***Original Research Article***

# THE PIRANI SCORING SYSTEM IS EFFECTIVE IN ASSESSING SEVERITY AND MONITORING TREATMENT OF CLUBFEET IN CHILDREN


**ABSTRACT (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)**

**Background**: Pirani scoring system is one of the classification systems and is simple, easy to use in the management of clubfoot; however, there is paucity of studies using Pirani system to determine the severity and monitor progress in the treatment of clubfoot. We therefore set out with the aim of assessing severity and monitoring the progress of treatment using the Pirani scoring system. The study was conducted at the Department of Orthopaedics and Traumatology of Obafemi Awolowo University Teaching Hospitals Complex, Ile Ife between January 2011 and June 2015.

**Methodology**: It was a prospective study of 102 clubfeet in 61 patients less than 3 years of age, and born with idiopathic congenital talipes equinovarus. Corrective serial casts were applied after initial manipulations using Ponseti method. Variables of interest such as the biodata, midfoot score, hindfoot score, Pirani score, need for tenotomy and the number of casts to achieve correction were measured. The data obtained were subjected to statistical analysis using SPSS version 22. Significant statistical inferences were drawn at $p<0.05$.

**Results**: The correlation between the midfoot score, hindfoot score, Pirani score and the number of casts to achieve correction was significant ($p<0.001$). Also, there was correlation between the Pirani score and the need for tenotomy ($p<0.001$); between the number of casts to achieve correction and the need for tenotomy ($p<0.001$). Moreover, the progress of treatment can be monitored with the Pirani score ($p<0.001$)

**Conclusion**: Pirani scoring system is a simple and reliable system to determine severity and

monitor progress in the treatment of clubfoot.

*Keywords:* clubfoot, Pirani score, Ponseti method,

## 1. INTRODUCTION

Congenital Idiopathic Talipes Equinovarus (CTEV) is a common congenital Orthopaedic condition. According to Gray K et al., it is characterized by an excessively turned in foot and high medial longitudinal arch[1].

This entity is not just an isolated foot deformity but a complex, three-dimensional deformity of the foot with four components which are equinus, varus, adductus and cavus deformities[2].

The right foot is being affected slightly more often than the left. It is 2 - 2.5 times more common in males than females, regardless of the population studied[2].

There may also be development of secondary Genu recurvatum if the deformity is not corrected early[3].

Clubfoot presents in two forms: "syndromic", in which other malformations exist, and the more common "idiopathic" form, where there are no other associated malformations[4].

Globally, approximately one in one thousand people are born with at least one clubfoot; this incidence rate is fairly constant, with higher and lower incidences in specific ethnic groups. Eighty percent of infants with clubfoot live in developing countries[5]. It is said to be the commonest congenital musculoskeletal deformity in Nigeria[6] accounting for 52.8% of all malformations[7] with live births incidence of 3.4/1000[8].

The Ponseti method involves specific ways of manipulation and casting to achieve correction[9]. Once plastering is finished, the affected children are placed in a foot-abduction brace. The Ponseti technique is well established and has been shown to be highly effective[10]. Initial correction of the clubfoot deformity has been achieved in 95% of patients with use of Ponseti

method[11]. In Nigeria, Ponseti method has reduced the total costs of care and frequency of surgery[12] though there are still challenges among practitioners and parents of patients with clubfoot[13].

"The goal of clubfoot management is to provide long term correction of the deformity resulting in a foot that is fully functional, pain-free"[14] and without calluses and such patient is able to put on normal shoes[15].

Clubfoot has been classified into mild, moderate and severe but this is too subjective.

There are different classification systems used to determine the severity and outcome of treatment among which are Dimeglio/Bensahel classification system[16,17], Catteral/Pirani classification system[18], Ponseti and Smoley classification system[18,19], Harrold and Walker classification system[20] and the International Clubfoot Study Group[17]. Out of these systems, the commonly used ones are the Dimeglio/Bensahel and the Catteral/Pirani systems[18].

The Pirani system, devised by Shafiq Pirani, MD, of Vancouver, has six categories; three in the mid-foot and three in the hind-foot. The mid-foot categories are curvature of the lateral border of the foot (CLB), medial crease (MC), uncovering of the lateral head of talus (LHT). The hind-foot categories are posterior crease (PC), emptiness of the heel (EH), and degree of dorsi-flexion (DF) [21,22]. Each category can have three scores depending on the severity which are 0, 0.5 and 1. The best possible score for a normal foot is 0 and the worse is 6. Pirani et al. system had been validated and proven reliable to accurately quantify the severity of a clubfoot deformity. This system is now routinely used in describing the outcomes of treatment[23]. This study aims to evaluate the reliability of the Pirani score in assessing severity of clubfoot and monitoring progress of treatment.

## 2. METHODOLOGY

It was a hospital based prospective study designed to evaluate the reliability of the Pirani score in assessing severity of clubfoot and monitoring progress of treatment. Consecutive patients

presenting at the outpatient clubfoot clinic of Obafemi Awolowo University Teaching Hospitals Complex, Ile Ife with idiopathic clubfoot and in-patients with clubfoot who are less than 3 years old, were recruited into the study. Exclusion criteria included: clubfoot patients that are 3 years old and more, syndromic clubfoot and recurrent clubfoot. Ethical approval was obtained from the institution ethics and research committee.

An informed consent was obtained from the parent/guardian. Patient's bio-data, clinical examination and Pirani score at presentation were entered into a structured information sheet by the main author. Corrective serial casts were applied after carrying out manipulations for three minutes according to the Ponseti method, these castings were done by consultants and Senior Residents in the department that are experienced in Ponseti method of clubfoot management and they were blinded to the study. The ligaments, joint capsules and tendons were stretched with gentle manipulations and a plaster cast (above knee cast) with knee in 90 degree flexion was applied after each session to retain the degree of correction obtained and to soften the ligaments.

As a result of these, the displaced bones were gradually brought into the correct alignment. Serial manipulation and above knee cast was continued until $50^0$ – $70^0$ abduction was achieved. The last cast was to correct the equinus and if ≥$15^0$ dorsiflexion was gotten, the cast was applied for three week after which patient had foot abduction brace. However, if the dorsiflexion was less than $15^0$, patient then had Tendo- Achilles tenotomy to achieve at least $15^0$ of dorsiflexion, thereafter, patient had cast for three week, following which foot abduction brace to retain the correction was applied.

Patients were made to wear the brace for about 23 hours a day for the first 3 months after achieving correction and thereafter the braces were worn at nights till patient attains age 4. The Pirani scores of the patients were monitored throughout the treatment period.

Severity in this study was determined based on the number of casting sessions and the need for tenotomy as shown below[24]. Mild cases according to this table had less than or equal to 5 casting sessions without tenotomy; moderate cases had more than 5 casting sessions without tenotomy or less than or equal to 5 casting sessions with tenotomy while severe cases had more than 5 casting sessions with tenotomy.

**Table 1: Severity of Categories**

| Severity of Clubfoot | No of casting sessions | Need for Tenotomy |
|---|---|---|
| Mild | < 5 | No tenotomy |
| Moderate | >5 | No tenotomy |
| | ≤ 5 | Had tenotomy |
| Severe | >5 | Had tenotomy |

All analyses were performed by the main author on the basis of the intention-to-treat cohort, defined as all clubfoot patients who received at least one form of clubfoot treatment.

The Data that were collected included the name, age, sex, initial Pirani scores, number of casting sessions, the need for tenotomy and Pirani scores at full correction. Data collected from the study groups was entered into a worksheet and analysis was performed using the statistical package for social sciences (SPSS; IBM; Chicago, Illinois) software for windows version 22. Frequency distribution for the variables were presented in tables and charts and significant statistical deductions were made at $p<0.05$. Analysis of Variance (ANOVA) was used to compare means in various severity groups in order to know which component of the score best predicts severity. Pearson correlation coefficient was also used to compare midfoot, hindfoot and Pirani scores with the number of casts to achieve correction..

## 3. RESULTS

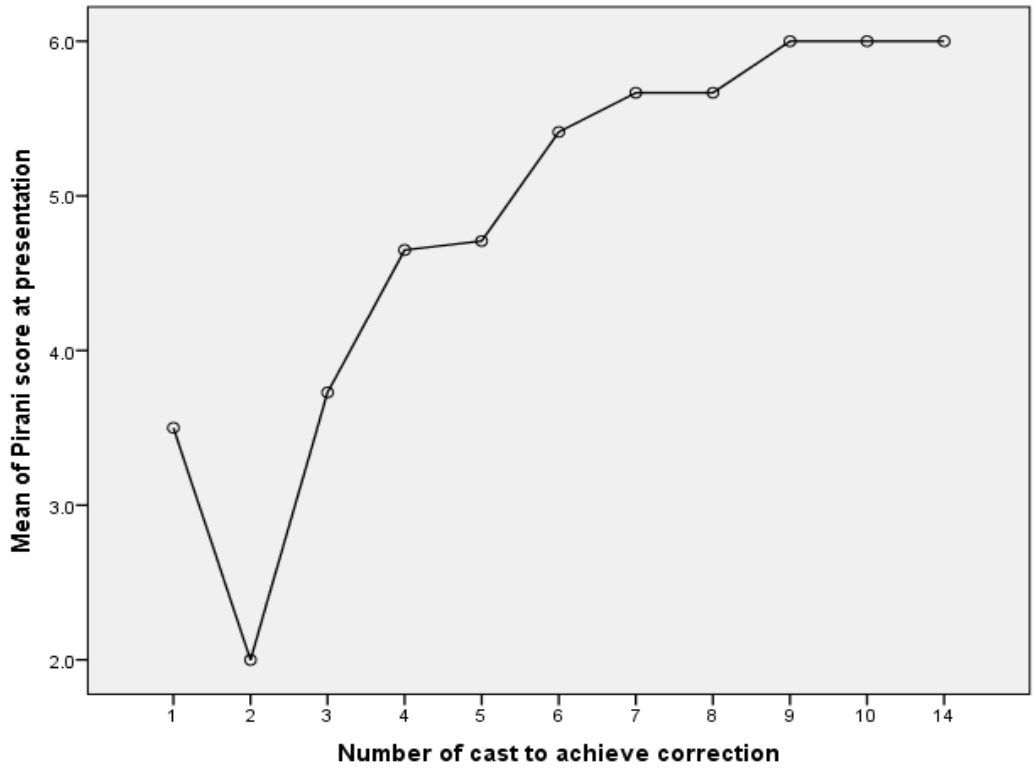
Sixty one patients comprising of thirty eight males (62.3%) and twenty three females (37.7%) with sex ratio of 1.7:1 were recruited. Twelve weeks was the median age (range: 0.6 -134 weeks), twenty two patients (36.1 %) were neonates, thirty one (50.8%) were infants while the remaining eight patients (13.1%) were above one year at presentation. Forty one patients (67.2%) had bilateral clubfoot (82 feet) while twenty (32.8%) had unilateral clubfoot (20 feet). Among the twenty unilateral clubfoot, ten patients (16.4%) were left sided while the remaining ten (16.4%) were right sided. The numbers of clubfeet managed in these sixty one patients were one hundred and two. Sixty seven feet (65.7%) had tenotomy while thirty five (34.3%) feet did not have tenotomy. The mean number of casting sessions was 5.1+/- 2.2. Nineteen feet (18.6%) had more than 6 casting sessions. The mean of the midfoot score, hindfoot score and the Pirani score at presentation are as shown in table 2 below.

**Table 2: Demographic characteristics of patients and the number of casts to achieve correction, the midfoot scores, the hindfoot scores and the Pirani scores of the 102 feet examined.**

| Patients' characteristics | | Frequency (%) |
|---|---|---|
| **Age (weeks)** | 0 – 4 | 22 (36.1) |
| | >4 – 52 | 31 (50.8) |
| | >52 | 8 (13.1) |
| **Sex** | Male | 38 (62.3) |
| | Female | 23 (37.7) |
| **Foot affected** | Bilateral | 41 (67.2) |
| | Unilateral | 20 (32.8) |
| **Tenotomy** | Yes | 67 (65.7) |
| | No | 35 (34.3) |
| | | |
| **Variables** | | **Mean (Standard deviation)** |
| **Number of cast to achieve correction** | | 5.07 (2.23) |
| **Midfoot score at presentation** | | 2.36 (0.60) |
| **Hindfoot score at presentation** | | 2.39 (0.62) |
| **Pirani score at presentation** | | 4.75 (0.11) |

The mean Pirani score for clubfoot that had tenotomy at presentation was 5.1 +/-1.0 while that for the feet that did not have tenotomy was 4.2 +/-1.1. This was statistically significant. (T-test= 9.24; df =1; p=<0.001; 95% C.I. =1.112-1.722).

**Figure 1: Graph depicting the Pirani score at presentation and number of cast to achieve correction.**




There was a significant statistical association between the Pirani, midfoot and hindfoot scores at presentation and the number of casting sessions patients had (p<0.001).

**Table 3: Correlation between number of casts to achieve correction versus the midfoot, hindfoot and the Pirani scores**

| Categories | Variables | N | Mean no of cast (SD) | P value < |
|---|---|---|---|---|
| Midfoot score | Mild | 27 | 3.48 (0.80) | .001[x] |
| | Moderate | 42 | 4.29 (1.40) | |
| | Severe | 33 | 7.36 (2.07) | |
| Hindfoot score | Mild | 27 | 3.48 (0.80) | .001[x] |
| | Moderate | 42 | 4.29 (1.40) | |
| | Severe | 33 | 7.36 (2.07) | |
| Pirani score | Mild | 27 | 3.48 (0.80) | .001[x] |
| | Moderate | 42 | 4.29 (1.40) | |
| | Severe | 33 | 7.36 (2.07) | |

[x]**Pearson correlation coefficient**

In order to assess for the statistical significance of whether the Pirani score can be used to monitor the progress of treatment of clubfoot using Ponseti protocol, paired T test was used to compare the Pirani scores at presentation and Pirani scores at full correction on one hand and the Pirani scores at presentation and whether or not the patient had tenotomy. This was found to be statistically significant, which means that the progress of treatment of clubfoot and whether or not the patient will need tenotomy can be assessed using the Pirani scoring system (P<0.001).

**Table 4: Association between the Pirani scores at presentation/Pirani score at correction and Pirani score at presentation/the need for tenotomy.**

| Categories | Variables | N | Mean (SD) | P value < |
|---|---|---|---|---|
| Pirani score | At Presentation | 102 | 4.750 (1.105) | .001* |
| | At full correction | 102 | 0.177 (0.315) | |
| Pirani score | Had tenotomy | 67 | 5.060 (0.177) | .001* |
| | Did not have tenotomy | 35 | 4.157 (1.149) | |

*Paired T-test

**Tables 5: Severity of clubfoot versus mean Pirani score.**

| Categories | Variables | N | Mean of the initial Pirani score(SD) | P value < |
|---|---|---|---|---|
| Pirani score | Mild | 27 | 3.80 (1.02) | .001 |
| | Moderate | 42 | 4.67 (0.98) | |
| | Severe | 33 | 5.64 (0.44) | |
| Number of cast | Mild | 27 | 3.48 (0.80) | .001 |
| | Moderate | 42 | 4.29 (1.40) | |
| | Severe | 33 | 7.36 (2.07) | |

## Discussion.

Clubfoot is a common musculoskeletal deformity in our environment[7]and Ponseti treatment protocol is the current standard of care globally[25]. The age range of the sixty-one patients studied was 0.6 to 134 weeks with median age of 12weeks. This is rather late when compared with figures obtained by workers in developed world such as Zimmerman et al.[26] and Brewster et al.[27]. This age disparity at tenotomy was also noted by Adegbehingbe et al.[28] and Goksan et al.[29]. Late presentation as seen in our study may be because, most of our patients pay out of pocket to access treatment and this may take a while for the parents to raise sufficient fund for

the treatment. Also, there are not enough trained personnel to manage clubfoot deformity in the developing countries which might make our patients to travel several hundred kilometres to access treatment. There was male preponderance with male to female ratio of 1.7:1; this is similar to findings by other researchers[4,30,31]. Among the 61 patients studied, 67.2% of the patients had bilateral clubfoot, while the remaining 32.8% were unilateral with equal distribution between the left and the right. This is similar to the result of Awang et al.[32]. However, this is in contrast to the preponderance of unilateral clubfoot as documented by Ponseti, Matuszewski and Adewole et al. in their studies at different point in time[6,19,33].

In our study, 24 feet were in the mild, 42 feet in moderate and 33 feet in the severe group according to the classification earlier stated. Wang et al. in their study in 2009 classify clubfoot into mild, moderate and severe based solely on the Pirani score with highest number in the moderate group similar to the finding in this study[34]. However, Harrold in 1983 with similar classification had highest number in the mild group[20]. It should be noted that different parameters were used in the two studies. In addition to this, 102 feet had Ponseti treatment in this study, 65.7% of them had tenotomy while 34.3% did not have tenotomy. Lebel et al. in their study on 56 babies, 73% of them had percutaneous tenotomy[35]; of the two groups studied by Xu in Beijing, 87.5% of each of the groups had tenotomy[36]. In contrast to this, Tindall et al. in their study done in Blantyre, 57 of the 98 feet corrected using the Ponseti treatment protocol did not require tenotomy[37]. It should be noted that percutaneous tenotomy could be used to determine the severity of clubfoot[38,39].

The mean number of casting sessions for the affected feet was 5.1 ± 2.2. Pulak et al. in Ethiopia 2012 found average number of casting sessions of 4.9[39], Awang et al. had an average of 5.2 casting sessions[32] and Laaveg et al. in 1980, in USA had mean number of casts of 7[40]. This is an interesting finding because despite the late presentation in our setting, we still have a comparable number of casting sessions with workers in other parts of the world where patients

presented earlier. The implication of this may be the fact that outcome of clubfoot treatment may not be significantly affected by age at presentation as long as the patient is an infant. This may need further research. The average Pirani score for the feet that had tenotomy was 5.1±1.0 which was higher than 4.2±1.1 for the feet that did not have tenotomy. This was similar to the average Pirani score as reported by Dyer et al. in their study on the role of the Pirani scoring system in the management of club foot by the Ponseti method done in 2006[22]. Singh in 2009 found a positive correlation between the initial Pirani score and the need for tenotomy[41]. In another study by Scher et al, 85.2% of the patients that had Pirani score of ≥5 had tenotomy, moreover, those that underwent tenotomy required significantly more casts[23]. This proves that severe clubfoot (as predicted by higher Pirani score) may need tenotomy hence, both the managing team and the parents of the patient may be better prepared. Comparing the initial midfoot scores, hindfoot scores, Pirani scores and the number of casts needed to achieve correction, the correlation between the parameters was significant, this implies that the higher the midfoot, hindfoot and Pirani scores, the more the number of casting sessions needed by the patient to achieve correction. Since the Pirani score is made up of the summation of mid foot and hind foot scores, this observed positive correlation which is a direct proportional relationship is not unexpected. Agarwal et. al in 2014 showed positive correlation between the initial Pirani scores and the number of casts to achieve full correction in 297 patients with 442 clubfeet[42]. Awang et. al in 2014 studied the effect of age, weight and initial Pirani score on the number of casts needed for full correction and came out with the conclusion that Pirani score was the only significant predictor among the parameters studied[32]. Some other authors showed the effect of midfoot, hindfoot and initial Pirani score on the rate at which full correction was achieved[43-45]. However, Gao et. al and Chu et. al showed no correlation between the Pirani score and the number of casts to achieve correction in the clubfoot patients treated[18,46].

Moreover, monitoring the progress of treatment of clubfoot using the Ponseti protocol employed the paired T-test to compare the initial Pirani scores and the Pirani scores at full correction on one hand and the initial Pirani scores and whether or not the patient had tenotomy. This showed statistical significance which implies that Pirani score can be used to monitor the progress of treatment of clubfoot using the Ponseti protocol. Pulak et.al in 2012 found out that there was a significant difference between the pre-treatment Pirani scores and the post-treatment Pirani scores in the 40 patients they treated in Ethiopia with the Ponseti method[39]. Moreover, Faizan et. al in 2015 showed statistical significance between the pre and post treatment Pirani scores among 19 patients with 28 clubfeet[47]. Some authors also showed statistically significant effect of the severity of clubfoot on the need for tenotomy[22,23,39]. It was noted that the severity of the clubfoot determines the number of casts needed to achieve full correction: mild clubfoot had fewer numbers of casts than moderate which also had fewer numbers of casts compared to the severe clubfoot. Statistical test showed that this is significant. Wang et. al in 2009 showed significant difference in the number of casts to achieve correction in the three groups of mild, moderate and severe clubfoot deformities they studied[34].

This study is one of the few studies assessing the severity of clubfoot and monitoring progress of treatment using Pirani scoring system done in developing world, however, it would have been better to have higher sample size than this.

## 4. CONCLUSION

Pirani scoring system can be used to assess severity of clubfoot and at the same time monitor the progress of treatment. This is a simple and easy to use classification system.

## CONSENT

Informed consent was obtained from the parents/caregivers of the patients that were recruited for this study. This was a prerequisite to obtaining the ethical approval. A copy of the consent will be made available to the editors on request.

## ETHICAL APPROVAL

Ethical approval was obtained from the institution ethics and research committee. Registration number: International IRB/IEC/0004553. National: NHREC/27/02/2009a. Protocol number: ERC/2012/10/08.

## REFERENCES


1. Gray K, Pacey V, Gibbons P, Little D, Frost C, Burns J. Interventions for congenital talipes equinovarus (clubfoot). *The Cochrane database of systematic reviews.* 2012;4:Cd008602.
2. Miedzybrodzka Z. Congenital talipes equinovarus (clubfoot): a disorder of the foot but not the hand. *Journal of anatomy.* 2003;202(1):37-42.
3. Ballantyne J, Macnicol M. (i) Congenital talipes equinovarus (clubfoot): an overview of the aetiology and treatment. *Current Orthopaedics.* 2002;16(2):85-95.
4. Pavone V, Bianca S, Grosso G, et al. Congenital talipes equinovarus: an epidemiological study in Sicily. *Acta orthopaedica.* 2012;83(3):294-298.
5. Saltzman HM. Foot focus: international initiative to eradicate clubfeet using the Ponseti method. *Foot & ankle international.* 2009;30(5):468-471.
6. Adewole OA, Giwa SO, Kayode MO, Shoga MO, Balogun RA. Congenital club foot in a teaching hospital in Lagos, Nigeria. *African journal of medicine and medical sciences.* 2009;38(2):203-206.
7. Omololu B, Ogunlade SO, Alonge TO. Pattern of congenital orthopaedic malformations in an African teaching hospital. *West African journal of medicine.* 2005;24(2):92-95.
8. Ukoha U, Okafor A, Ogugua I, Udemezue P, Olisah O, Anyabolu R. Incidence of congenital talipes equinovarus among children in southeast Nigeria. *Int J of Biol & Med Res.* 2011;2:712-715.
9. 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):376-380.
10. Harnett P, Freeman R, Harrison WJ, Brown LC, Beckles V. An accelerated Ponseti versus the standard Ponseti method: a prospective randomised controlled trial. *The Journal of bone and joint surgery. British volume.* 2011;93(3):404-408.
11. Steinman S, Richards BS, Faulks S, Kaipus K. A comparison of two nonoperative methods of idiopathic clubfoot correction: the Ponseti method and the French functional (physiotherapy) method. Surgical technique. *The Journal of bone and joint surgery. American volume.* 2009;91 Suppl 2:299-312.
12. Adegbehingbe OO, Oginni LM, Ogundele OJ, Ariyibi AL, Abiola PO, Ojo OD. Ponseti clubfoot management: changing surgical trends in Nigeria. *The Iowa orthopaedic journal.* 2010;30:7-14.
13. Akintayo OA, Adegbehingbe O, Cook T, Morcuende JA. Initial program evaluation of the Ponseti method in Nigeria. *The Iowa orthopaedic journal.* 2012;32:141-149.
14. Dobbs MB, Gurnett CA. Update on clubfoot: etiology and treatment. *Clinical orthopaedics and related research.* 2009;467(5):1146-1153.
15. Dobbs MB, Rudzki JR, Purcell DB, Walton T, Porter KR, Gurnett CA. Factors predictive of outcome after use of the Ponseti method for the treatment of idiopathic clubfeet. *The Journal of bone and joint surgery. American volume.* 2004;86-a(1):22-27.

16. Dimeglio A, Bensahel H, Souchet P, Mazeau P, Bonnet F. Classification of clubfoot. *Journal of pediatric orthopedics. Part B.* 1995;4(2):129-136.
17. Celebi L, Muratli HH, Aksahin E, Yagmurlu MF, Bicimoglu A. Bensahel et al. and International Clubfoot Study Group evaluation of treated clubfoot: assessment of interobserver and intraobserver reliability. *Journal of Pediatric Orthopaedics B.* 2006;15(1):34-36.
18. Chu A, Labar AS, Sala DA, van Bosse HJ, Lehman WB. Clubfoot classification: correlation with Ponseti cast treatment. *Journal of pediatric orthopedics.* 2010;30(7):695-699.
19. Ponseti IV, Smoley EN. The classic: congenital club foot: the results of treatment. 1963. *Clinical orthopaedics and related research.* 2009;467(5):1133-1145.
20. Harrold AJ, Walker CJ. Treatment and prognosis in congenital club foot. *The Journal of bone and joint surgery. British volume.* 1983;65(1):8-11.
21. Hussain FN. The role of the Pirani scoring system in the management of club foot by the Ponseti method. *The Journal of bone and joint surgery. British volume.* 2007;89(4):561; author reply 561-562.
22. Dyer PJ, Davis N. The role of the Pirani scoring system in the management of club foot by the Ponseti method. *The Journal of bone and joint surgery. British volume.* 2006;88(8):1082-1084.
23. Scher DM, Feldman DS, van Bosse HJ, Sala DA, Lehman WB. Predicting the need for tenotomy in the Ponseti method for correction of clubfeet. *Journal of pediatric orthopedics.* 2004;24(4):349-352.
24. Ponseti IV. Clubfoot management. *Journal of pediatric orthopedics.* 2000;20(6):699-700.
25. Iltar S, Uysal M, Alemdaroglu KB, Aydogan NH, Kara T, Atlihan D. Treatment of clubfoot with the Ponseti method: should we begin casting in the newborn period or later? *The Journal of foot and ankle surgery : official publication of the American College of Foot and Ankle Surgeons.* 2010;49(5):426-431.
26. Zimmerman CC, Nemeth BA, Noonan KJ, et al. Reliability of radiographic measures in infants with clubfoot treated with the Ponseti method. *Journal of children's orthopaedics.* 2015;9(2):99-104.
27. Brewster MB, Gupta M, Pattison GT, Dunn-van der Ploeg ID. Ponseti casting: a new soft option. *The Journal of bone and joint surgery. British volume.* 2008;90(11):1512-1515.
28. Adegbehingbe OO, Asuquo JE, Joseph MO, Alzahrani M, Morcuende JA. The Heel Pad in Congenital Idiopathic Clubfoot: Implications of Empty Heel for Clinical Severity Assessment. *The Iowa orthopaedic journal.* 2015;35:169-174.
29. Goksan SB, Bilgili F, Eren I, Bursali A, Koc E. Factors affecting adherence with foot abduction orthosis following Ponseti method. *Acta orthopaedica et traumatologica turcica.* 2015;49(6):620-626.
30. Lavy CB, Mannion SJ, Mkandawire NC, et al. Club foot treatment in Malawi - a public health approach. *Disability and rehabilitation.* 2007;29(11-12):857-862.
31. Ford-Powell VA, Barker S, Khan MS, Evans AM, Deitz FR. The Bangladesh clubfoot project: the first 5000 feet. *Journal of pediatric orthopedics.* 2013;33(4):e40-44.
32. Awang M, Sulaiman AR, Munajat I, Fazliq ME. Influence of Age, Weight, and Pirani Score on the Number of Castings in the Early Phase of Clubfoot Treatment using Ponseti Method. *The Malaysian journal of medical sciences : MJMS.* 2014;21(2):40-43.
33. Matuszewski L, Gil L, Karski J. Early results of treatment for congenital clubfoot using the Ponseti method. *European journal of orthopaedic surgery & traumatology : orthopedie traumatologie.* 2012;22(5):403-406.

34. Wang YZ, Wang XW, Zhang P, Wang XS. Application of Ponseti method in patients older than 6 months with congenital talipes equinovarus. *Beijing da xue xue bao. Yi xue ban = Journal of Peking University. Health sciences.* 2009;41(4):452-455.
35. Lebel E, Karasik M, Bernstein-Weyel M, Mishukov Y, Peyser A. Achilles tenotomy as an office procedure: safety and efficacy as part of the Ponseti serial casting protocol for clubfoot. *Journal of pediatric orthopedics.* 2012;32(4):412-415.
36. Xu RJ. A modified Ponseti method for the treatment of idiopathic clubfoot: a preliminary report. *Journal of pediatric orthopedics.* 2011;31(3):317-319.
37. Tindall AJ, Steinlechner CW, Lavy CB, Mannion S, Mkandawire N. Results of manipulation of idiopathic clubfoot deformity in Malawi by orthopaedic clinical officers using the Ponseti method: a realistic alternative for the developing world? *Journal of pediatric orthopedics.* 2005;25(5):627-629.
38. Aydin BK, Senaran H, Yilmaz G, Acar MA, Kirac Y. The need for Achilles tenotomy in the Ponseti method: Is it predictable at the initiation or during the treatment? *Journal of pediatric orthopedics. Part B.* 2015;24(4):341-344.
39. Pulak S, Swamy M. Treatment of idiopathic clubfoot by ponseti technique of manipulation and serial plaster casting and its critical evaluation. *Ethiopian journal of health sciences.* 2012;22(2):77-84.
40. 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.
41. Singh A. Analysis of Correlation of Foot Bimalleolar Angle and Pirani Scoring for its Predictive value in the management of Idiopathic CTEV by Ponseti Method *Internet J Ortho Surg.* 2008;12(1).
42. Agarwal A, Gupta N. Does initial Pirani score and age influence number of Ponseti casts in children? *International orthopaedics.* 2014;38(3):569-572.
43. Goriainov V, Judd J, Uglow M. Does the Pirani score predict relapse in clubfoot? *Journal of children's orthopaedics.* 2010;4(5):439-444.
44. Nagaraju KD, Vidyadhara S, Shetty AP, Venkatadass K, Rajasekaran S. Use of Ponseti's technique in recurrent clubfeet following Kite's method of correction. *Journal of pediatric orthopedics. Part B.* 2008;17(4):189-193.
45. Rijal R, Shrestha BP, Singh GK, et al. Comparison of Ponseti and Kite's method of treatment for idiopathic clubfoot. *Indian journal of orthopaedics.* 2010;44(2):202-207.
46. Gao R, Tomlinson M, Walker C. Correlation of Pirani and Dimeglio scores with number of Ponseti casts required for clubfoot correction. *Journal of pediatric orthopedics.* 2014;34(6):639-642.
47. Faizan M, Jilani LZ, Abbas M, Zahid M, Asif N. Management of Idiopathic Clubfoot by Ponseti Technique in Children Presenting After One Year of Age. *The Journal of foot and ankle surgery : official publication of the American College of Foot and Ankle Surgeons.* 2015;54(5):967-972.