Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i3.4734

# CORRELATION OF RADIOLOGICAL PARAMETERS WITH CLINICAL OUTCOME OF CLUBFOOT TREATED WITH PONSETI METHOD

**Dr. Sudeep Madhukar Nambiar[1], Dr. Viplav Shetty[2], Dr. Ramvivek V.M.[3], Dr. Gandi Adinarayana Roy[4*], Dr. Nagakiran K.V.[5], Dr. Vyshnavi J.M.[6], Dr. Sheshachala S.[7]**

[1]Associate Professor, Department of Orthopaedics, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.
[2]Assistant Professor, Department of Orthopaedics, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.
[3]Assistant Professor, Department of Orthopaedics, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.
[4*]Assistant Professor, Department of Orthopaedics, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.
[5]Professor & HOD, Department of Orthopaedics, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.
[6]Junior Resident, Department of Orthopaedics, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.
[7]Junior Resident, Department of Orthopaedics, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.

***Corresponding Author:** Dr. Gandi Adinarayana Roy
*Assistant Professor, Department of Orthopaedics, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.

## Abstract

**Background:** Congenital talipes equinovarus also known as clubfoot is one of the most common congenital orthopedic conditions. Currently, the Ponseti plaster method is the gold standard for the treatment of clubfoot, which involves weekly manipulation and plaster application. The role of radiological parameters in the evaluation and treatment of CTEV (Congenital talipes equinovarus) is still controversial. The study aims to evaluate the correlation of radiological parameters with the clinical outcome of clubfoot treated with the Ponseti method.

**Methods:** This study was conducted with 40 feet in 30 patients with idiopathic from January 2021 to July 2022. The Pirani scoring system was used for clinical evaluation.

**Results:** The anteroposterior view was scored for talocalcaneal angle and first metatarsal talo angle, while the lateral view was scored for talocalcaneal angle and tibiocalcaneal angle. The mean initial total Pirani score was 5.5 which decreased to 0.9. The mean initial talocalcaneal angle in anteroposterior and lateral views was 19.7 and 24.5, increasing to 41 and 38.1 after correction. The mean talocalcaneal index increased from 22.1 before correction to 39.5 after correction. The mean talo-first metatarsal angle in the anteroposterior view improved from 28.1° before correction to -13.3°

after correction. The relationship between the differences in Pirani scores at the first visit and after correction and the differences in radiographic parameters at the first visit and after correction revealed a statistically significant correlation.

**Conclusion:** Radiographic parameters showed a statistically insignificant correlation with the clinical outcome. Thus, evaluation of clubfeet correction treated by the Ponseti technique can rely mainly on clinical scores

**Keywords:** Congenital talipes equinovarus, Midfoot score (MS**),** Hindfoot score (HS), Talocalcaneal angle-Anterioposterior view(TCA-AP), Talo 1st metatarsal angle –Anterior-posterior view (TMT-AP), Lateral: Talocalcaneal angle-Lateral view (TCA), Lateral: Tibiocalcaneal angle-Lateral view (TiC), Talocalcaneal index (TCI), Magnetic Resonance Imaging (MRI), Computed Tomography (CT), DB splint: Denis Browne splint

## INTRODUCTION

Congenital talipes equinovarus, or clubfoot, is the most common congenital orthopaedic conditions with an incidence of approximately 1 in 1000 live births[1] with four deformities 1. Cavus in the midfoot 2. Adduction in the forefoot 3. Varus in the hind foot 4. Equinus in the ankle[2]. Severity of the clubfoot is calculated using scoring systems, mostly used are Pirani and Dimeglio with scores[3,4]. The Pirani scoring system is calculated entirely based on clinical examination that correlates with severity of the deformity[5]. Radiological assessment of clubfoot severity is assessed by using parameters including A.Talocalcaneal angle [TCA]-AP view. B. Talo-1stmetatarsalangle [TMT]-AP view. C.Talocalcanealangle[TCA] Lateral view D.Tibiocalcanealangle[TiC]-Lateral view[6,7]. Most of the cases in developing countries like India occur due to negligence, misconception, or low economic status[8,9]. Untreated clubfoot is a major issue due to congenital bone and joint deformities which affects the patient's quality of life and the economic burden on the healthcare system[10]. Treatment goals include ability to walk normally and free of pain and ability to wear normal footwear[11].

The Ponseti method is the gold standard for the treatment of clubfoot[11], which consists of serial manipulation with above knee cast application weekly[12].

In the available literature, some studies showed the correlation between clinical and radiological parameters during the correction of CTEV treated with the Ponseti method.

While other studies showed no correlation. Hence this study aimed to investigate the correlation between clinical and radiological parameters in patients with idiopathic CTEV undergoing correction using the Ponseti technique.

## AIMS AND OBJECTIVES

1.Correlation of radiological parameters with clinical outcome of clubfoot treated with the Ponseti method.
2.To study the clinical outcome of clubfoot treated with the Ponseti method.

## MATERIALS AND METHODS

This is a prospective observational study including 30 patients with age <2 years having idiopathic CTEV excluding meningomyelocele, Arthrogyropsis multiplex congenital and Larsen's syndrome for a period of 18m (Jan 2021-July 2022) in our institution and assessed them using Pirani score and radiological parameters. An approval from the institutional ethics committee for research on human subjects was granted by institution board. In ponseti treatment phase start with 1st cast for forefoot to align with mid foot and hind foot. After cavus deformity was corrected, weekly above knee casts applied till 70º abduction was achieved with foot in supination. Usually 5-7 casts are changed weekly after manipulation of foot, with an average of 6 casts required to correct the deformity. At each follow up foot was evaluated for deformity correction using PIRANI score. After sufficient manipulation, if eqinus deformity persisted then per cutaneous tenotomy of Achilles tendon was performed. The final cast was applied in foot with 70º abduction and 10-15º dorsiflexion. Then a brace was applied for 23

hours a day for 1st 3 months and worn only at night time for 2-4 years. Once the child started walking custom made shoes were used. The children were followed up for every 3 months till the baby attained 3 years of age.

**Radiological measurements**

Radiographs taken at first visit before treatment and repeated after treatment when foot is estimated as normal according to Pirani score. Radiological parameters of AP and lateral views of ankle and foot were measured.

In lateral view lines drawn on lateral view longitudinally through the central axis of first tarsal bone.in this projection, talocalcaneal angle (tcl), tibiocalcaneal angle (ticl), talofirst metatarsal angles were measured.

Then talocalcaneal (Tci) index is measured which is the sum of talocalcaneal angles in ap and lat views.


**Image 1**

In the radiograph above, antero-posterior view of ankle line 1 is drawn along long axis of calcaneum and line 2 is drawn along long axis of talus, angle subtended between line 1 and line 2 is talocalcaneal angle on AP view.


**Image 2**

In the radiograph above, antero-posterior view of ankle line 3 is drawn along longitudinal axis of 1st metatarsal and line 4 is drawn along long axis of talus, angle subtended between line 3 and line 4 is talus-1st metatarsal angle on AP view.

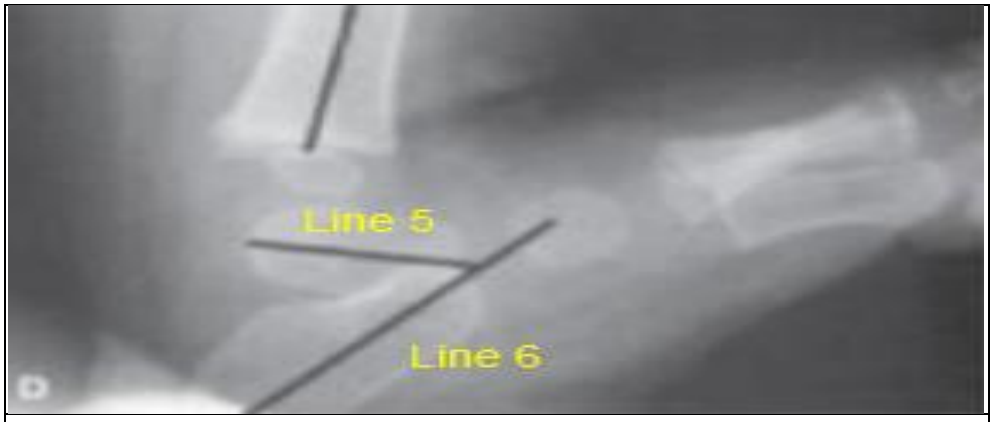


**Image 3**

In the radiograph above, lateral view of ankle line 5 is drawn along longitudinal axis of talus and line 6 is drawn along long axis of calcaneum, angle subtended between line 5 and line 6 is talo-calcaneal angle on lateral view.

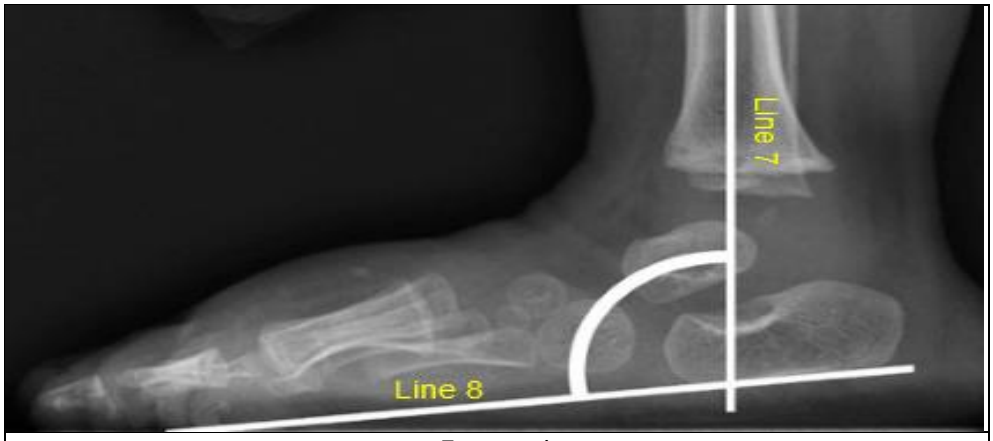


**Image 4**

In the radiograph above, lateral view of ankle line 7 is drawn along longitudinal axis of tibia and line 8 is drawn along long axis of calcaneum, angle subtended between line 7 and line 8 is tibio-calcaneal angle on lateral view

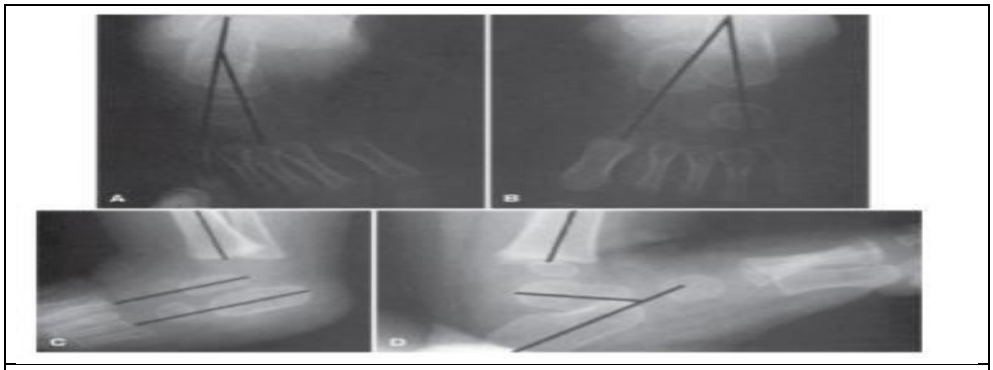

**Image 5**

Figure 1. A. Anteroposterior view of right clubfoot with the decrease in talocalcaneal angle and negative talus-first metatarsal angle. B, Talocalcaneal angle on the anteroposterior view of the normal left foot. C, Talocalcaneal angle of 0 degrees and negative tibiocalcaneal angle on dorsiflexion lateral view of right clubfoot. D, Talocalcaneal and tibiocalcaneal angles on dorsiflexion lateral view of normal left foot.

**Statistical Analysis**

Using SPSS Version 25.0 (IBM Corp, Armonk, NY), qualitative variables were expressed as frequencies and percentages, while quantitative data were expressed as means and standard deviations. The Wilcoxon signed-rank test was used to compare the Pirani score and radiographic parameters' pre- and post-correction values.

**RESULTS**

In this prospective study, a total of 40 feet (30 patients) underwent serial cast correction by the Ponseti technique, with results being evaluated using the Pirani scoring system. Out of 30 cases, there are 20 unilateral (33.3%) and 10 bilateral cases (66.7%). A heel cord tenotomy was performed in 33.3% of cases following the casting, and the bracing protocol was initiated. The mean age was 3.8 months when treatment first began (range1-10 months). There were 18 males (60 %) and 12 females (40 %). The initial Pirani severity score on average was 5.7. The final mean Pirani score at follow-up was observed to be 0.7 and the mean change in score was observed to be 5.0 after correction by the Ponseti procedure. The paired t-test was used to assess this, and the significant p-value was 0.0005.

**Table 1:** Comparison of different scores at 1st visit and Pirani score after correction of the deformity of study subject

| | **Mean** | **Standard deviation** | **P-value** | **Results** |
|---|---|---|---|---|
| Talocalcaneal angle AP at first visit | 14.8º | 6.9 | <0.0001* | Significant |
| Talocalcaneal angle AP after correction | 30.7º | 6.4 | | |
| Talo1st metatarsal angle at 1st visit | 34.6º | 29.4 | <0.0001* | Significant |
| Talo1stmetatarsal angle after correction | 10.2º | 4.8 | | |
| The talocalcaneal angle at the first visit | 18.7º | 7.4 | <0.0001* | Significant |
| Talocalcaneal angle after correction | 29.3º | 8.7 | | |
| TiC {tibio calacaneal}angle- at 1st visit | 119.7º | 18.2 | <0.0001* | |
| TiC{tibio calacaneal} angle- after correction | 66.7º | 143 | | Significant |
| Pirani score at 1st visit | 5.7 | 0.5 | <0.0001* | Significant |
| Pirani score after correction | 0.7 | 0.6 | | |

*P<0.05 statistically significant

From the above, it was stated that the post procedure mean talocalcaneal angle on AP was significantly higher than pre procedure mean value, whereas the post procedure talo first metarsal angle is significantly lower than the pre procedure mean and the post procedure talo calcaneal angle on lateral view was significantly higher than that of the pre procedure mean and finally the post procedure mean of tibiocalcaneal angle was significantly lower than the pre procedure mean.

**Table 2:** Pearson's Correlation of changes in Pirani score and changes in talocalcanealangle parameters of the study

| **Parameter** | **Changes of talo first metatarsal angle** | | **Results** |
|---|---|---|---|
| | **R** | **P** | |
| **Changes of Pirani score** | 0.0413 | 0.8002 | **Not significant** |
| **parameter** | **Changes of talo calcaneal angle** | | **Results** |
| | **R** | **P** | |
| **Changes of Pirani score** | -0.0865 | 0.5954 | **Not significant** |
| **parameter** | **Changes of Talo calcaneal angle -lat view** | | **Results** |
| | **R** | **P** | |
| **Changes of Pirani score** | 0.1177 | 0.4696 | **Not significant** |
| **parameter** | **Changes of tibio calcaneal angle** | | **Results** |
| | **R** | **P** | |
| **Changes of Pirani score** | -0.1385 | 0.3942 | **Not significant** |

From the above, there was no significant clinical correlation between changes in the Pirani score and changes in the talocalcaneal angle parameters of the study
There was no significant clinical correlation with changes in the Pirani score of the talo1stmetatarsal angle.
There was no significant clinical correlation with changes in the Pirani score of talocalcaneal angle-lateral view parameters of the study and
There was no significant clinical correlation with changes in the Pirani score of tibiocalcaneal angle parameters of the study.

**CASE 1**

**Image 6: At 1st visit Pirani score6/6**

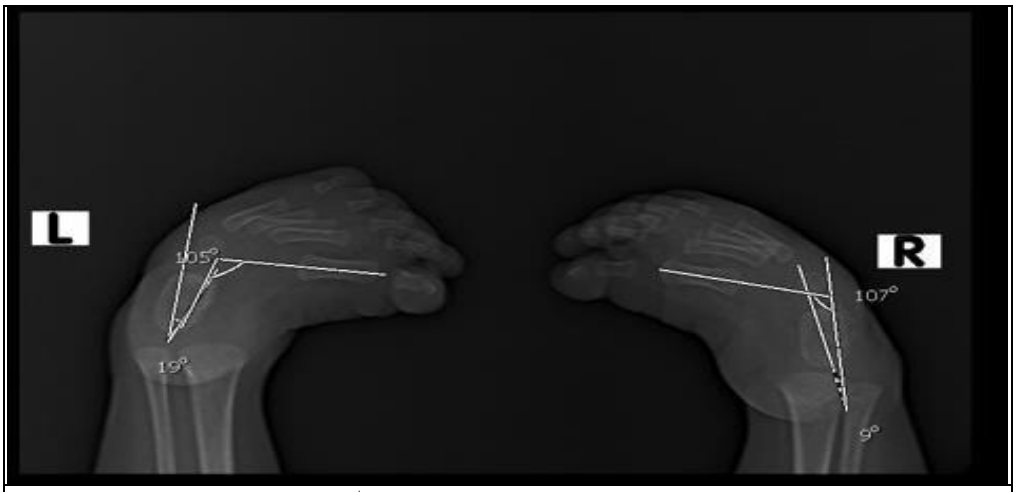


**Image 7: TCA –AP at 1st visit-19º/9º &TMT-AP view at visit:-105º/107º**

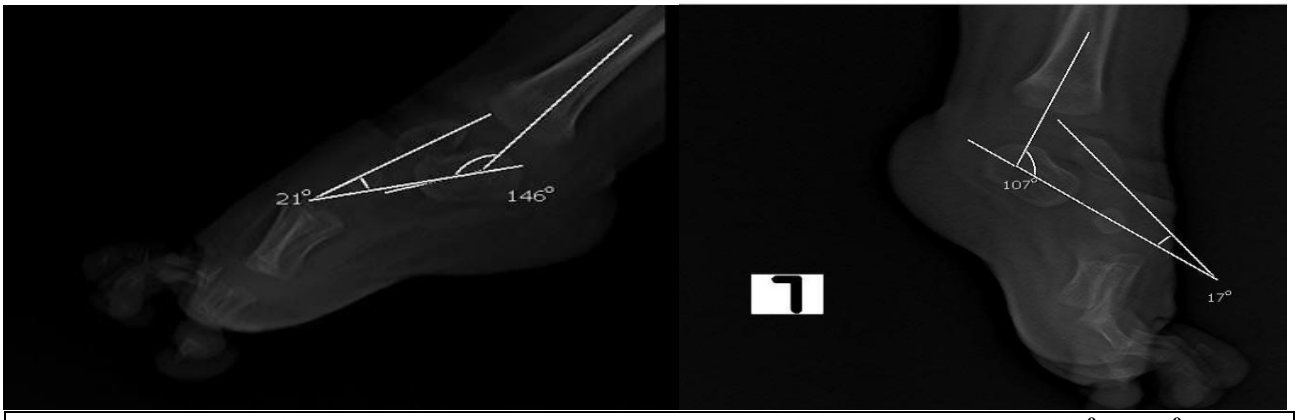


**Image 8: TCA-Lateral view at visit-21º&17º &TiC angle at 1st visit-146$^0$&107$^0$**

**Image 9: Cavus correction**

**Image 10: Correction of adduction and varus**

**Image 11: Cast in abduction**

**Image 12: Final appearance after post-tenotomy cast for 3 weeks**

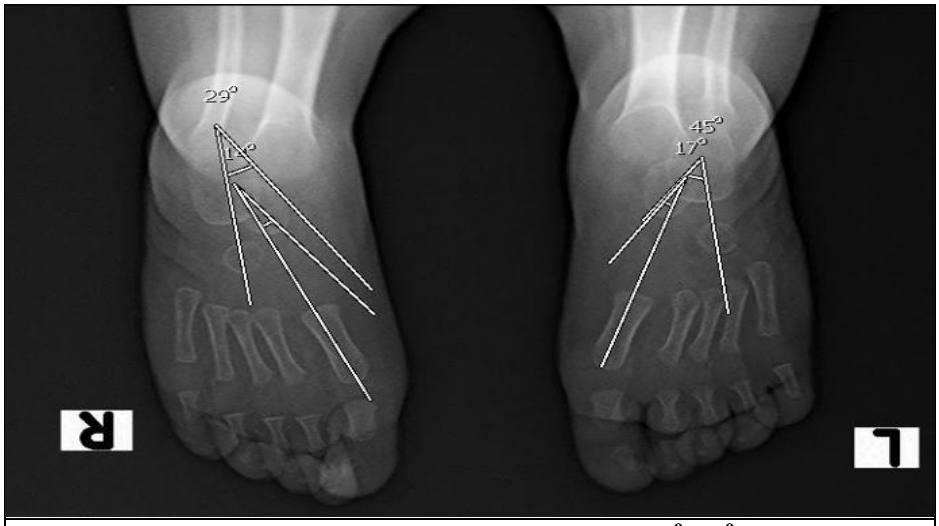


**Image 13: TCA-AP after correction of CTEV -29$^0$/45$^0$ & TMT angle after correction of TEV14$^o$/17$^o$**

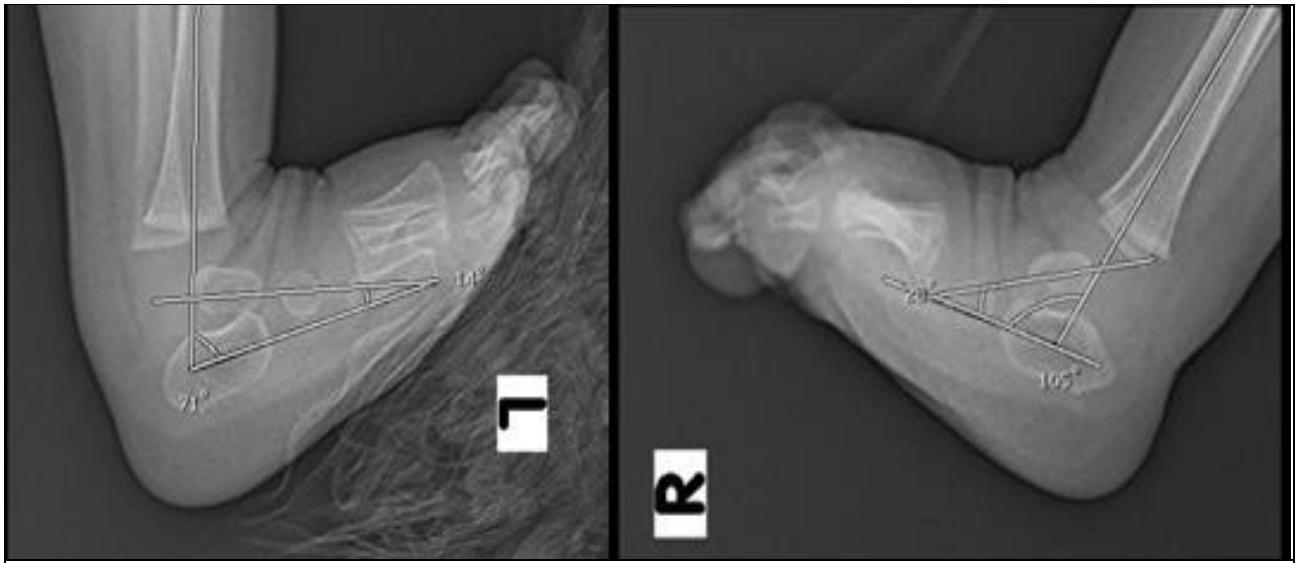


**Image 14: TiC angle-Lateral view after correction of CTEV -106$^o$&71$^0$ &TCA-Lateral views after correction 20$^o$&14$^o$**

**Image 15: Followup at 8 months**

## DISCUSSION

Clubfoot, also known as congenital talipes equinovarus, is one of the congenital orthopaedic conditions.[1] Clinical scoring systems are used to accomplish the clinical assessment of the severity of clubfoot. Scores like Pirani and Dimeglio scoring systems are the most popular. Previous studies have shown that the Pirani grading method is probably the most dependable and repeatable one out.[13,14] The number of casts needed and the requirement for tenotomy are both highly predictable using the Pirani grading system. The initial Pirani score and the number of casts needed for complete clubfoot repair with the Ponseti procedure are correlated positively and statistically significantly, according to earlier researchers. Ayehualem et al. also discovered that there was a statistically significant difference in the initial Pirani score between the tenotomy and non-tenotomy groups.[15] Controversy still exists regarding the use of radiological parameters to assess CTEV [16.] Radiographic measures, such as TCA-AP view, TMT-AP view, TCA –lateral view, and TiC Lateral view are used to determine the severity of clubfoot.[6,7] As the total of lateral and AP TCA, TCI is another often studied parameter. TCA (AP view) 20°–40°, TCA (lateral view) 35°–50°, TCI 40°, and tarsometatarsal angle (AP view) 0°–20° were the radiographic values for children's feet according to Simons.[17] It is not possible to describe a specific range of angle measurements to healthy feet and club feet, as stated by **Herbsthofer et al.** Furthermore, traditional radiography is inaccurate for categorizing the severity of the clubfoot deformity due to the significant standard deviation in each group.[18] **Ippolito et al.** showed that in 75% of cases, AP view TCA was a poor predictor of hind foot correction.[19]

There are inherent hazards associated with significant surgical release, both short-term and long-term. Wound complications such as scarring, infection, neurovascular compromise, and avascular necrosis may occur in the immediate postoperative period. Overcorrection with calcaneus deformity, heel valgus, pes planus, and forefoot abduction may also occur, as well as in-correction with persistent equinus, heel varus, and adduct metatarsus. The non-surgical treatment of clubfoot has attracted renewed interest since these consequences have become more clearly seen.

Most clubfeet when treated shortly after birth, can be easily corrected by weekly manipulation and application of five or eight plaster casts by the Ponseti method.

The male-to-female ratio was 1.5:1. The male: female ratio in **Kite's series** was 2.07:1[20] and in the series of **Wyne Davis** was 2.17: 1[21]. In the **Jose A. Morcuende et.al** series male to female ratio was 2.02:1.[11] In **P.Harnett et.al.series** male to female ratio was 1:1.[22] The ratio obtained from our study is similar to the literature on age distribution.

As regards laterality, the ratio of bilateral to unilateral clubfoot is 1:2 (33.3 % bilateral and 66.7 % unilateral) which is in concordance with other series presented by workers like **Wyne Davis[23]** (44% bilateral and 56% unilateral), **P. Harnettet.al[22]** (52.5% bilateral and 47.5%unilateral), **Jose A. Morcuende et.al**[11] (38 % bilateral and 62 %unilateral).

We found that those feet which had lower initial Pirani scores of 3 to 4 were more amenable to correction and responded relatively early when compared to those with higher initial scores of 4 -6.

The average number of cast applications required to achieve full correction of the deformity in patients with a Pirani score of 4.5 to 6.0 was 7.6 and the average number of casts required to achieve full correction of deformity in patients with a Pirani score less than 4 is 5. In another study by **Laaveg et al**. the mean number of casts during their treatment was seven.[24] **Morcuende et.al[11]** reported that 90% of the patients required five or fewer casts. So no. of casts required for correction of the deformity is the same with compare to other studies.

In our study, 10 patients (33.3%) required percutaneous tenotomy of the Achilles tendon. According to the literature, 80% of the clubfoot treated by the Ponseti method requires percutaneous tenotomy, but the difference in our study may be due to the smaller number study population we were not able to conclude it.

In our study, we used 5 radiological parameters: the TCA and talo-first metatarsal angle on the AP view, the TCA and Tibiocalcaneal angle on the lateral view, and the TCI. We demonstrated a statistically significant improvement in all parameters towards the normal range during clinical correction using the Ponseti technique. In addition, both components of the Pirani score (midfoot and hindfoot scores) showed a significant improvement from the first visit to post-correction. We also investigated the correlation between the changes in clinical scores and the changes in radiological parameters. We found that the improvement in the Pirani score correlates insignificantly with the improvement in radiological parameters**.**

**El Hadi et al.** concluded that only AP and lateral talo-first metatarsal angles correlated with the Pirani score, while TCA on the AP view and tibiocalcaneal angle did not.[25]

**Bor et al.** treated 43/74 children with bilateral CTEV with a long 5-year follow-up. The mean pre-treatment Pirani scores were 5.08 ± 1.29. The successful outcome was achieved in 89% of children [26].

**Bhatiwal et al.** treated 156/300 children with bilateral clubfeet (mean pre-treatment Pirani scores was 5.5) were treated with the Ponseti technique with a successful outcome in 92% of patients. Percutaneous tenotomy of the Achilles tendon was done in 78% of cases.[27]

**Taghi Baghdadi, MD et study:** Conducted a study on 149 patients with 226 club feet and concluded that poor correlation between radiographic features and clinical outcome of clubfoot treated with the Ponseti method.[28]

**Sriharsha et al**. studied 76 patients of idiopathic clubfoot. They assessed the clinical outcome using the Pirani and Dimeligo scoring systems and assessed the radiological outcome using eight radiographic parameters. All 8 radiological parameters were found to correlate significantly with both clinical scores.[29]

In a series of 50 surgically treated patients, **Fridman et al.** concluded that there is a significant degree of association between the clinical outcome and the talo-first metatarsal angle, the calcaneo-second metatarsal, and the calcaneo-fifth metatarsal angles in AP projection. However, the TCA in both projections and the TCI did not show a statistically significant relationship with the functional score.[30]

In a series of 70 idiopathic clubfeet treated surgically, **Abulsaad and Abdelgaber et.al** measured the TCA, TCI, talo-first metatarsal angle, and calcaneo-first metatarsal angle in AP and lateral radiographs. Their clinical results were graded as excellent in 28.6% (20 feet), good in 40% (28 feet), fair in 17.1% (12 feet), and poor in 14.3% (10 feet). They confirmed that there was a statistically significant correlation between the clinical results and two angles: the talo-first metatarsal angle in the AP view and the calcaneo-first metatarsal angle in the lateral view.[31]

No statistically significant correlation was found between changes in the Pirani score and changes in radiological parameters. This has been previously suggested by many authors.[32]

Of the 40 cases, 8 feet had a recurrence of forefoot adduction, which required additional castings but finally, all the feet were supple and fitted properly within the Denise Browne splint. Repeat correction and casting were done after 2 weeks for them. Wallace.B.Lehman in his study on club foot puts the incidence of complications to be 10.2%. We had 0 % cast loosening because of good compliance of patients. 5 (16.6%) babies had developed pressure sores because of the cast which healed uneventfully.

Chatupon Chotigavanichaya MD et al concluded that the two most common complications of Ponseti serial casting were cast loosening (5.48%) and cast-associated skin irritation (5.48%).[33]

## LIMITATIONS OF THE STUDY

The limitations of the study include a small sample size, lack of a control group, and short follow-up.

## CONCLUSION

The clinical outcome is measured with Pirani clinical scoring system and many studies have shown their correlation during the phases of correction of CTEV. They are few attempts to correlate the radiological parameters with Pirani clinical scoring system. Our aim was to further find out whether a correlation between these parameters actually exists.

Out of 40 feet in 30 patients studied, our tabulated results show an insignificant correlation between changes in radiological parameters and changes in Pirani score during pre and post-correction, which is also supported by many other researchers. Although individually Pirani scores and radiological parameters correlated with the decrease in the severity of the corrected deformity during the course of the treatment. However, they don't significantly correlate with each other. They are good clinical outcome predictors by themselves. Our second objective was to determine whether the Pirani scoring system correlated with the clinical outcome of CTEV correction. According to our study findings, the Pirani scoring system correlated significantly with the clinical outcome of CTEV.

## REFERENCES

1. Gibbons PJ, Gray K. Update on clubfoot. Journal of paediatrics and child health 2013;49(9):E434-7.
2. Zionts LE, Jew MH, Ebramzadeh E, Sangiorgio SN. The influence of sex and laterality on clubfoot severity. Journal of Pediatric Orthopaedics. 2017;37(2):e129-33.
3. Harvey NJ, Mudge AJ, Daley DT, Sims SK, Adams RD. Inter-rater reliability of physiotherapists using the Pirani scoring system for clubfoot: comparison with a modified five-point scale. Journal of Pediatric Orthopaedics B. 2014;23(6):493-500.
4. Jain S, Ajmera A, Solanki M, Verma A. Interobserver variability in Pirani clubfoot severity scoring system between the orthopedic surgeons. Indian Journal of Orthopaedics. 2017;51(1):81-5.
5. Pirani S, Outerbridge HK, Sawatzky B, Stothers K. A reliable method of clinically evaluating a virgin clubfoot evaluation. In21st SICOT congress 1999;29:2-30.
6. Radler C, Manner HM, Suda R, Burghardt R, Herzenberg JE, Ganger R, Grill F. Radiographic evaluation of idiopathic clubfeet undergoing Ponseti treatment. JBJS. 2007;89(6):1177-83.
7. 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.
8. Morcuende JA. Congenital idiopathic clubfoot: prevention of late deformity and disability by conservative treatment with the Ponseti technique. Pediatric Annals. 2006;35(2):128-36.
9. Saltzman HM. Foot focus: international initiative to eradicate clubfeet using the Ponseti Method. Foot & ankle international. 2009;30(5):468-71.
10. Saltzman HM. Foot focus: international initiative to eradicate clubfeet using the Ponseti Method. Foot & ankle international. 2009;30(5):468-71.
11. Morcuende JA, Dolan LA, Dietz FR, Ponseti IV. Radical reduction in the rate of extensive corrective surgery for clubfoot using the Ponseti method. Pediatrics. 2004;113(2):376-80.
12. Herzenberg JE, Radler C, Bor N. Ponseti versus traditional methods of casting for idiopathic clubfoot. Journal of Pediatric Orthopaedics. 2002;22(4):517-21.
13. Flynn JM, Donohoe M, Mackenzie WG. An independent assessment of two clubfootclassification systems. Journal of Pediatric Orthopaedics 1998;18(3):323-7.

14. Wainwright AM, Auld T, Benson MK, Theologis TN. The classification of congenital talipes equinovarus. The Journal of Bone and Joint Surgery. British volume 2002;84(7):1020-4.
15. Addosooki A, Tammam H, Morsy AF, Marzouq A, Ahmed EH, Ahmed AM, Said E. Correlation of radiographic parameters with clinical correction in idiopathic congenital talipes equinovarus undergoing Ponseti treatment. International Orthopaedics 2021;45(12):3139-46.
16. Bansal VP, Daniel J, Rai J. Radiological score in the assessment of clubfoot. International orthopaedics 1988;12(3):181-5.
17. Simons GW. A standardized method for the radiographic evaluation of clubfeet. Clinical orthopaedics and related research 1978;(135):107-18.
18. Herbsthofer B, Eckardt A, Rompe JD, Küllmer K. Significance of radiographic angle measurements in the evaluation of congenital clubfoot. Archives of orthopaedic and trauma surgery. 1998;117(6):324-9.
19. Ippolito E, Fraracci L, Farsetti P, De Maio F. Validity of the anteroposterior talocalcaneal angle to assess congenital clubfoot correction. American Journal of Roentgenology. 2004;182(5):1279-82.
20. Turco VJ. Resistant congenital club foot--one-stage posteromedial release with internal fixation. A follow-up report of a fifteen-year experience. The Journal of Bone and Joint surgery. American Volume. 1979;61(6A):805-14.
21. Ganesan B, Luximon A, Al-Jumaily A, Balasankar SK, Naik GR. Ponseti method in the management of clubfoot under 2 years of age: A systematic review. PloS one 2017;12(6):e0178299.
22. Harnett P, Freeman R, Harrison WJ, Brown LC, Beckles V. An accelerated Ponseti versus the standard Ponseti method: a prospective randomized controlled trial. The Journal of Bone and Joint Surgery. British volume. 2011;93(3):404-8.
23. Wynne-Davies R. Family studies and the cause of congenital club foot. The Journal of Bone and Joint Surgery. British Volume. 1964;46(3):445-63.
24. Laaveg SJ, Ponseti IV. Long-term results of treatment of congenital club foot. The Journal of Bone and Joint Surgery. American Volume. 1980;62(1):23-31.
25. El Hadi MH, Nurein MA, Bader MA, Salih MM, Babikir HE. Radiological study of the anatomical bony arrangement of the clubfoot deformity and its correlation with the Pirani clinical scoring system: A multicenter study. Sudanese Journal of Paediatrics. 2019;19(2):101.
26. Bor N, Coplan JA, Herzenberg JE. Ponseti treatment for idiopathic clubfoot: minimum 5-year follow-up. Clinical orthopaedics and related research. 2009;467(5):1263-70.
27. Bhatiwal SK, Chopra BL, Khajotia BL, Chauhan S. Idiopathic clubfoot treated by Ponseti method: a series of 300 cases. Int J Res Orthop 2018;4:954.
28. Baghdadi T, Bagheri N, Najafi A, Mansouri P, Farzan M. Ponseti casting method in idiopathic congenital clubfoot and its correlation with radiographic features abstract. Archives of Bone and Joint Surgery. 2017;5(3):168.
29. Sriharsha Y, Balaji G, Bharathi D, Patro DK. Do the clinical scores (Pirani and Dimeglio scores) correlate with the radiological parameters of idiopathic clubfoot in infants? A cross-sectional study. Journal of Pediatric Orthopaedics B. 2020;30(5):471-7.
30. Fridman MW, de Almeida Fialho HS. The role of radiographic measurements in the evaluation of congenital clubfoot surgical results. Skeletal radiology. 2007;36(2):129-
31. Abulsaad M, Abdelgaber N. Correlation between clinical outcome of surgically treated clubfeet and different radiological parameters. Acta Orthopaedica Belgica 2008;74(4):489.
32. Ansar A, Rahman AE, Romero L, Haider MR, Rahman MM, Moinuddin M, Siddique MA, Al Mamun M, Mazumder T, Pirani SP, Mathias RG. Systematic review and metaanalysis of global birth prevalence of clubfoot: a study protocol. BMJ open 2018;8(3):e019246.
33. Chotigavanichaya C, Eamsobhana P, Ariyawatkul T, Saelim C, Kaewpornsawan K. Complications associated with PonsetI serial casting and surgical correction via soft tissue release in congenital idiopathic clubfoot. J Med Assoc Thai 2016;99(11):1192-7.