

Clubfoot, in spite of being known to world from Hippocrates time, the assessment of clubfoot still has no uniform accepted method. A uniform accepted method is essential for treatment planning, its follow up, evaluating long term outcome and in assessing the outcome of various therapeutic approaches. Till now, evaluation of clubfoot was based mainly on various clinical scoring systems. Even after clinical correction the underlying bony anatomy was still altered. So, there was need of supplementing clinical scoring system with imaging modalities.

Sonography is a recently introduced alternative imaging modality for clubfoot assessment. There are several advantages of Ultrasound in the initial evaluation of neonatal clubfoot. It is readily available, relatively inexpensive, harmless to the baby, can be repeated, offers the possibility of a dynamic evaluation and can provide objective documentation of the severity of deformity [5-10]. The tarsal bones are easily visualized on ultrasound and it allows for objective monitoring of the progressive correction of clubfoot treated conservatively. In addition, its ability to provide information about the anatomic relationships between the ossified and nonossified tarsal bones.

In our study, sonographic measurement was obtained in several planes, which give different information.

In *Medial projection*, Medial malleolus and navicular distance was measured as an indicator of displaced navicular and of talo-navicular malalignment which is one of the most significant component of clubfoot. The Mean MMN distance was significantly shorter in clubfoot.

Bhargava *et al*. [11] reported the Mean MMN distance at the time of presentation as 5.5 $\pm$ 0.44 mm, Shiels *et al*. [12] reported the same to be 5.3±2.8 mm and Aurell *et al*. [13] reported the same as 4.6 $\pm$ 1.7 mm while we reported the same as 4.68$\pm$ 90 mm.

In our study, mean MMN distance at the time of presentation was 4.68$\pm$0.90 mm, while Khaled *et al*. [14] reported the same as 4.1 $\pm$ 3.1 mm and similarly mean MMN distance at the completion of treatment was 8.17 $\pm$ 0.70 mm, while Khaled *et al* reported the same as 11 $\pm$ 4.3 mm. The low value of mean MMN distance at completion of treatment in our study, may be due to the fact that, final assessment in our study was done at mean age of 3.98 $\pm$ 2.23 months whereas in Khaled *et al* the same was done at mean age was 6.3 $\pm$ 4.3 months.

When MMN distance was compared with clinical assessment (Pirani score), during the course of treatment, MMN distance was increased with decreasing Pirani score, which on statistical analysis using Pearson correlation coefficient, we found strong negative correlation. Our finding were similar to Agarwal *et al*. [15] and Khaled *et al*.

During Ponseti treatment, serial monitoring of USG parameter gave us an important information about the effectiveness of treatment and degree of restoration of normal alignment after treatment. Our observation were similar to Desai *et al*. [16] who found MMN distance as an objective parameter to monitor effect of treatment. When MMN distance was compared with the clinical grading of forefoot adduction**.** MMN distance increased with decrease in the grading of deformity.

In *lateral projection*, the calcaneocuboid relationship was assessed with C–C angle. This view demonstrated the medial deviation of cuboid in clubfoot as evident by the significantly increased C-C angle in clubfeet. Calcaneocuboid (C-C) angle measures the degree of adduction of the foot, which is characteristically high in typical clubfoot and increased with increase in forefoot adduction.

In our study, mean C-C angle at the time of presentation was found to be 18.47º $\pm$ 2.09º, while Bhargava *et al* reported the same as 23.7 $\pm$ 10.2º. The lower value may be due to the difference in number of cases or difference in the age of assessment.

In our study, the mean C-C angle at presentation was 18.47$\pm$2.09º while Gigante *et al*. [17] reported the same as 17º (range, 12–26) and similarly, the mean C-C angle at end of treatment was 11.8º $\pm$ 1.57º while Gigante *et al* reported the same as 8º (range 6-12º).

When C-C angle was compared with clinical assessment by Pirani score, during the course of treatment, C-C angle decreased with decreasing Pirani score, which had strong positive correlation.

The *posterior projection* was useful to evaluate the Tibio-calcaneal (T-C) relationship and the ankle mortise. The range of movement of the ankle and of the subtalar joints was established in each foot by measuring the T-C distance. It is a direct indicator of equinus deformity. The T-C distance decreased significantly with increase in the severity of equinus. The T-C distance measured was found to be significantly shorter in clubfeet, due to contracture of posterior soft tissue.

In our study, the mean T-C distance was 10.35 $\pm$ 1.24 mm,

while Bhargava *et al* reported the same as 14.2 ± 3.6 mm. The difference in mean may due to the difference in number of cases and/or difference in mean age of assessment.

In our study, the mean T-C distance at presentation was 10.35±1.24 mm, while Gigante *et al*. [17] reported the same as 10.5 mm (9.5-11.5mm) and mean T-C distance was 13.68±1.40 mm at the end of treatment, while Gigante *et al* reported the same as 15 mm. The mean reported in our study was comparable with Gigante *et al*.

When T-C distance was compared with clinical assessment (Pirani score), during the course of treatment, there was increase T-C distance with decreasing Pirani score, which had strong negative correlation. The low mean values of the T-C distance for clubfeet at maximal dorsiflexion reflect the fixed contracture of the posterior soft tissues. The increase in mean T-C distance at each step of treatment reflects the progressive gain of dorsiflexion ability in the malformed foot.

5. Conclusion: Sonography can be used as supplement for clinical scoring system, as being readily available, inexpensive, non-invasive, and can give information about unossified cartilaginous structures, and soft tissues. So, it can be used repeatedly for assessment of deformity correction during manipulation and can help to determine any spurious correction. So, it should be part of routine assessment along with clinical assessment of clubfoot. Further studies are needed to confirm if residual post-treatment sonographic abnormalities are associated with future recurrence.

6. References

1. Ponseti IV. Clubfoot: Ponseti Management: Global Help Publications, 2003.
2. Herring JA. Tachdjians Pediatric Orthopaedics: Congenital Talipes Equinovarus. WB Saunders Co, 2002.
3. Vincent J Turco, MD; CLUBFOOT.
4. Dyer PJ, Davis N. The role of the Pirani scoring system in the management of clubfoot by the Ponseti method. J Bone Joint Surg Br. 2006; 88:1082-1084.
5. Hamel J, Becker W. Sonographic assessment of clubfoot deformity in young children. J Pediatr Orthop B. 1996; 5:279Y286.
6. Suda R, Suda AJ, Grill F. Sonographic classification of clubfoot according to severity. J Pediatr Orthop B. 2006; 15(2):134Y140.
7. Chami M, Daoud A, Maestro M *et al*. Ultrasound contribution in the analysis of the newborn and infant normal and clubfoot. A preliminary study. Pediatr Radiol. 1996; 26:298Y302.
8. Gigante C, Talenti E, Turrra S. Sonographic assessment of clubfoot. J Clin Ultrasound. 2004; 32:235Y242.
9. Maiza D, Themar-Noel C, Legrand I *et al*. Ultrasonographic approach to the neonatal foot: preliminary study. J Pediatr Orthop B. 1995; 4:123Y128.
10. Tolat V, Boothroyd A, Carty H *et al*. Ultrasound: a helpful guide in the treatment of congenital talipes equinovarus. J Pediatr Orthop B. 1995; 4:65Y70.
11. Bhargava SK, Tandon A, Prakash M, Arora SS, Bhatt S, Bhargava S. Radiography and sonography of clubfoot: A comparative study. Indian Journal of Orthopaedics. 2012; 46(2):229-35.
12. Shiels II WE, Coley BD, Kean J, Adler BH. Focused dynamic sonographic examination of the congenital clubfoot. Pediatric radiology. 2007; 1;37(11):1118-24.
13. Aurell Y, Johansson A, Hansson G, Wallander H, Jonsson K. Ultrasound anatomy in the normal neonatal and infant foot: an anatomic introduction to ultrasound assessment of foot deformities. European radiology. 2002; 1;12(9):2306-12.
14. El-Adwar KL, Kotb HT. The role of ultrasound in clubfoot treatment: correlation with the Pirani score and assessment of the Ponseti method. Clinical Orthopaedics and Related Research®. 2010; 1;468(9):2495-506.
15. Agrawal S, Srivastava D, Gangwar HS, Agrawal S, Agrawal PK. Sonography as an objective tool for monitoring serial corrections and detecting spurious corrections in clubfoot: A review. The Foot. 2012; 31;22(4):315-8.
16. Desai S, Aroojis A, Mehta R. Ultrasound evaluation of clubfoot correction during Ponseti treatment: a preliminary report. Journal of Pediatric Orthopaedics. 2008; 1;28(1):53-9.
17. Gigante C, Talenti E, Turra S. Sonographic assessment of clubfoot. Journal of Clinical Ultrasound. 2004; 1;32(5):235-42.