

Original Research Article

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3 **ASSESSING CLUBFOOT SEVERITY AND MONITORING TREATMENT PROGRESS USING THE**
4 **PIRANI SCORING SYSTEM**
5 **ABSTRACT (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)**
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Background: Pirani scoring system is one of the classification systems and is simple, easy to use in management of clubfoot; however, there is paucity of study using Pirani system to determine the severity and 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 who are less than 3 years of age, and born with idiopathic congenital talipes equinovarus,. Thereafter, 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 cast to achieve correction was significant ($p < 0.001$). Also, there was correlation between the Pirani score and the need for tenotomy ($p < 0.001$) and between the number of cast 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 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 characterised 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. The calcaneus, navicular and cuboid bones are rotated medially in relation to talus, and they are held in adduction and inversion by the surrounding ligaments and tendons. "Although the foot is supinated, the front of the foot is pronated in relation to back of the foot, causing cavus. In addition, the first metatarsal is more plantar flexed" [2].

The right foot 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 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.

Between 150,000 and 200,000 babies are born with a clubfoot each year giving a rate of one infant born with clubfoot every 3 minutes. Eighty percent of infants with clubfoot live in developing countries[5] and 3.4/1000 live births incidence was reported in Nigeria[6].

31 The Ponseti method involves stretching of the deformity in synchronized technique followed by
32 application of a long-leg cast. The standard Ponseti protocol uses weekly above knee plaster
33 cast combined with specific manipulation techniques to correct the deformities. All components
34 of the deformity usually correct within 4 to 5 weeks with the exception of the equinus which is
35 corrected completely with percutaneous tendo-achilles tenotomy followed by a final plaster cast
36 for three weeks[7]. Once plastering is finished, children are placed in a foot-abduction brace.
37 The Ponseti technique is well established and has been shown to be highly effective[8].
38 Initial correction of the clubfoot deformity has been achieved in 95% of patients with use of
39 Ponseti method[9].
40 “The goal of clubfoot management is to provide long term correction of the deformity resulting in
41 a foot that is fully functional, pain-free”[10] and without calluses and the patient is able to put on
42 normal shoes[11].
43 Clubfoot has been classified into mild, moderate and severe but is too subjective.
44 There are different classification systems used to determine the severity and outcome of
45 treatment for clubfoot among which are Dimeglio/Bensahel classification system[12,13],
46 Catteral/Pirani classification system[14], Ponseti and Smoley classification system[14,15],
47 Harrold and Walker classification system[16] and the International Clubfoot Study Group[13]. Of
48 these systems, the commonly used ones are the Dimeglio/Bensahel and the Catteral/Pirani
49 systems[14].
50 The Pirani system, devised by Shafiq Pirani, MD, of Vancouver, has six categories; three in the
51 mid-foot and three in the hind-foot.
52 The mid-foot categories are curvature of the lateral border of the foot (CLB), medial crease
53 (MC), uncovering of the lateral head of talus (LHT). The hind-foot categories are posterior
54 crease (PC), emptiness of the heel (EH), and degree of dorsi-flexion (DF)[17,18]. Each category
55 can have three scores depending on the severity which are 0, 0.5 and 1. The best possible

56 score for a normal foot is 0 and the worse is 6. Pirani et al. system had been validated and
57 proven reliable to accurately quantify the severity of a clubfoot deformity. This system is now
58 routinely used in describing the outcomes of treatment[19]. This study is aimed at assessing the
59 severity and progress of clubfoot treatment using Pirani score. Outcome of this study will help in
60 predicting the probable patients that will benefit from tenotomy, and also assist in estimating
61 number of casting session that may be required. This in turn will assist the parent /caregiver to
62 prepare both psychologically and financially for the treatment which may help in reducing the
63 rate of dropout during treatment.

64 **2. METHODOLOGY**

65 It was a hospital based prospective study designed to predict the severity and monitor progress
66 of treatment of clubfoot using the Pirani classification system. Consecutive patients presenting
67 at the outpatient clubfoot clinic of Obafemi Awolowo University Teaching Hospitals Complex, Ile
68 Ife with idiopathic clubfoot, in patients who are less than 3 years old, were recruited into the
69 study. Ethical approval was obtained from the institution ethics and research committee. An
70 informed consent was obtained from the parent/guardian. Patient's bio-data, clinical
71 examination and Pirani score at presentation was entered into a structured information sheet.
72 Corrective serial casts were applied after carrying out manipulations for three minutes according
73 to the Ponseti method.
74 The ligaments, joint capsules and tendons were stretched with gentle manipulations. A plaster
75 cast (above knee cast) with knee in 90 degree flexion was applied after each session to retain
76 the degree of correction obtained and to soften the ligaments.
77 Thereby, the displaced bones were gradually brought into the correct alignment.
78 Treatment was started as soon as referral was received. After achieving correction of the
79 deformity, foot abduction brace was instituted to retain the correction. Patients were made to
80 wear the brace for about 23 hours a day for the first 3 months after achieving correction and
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83 thereafter the braces are worn at nights. The Pirani scores of the patients were monitored

84 throughout the treatment period.

85 Severity in this study was determined based on the number of casting sessions and need for

86 tenotomy as shown below [20]. Mild cases according to this table had less than or equal to 5

87 casting sessions without tenotomy; moderate cases had more than 5 casting sessions without

88 tenotomy or less than or equal to 5 casting sessions with tenotomy while severe cases had

89 more than 5 casting sessions with tenotomy.

90 **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

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93 All analyses were performed on the basis of the intention-to-treat cohort, defined as all clubfoot

94 patients who received at least one form of clubfoot treatment.

95 The Data that were collected included the name, age, sex, initial Pirani scores, number of

96 casting sessions, the need for tenotomy and Pirani score at full correction. Data collected from

97 the study groups was entered into a worksheet and analysis was performed using the statistical

98 package for social sciences (SPSS; IBM; Chicago, Illinois) software for windows version 22.

99 Frequency distribution for the variables were presented in tables and charts and significant

100 statistical deductions were made at $p < 0.05$. Analysis of Variance (ANOVA) was also used to

101 compare mean in various severity groups in order to know which component of the score best

102 predicts severity.

103 **3. RESULTS AND DISCUSSION**

104 Sixty one patients comprising of thirty eight males (62.3%) and twenty three females (37.7%)
 105 with sex ratio of 1.7:1 were recruited. Twelve weeks was the median age (range: 0.6 -134
 106 weeks), twenty two patients (36.1 %) were neonates, thirty one (50.8%) were infants while the
 107 remaining eight patients (13.1%) were above one year at presentation. Forty one patients
 108 (67.2%) had bilateral clubfoot (82 feet) while twenty (32.8%) had unilateral clubfoot (20 feet).
 109 Among the twenty unilateral clubfoot, ten patients (16.4%) were left sided while the remaining
 110 ten (16.4%) were right sided. The numbers of clubfeet managed in these sixty one patients were
 111 102. Sixty seven feet (65.7%) had tenotomy while thirty five (34.3%) feet did not have tenotomy.
 112 The mean number of casting sessions was 5.1+/- 2.2. Nineteen feet (18.6%) had more than 6
 113 casting sessions. The mean of the midfoot score, hindfoot score and the Pirani score at
 114 presentation are as shown in table 2 below.

115

116 **Table 2: Number of casts to achieve correction, the midfoot scores, the hindfoot scores**
 117 **and the Pirani scores of the 102 feet examined.**

Variables	Mean	Standard deviation
Number of cast to achieve correction	5.07	2.23
Midfoot score at presentation	2.36	.60
Hindfoot score at presentation	2.39	.62
Pirani score at presentation	4.75	.11

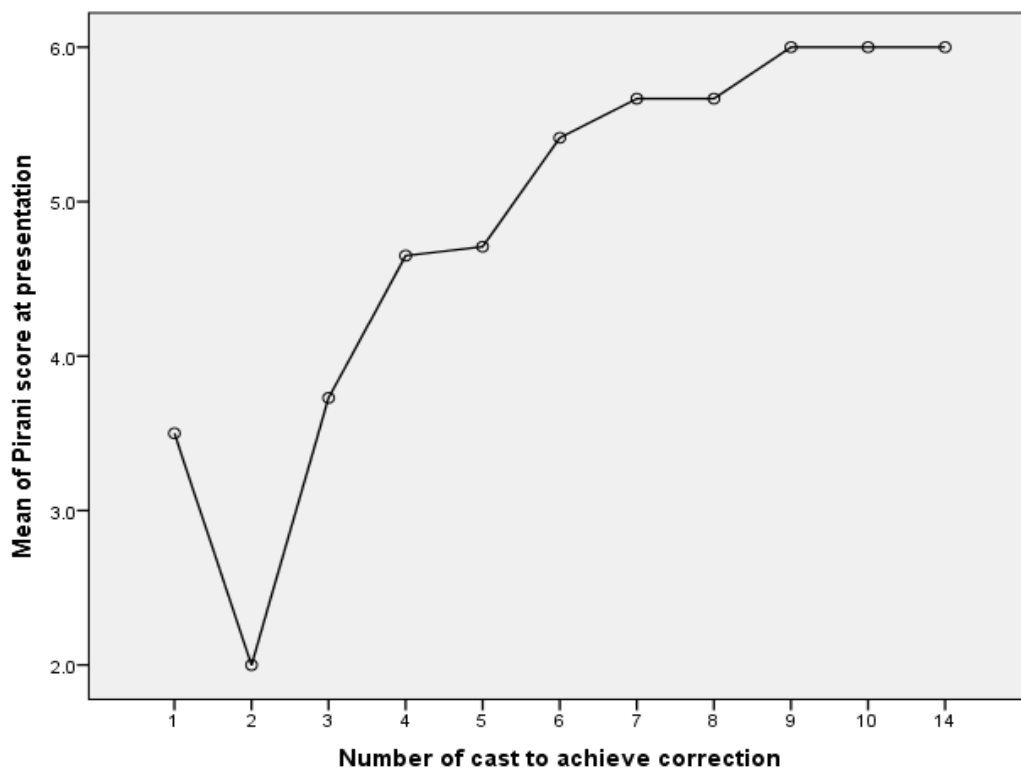
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119 The mean Pirani score at presentation for feet that eventually had tenotomy done was 5.1 +/-
 120 1.0 while that for the feet that did not have tenotomy done was 4.2 +/-1.1 There was a

121 statistically significant difference in the mean Pirani scores at presentation of those who had
 122 tenotomy and those who did not have. (t-test= 9.24; df=1; p=<0.001; 95% C.I.=1.112-1.722).

123

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



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There was a significant statistical association using ANOVA between the Pirani, midfoot and hindfoot scores at presentation and the eventual number of casting sessions patients had $p < 0.001$. The table below further explain the results.

Table 3: Number of casts to achieve correction versus the midfoot, hindfoot and the Pirani scores

Categor ies	Variables	N	Mean no of cast	SD	TEST OF STAT SIGNIFICANC E(DF)	P value <
Midfoot score	Mild clubfoot	27	3.48	0.80	F=18.62	.001
	Moderate clubfoot	42	4.29	1.40		
	Severe	33	7.36	2.07		
Hindfoo t score	Mild	27	3.48	0.80	F=18.62	.001
	Moderate	42	4.29	1.40		
	Severe	33	7.36	2.07		
Pirani score	Mild	27	3.48	0.80	F=18.62	.001
	Moderate	42	4.29	1.40		
	Severe	33	7.36	2.07		

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 score at presentation and Pirani score at full correction on one hand and the Pirani score at presentation and the score whether or not the patient had tenotomy 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 ($P < 0.001$).

127 **Table 4: Correlation between the Pirani scores at presentation versus at correction in one**
 128 **hand and versus 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	

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

Categories	Variables	N	Mean of initial Pirani score	SD	TEST OF STAT SIGNIFICANCE (DF)	P value
Pirani score	Mild	27	3.80	1.02	F=9.10	.001
	Moderate	42	4.67	0.98		
	Severe	33	5.64	0.44		
Number of cast	Mild	27	3.48	0.80	F= 18.62	.001
	Moderate	42	4.29	1.40		
	Severe	33	7.36	2.07		

134

135 **Discussion.**

136 This study revealed that the age range of the patients studied was 0.6 to 134 weeks with

137 median age of 12weeks. This is rather late when compared with figures obtained by workers

138 in developed world such as Zimmerman et al. in 2015 who recorded median age of 52 days at

139 tenotomy among 36 subjects[21]; Brewster et al. in 2012 recorded mean age of 4.5 weeks

140 among 51 clubfooted patients[22]. This age disparity at tenotomy was also noted by

141 Adegbehingbe et al. in 2015 with median age of 5.2 months among 79 patients [23] and Goksan

142 et al. in 2015 with mean age of 44.62 months among 153 patients [24]. Late presentation as

143 seen in our study may be because most of our patients pay out of pocket to access treatment

144 hence, it may take a while for the parents to raise sufficient fund for the treatment. Also, there
145 are not enough trained personnel to manage clubfoot deformity in the developing countries
146 hence, patients might have to travel several hundred kilometres to access treatment, hence the
147 late presentation. There was male preponderance with male to female ratio of 1.7:1, this is
148 similar to the one recorded by Lavy et al. in Malawi in 2007[25]; Pavone et al. in 2012 recorded
149 ratio of 2:1⁴ and Ford-Powell et al. in 2013 had a ratio of 2.7:1[26].

150 Among the 61 patients studied, 67.2% of the patients have bilateral clubfoot, while the
151 remaining 32.8% are unilateral with equal distribution between the left and the right. This is
152 similar to the result gotten by Awang et al. in Malaysia in 2014[27]. However, this was in
153 contrast to the preponderance of unilateral clubfoot as documented by Ponseti, Matuszewski
154 and Adewole et al. in their studies at different point in time [15,28,29].

155 Out of the 102 feet that had Ponseti treatment, 65.7% of them had tenotomy while 34.3% did
156 not have tenotomy. Lebel et al. in their study on 56 babies in 2012; 73% of them had
157 percutaneous tenotomy [30]; of the two groups studied by Xu in Beijing, China in 2011, 87.5% of
158 each of them had tenotomy [31]. In contrast to this, Tindall et al. in their study done in Blantyre,
159 Malawi in 2005, 57 of the 98 feet corrected using the Ponseti treatment protocol did not require
160 tenotomy.

161 The mean number of casting sessions for the affected feet was 5.1 ± 2.2 . Pulak et al. in Ethiopia
162 2012 found average number of casting sessions of 4.9[32], Awang et al. had an average of 5.2
163 casting sessions[27] and Laaveg et al. in 1980 in USA had mean number of casts of 7[33]. This
164 is an interesting finding because despite the late presentation in our setting, we still have a
165 comparable casting session with workers in other parts of the world where patients presents
166 earlier. The implication of this may be the fact that outcome of clubfoot treatment may not be
167 significantly affected by age of presentation as long as the patient is infant. This may need
168 further research. The average Pirani score for the feet that had tenotomy was 5.1 ± 1.0 which

169 was higher than 4.2 ± 1.1 for the feet that did not have tenotomy. This was similar to the average
170 Pirani score gotten by Dyer et al. in their study on the role of the Pirani scoring system in the
171 management of club foot by the Ponseti method done in 2006. In the study, the average Pirani
172 score for tenotomy group was 4.96 and for the group without tenotomy was 4[18]. This proves
173 that severe clubfoot(as predicted by higher Pirani score) may need tenotomy hence both the
174 managing team and the parents of the patient may be better prepared.

175 Comparing the initial midfoot scores, hindfoot scores, Pirani scores and the number of casts
176 needed to achieve correction, the correlation between the parameters was significant, this
177 implies that the higher the midfoot, hindfoot and Pirani scores, the more the number of casting
178 sessions needed by the patient to achieve correction. Since the Pirani score is made up of the
179 summation of mid and hind foot scores, this observed positive correlation which is a direct
180 proportional relationship is not unexpected. Agarwal et. al in 2014 showed positive correlation
181 between the initial Pirani scores and the number of casts to achieve full correction in 297
182 patients with 442 clubfeet.[34] Awang et. al in 2014 studied the effect of age, weight and initial
183 Pirani score on the number of casts needed for full correction and came out with the conclusion
184 that Pirani score was the only significant predictor among the parameters studied[27]. Some
185 other authors showed the effect of midfoot, hindfoot and initial Pirani score on the rate at which
186 full correction was achieved and also the effect on relapse [35-37]. However, Gao et. al and Chu
187 et. al showed no correlation between the Pirani score and the number of casts to achieve
188 correction in the clubfoot patients treated[14,38].

189 Moreover, monitoring the progress of treatment of clubfoot using the Ponseti protocol employed
190 the paired T-test to compare the initial Pirani scores and the Pirani scores at full correction on
191 one hand and the initial Pirani scores and whether or not the patient had tenotomy, the two
192 showed statistical significance which implies that Pirani score can be used to monitor the
193 progress of treatment of clubfoot using the Ponseti protocol. Pulak et.al in 2012 found out that

194 there was a significant difference between the pre-treatment Pirani scores and the post-
195 treatment Pirani scores in the 40 patients they treated in Ethiopia with the Ponseti method [32].
196 Moreover, study done by Faizan et. al in 2015 showed statistical significance between the pre
197 and post treatment Pirani scores among 19 patients with 28 clubfeet[39]. Some authors also
198 showed statistically significant effect of the severity of clubfoot on the need for
199 tenotomy[18,19,32].

200 In addition to this, the severity of the clubfoot determines the number of casts the patient will
201 need before full correction: mild clubfoot had fewer numbers of casts than moderate which also
202 has fewer numbers of casts compared with the severe clubfoot. Statistical test also showed that
203 this is significant. Wang et. al in 2009 showed significant difference in the number of casts to
204 achieve correction in the three groups of mild, moderate and severe clubfoot deformities they
205 studied[40].

206 **4. CONCLUSION**

207 The severity of clubfoot can be assessed using pirani scoring system and likewise the progress
208 of treatment in management of idiopathic clubfoot with ponseti protocol. this is simple and easy
209 to use.

210 **CONSENT**

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

214 **ETHICAL APPROVAL**

215 Ethical approval was obtained from the institution ethics and research committee. Registration
216

217 number: International IRB/IEC/0004553.

National:

218 NHREC/27/02/2009a. Protocol number: ERC/2012/10/08.

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