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ORIGINAL PAPER

Does initial Pirani score and age influence number of Ponseti casts in children?

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Abstract
Purpose The prediction of number of casts in the Ponseti method has always remained a subject of interest. We investigated the correlation of the number of casts before tenotomy with the age and initial Pirani score in Ponseti treatment of club foot.
Methods Inclusion criteria were idiopathic clubfeet corrected by Ponseti method requiring tenotomy for equinus correction in children up to ten years of age. Defaulters (noncompliance with serial casting schedule), children with postural, non idiopathic, previously surgically treated, recurrent clubfoot and clubfoot not requiring tenotomy were not included in this study. Further, children who did not require tenotomy were also excluded. ANOVA regression analysis was used for finding correlation between initial Pirani score, age in months and number of corrective casts prior to tenotomy.
Results There were a total of 297 children (442 feet) in the study. The average age of the child at presentation was 10.3 months and the average initial Pirani score was 4.8. The average number of corrective casts was seven per child (range, two to18). The regression analysis showed both Pirani and age had positive correlation with number of casts, although weak (r^2=0.05–0.20). The initial Pirani scoring correlated ten times more than age (in months) to the number of casts.
Conclusion The number of casts for correction in idiopathic clubfoot, although variable, is influenced by both initial Pirani score and age.

Keywords Idiopathic clubfoot · Ponseti method · Pirani score · Age

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Introduction

The Pirani score is one of the popular systems for classification of severity in clubfoot [1]. The initial Pirani scores have been investigated for correlation to the number of casts required for clubfoot correction with variable results [1–5]. With extended applications of Ponseti method in older children, another factor assuming importance in treatment is the age of the child at initiation of corrective casting. Whether age at beginning influences the number of corrective casting and to what extent still remains unknown [6].

Lack of data on these aspects makes it difficult to prognosticate parents regarding the duration of treatment which is closely related to financial and motivational aspects in developing countries. We retrospectively investigated how the number of casts required for deformity correction differed with (a) the age of the child at initial presentation and (b) pretreatment Pirani score. Further, if there was a difference, does a correlation exist between them?

Material and methods

We retrospectively analysed the records of enrolled children with primary idiopathic clubfoot managed in a Clubfoot Ponseti Clinic in association with CURE International India in a metropolitan city in northern India during the period March 2009 to June 2012. The clinic followed protocols based on Ponseti technique [7]. A standardized computerized data collection sheet was used to follow each patient in clinics following enrollment in the Clubfoot Clinic. The data sheet indicated the demographic data of the patient, the type of clubfoot, Pirani scores at presentation and during follow ups, number of corrective casts for each patient, timing of tenotomy and follow up after foot abduction brace [7].

Children with postural, non idiopathic (neuromuscular, syndromic, complex and others), surgical treatment in any

Table 1 Patient profile

Age group	Number of children	Number of feet			Average initial Pirani score	Average number of casts
		Unilateral	Bilateral	Total		
0–6 months	191	96	95	286	5	6.1
7–12 months	33	15	18	51	4.6	7.8
13–24 months	37	21	16	53	4.2	8.7
2–5 years	27	13	14	41	4.7	8.7
5–10 years	9	7	2	11	3.9	9.8

form, age greater than ten years, recurrent clubfoot and defaulters (noncompliance with serial casting schedule) were not included in this study. Further, children who did not require tenotomy were also excluded. The tenotomy criteria were *minimum* 40° of foot abduction and midfoot score of 0 for all children that were included. The number of casts prior to tenotomy was used for result evaluation. The same team was responsible for care of all the patients. From these records, the following facts about the children that met the inclusion criteria were recorded:

1. Age of the child in months at time of initial presentation
2. The pretreatment Pirani score at the time of initial presentation
3. The number of corrective casts required for the particular child till tenotomy was performed

Statistical analysis

We adopted the following statistical methods to analyse the data:

1. The correlation between pretreatment Pirani score, child's age in months at presentation and number of corrective casts was calculated after doing the ANOVA regression analysis.
2. ANOVA multiple regression analysis was applied to develop a combined mathematical equation to calculate the number of corrective casts from Pirani score (at initial presentation) and age (in months at the time of presentation) for the child.
3. Coefficient of determination (r^2) was calculated for each equation.

Table 2 Pirani score at presentation and number of corrective casts

Pirani score at presentation	Number of children in the group	Average age (in months)	Average number of casts
1	004	10.5	3.75
1.5	004	49.5	6.25
2	010	05.25	4.9
2.5	007	10.35	5.57
3	019	15.76	5.42
3.5	016	21.87	7.44
4	028	10.05	5.96
4.5	032	12.31	7.46
5	036	06.22	6.75
5.5	033	13.03	7.12
6	108	06.5	7.66

Results

There were a total of 297 children (442 feet) that met the inclusion criteria. Of these, 66 children presented with left sided, 86 right sided and 145 bilateral cases. The male–female ratio in the study was 3:1 with 225 males and 72 females. The average age of the child at presentation was 10.3 months (range, two weeks to 110 months). The average pretreatment Pirani score was 4.8 (range, one to six). The average number of corrective casts was seven per child (range, two to18). Eighty-eight children had a Pirani score of less than or equal to 4 (the average number of corrective casts required was 5.8) whereas 209 children had a Pirani score of more than 4 on presentation (the average number of corrective casts required was 7.5).

The average number of corrective casts required for the different age groups is given in Table 1. The Pirani score at presentation and number of corrective casts are given in Table 2. The statistical analysis results are presented in Table 3 with reference to Figs. 1 and 2.

The ANOVA analysis showed that initial Pirani scoring is in better correlation to number of corrective casts than age (in months) (Table 3). For an increase in initial Pirani score by 3,

Table 3 Statistical analysis results

Equation 1: Number of corrective casts=4.1+0.6 x pretreatment Pirani score (r^2=0.05; multiple r=0.24; p<0.001) (Fig. 1)

Equation 2: Number of corrective casts=6.4+0.05 x child's age in months at presentation (r^2=0.10; multiple r=0.32; p<0.001) (Fig. 2)

Equation 3: Number of corrective casts=2.5+0.8 x pretreatment Pirani score+0.07 x child's age in months at presentation (r^2=0.20; multiple r=0.44; p<0.001)

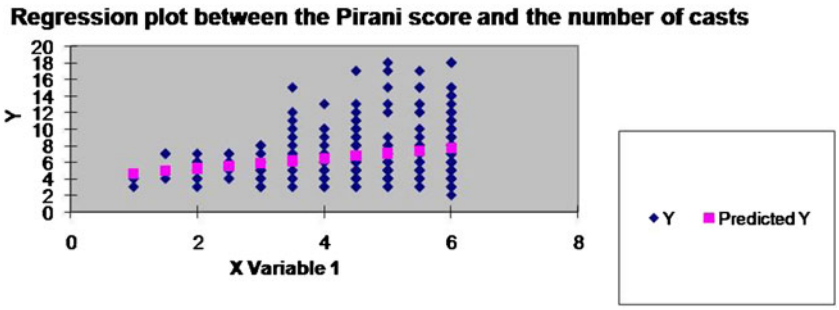

Fig. 1 The X variable 1 line-fit plot depicting the regression analysis between initial Pirani score and the number of corrective casts. The pink dots show the predicted number of casts on the basis of initial Pirani score and the blue dots show the actual number of casts. The point from where the pink dots start is the intercept which is the average minimum number of casts

the number of cast would increase by approximately two (Eq. 1). The regression analysis further suggests that the number of corrective casts required till tenotomy increases with age. There was an average increase of one cast for every increase in age of 20 months (Eq. 2). It shows that the effect of initial Pirani score (severity of deformity) on the total number of casts is approximately ten times more predictable for number of casts when compared to age in months (Eq. 3). The correlation was more useful when both Pirani scoring and age were taken into account (r^2=0.20). For younger children of six months, presenting with Pirani scores of 3 and 6, the average casts will be approximately five and eight, respectively. When the children are 24 months old, with above Pirani scores, the number of casts will be approximately 6.5 and nine, respectively. All these equations have low coefficient of determination.

Discussion

The Ponseti method has become the gold standard for clubfoot treatment [8]. Several short-term and long-term results of the Ponseti method in the treatment of idiopathic club foot are now available [9, 10]. Pirani scores have been frequently used to track treatment progress [11], predict tenotomy requirements [1, 4, 12, 13], number of casts of treatment [6] and relapse rates [14]. However, a question which is commonly posed by parents at time of initial counselling is the number of casts their child will require, especially when the child is older and walking. This assumes greater importance in developing countries where the duration of treatment has a strong bearing on parent's compliance and success of treatment. Conflicting reports are present in literature regarding use of Pirani score and it's predictive value for number of casts for correction. Dyer and Davis reported on predictive value of Pirani scoring on 70 idiopathic club feet [1]. They found a positive correlation (r=0.72) between initial Pirani score and number of casts required to correct the deformity. A foot scoring of 4 or more is likely to require at least four casts, and one scoring less than 4 will require three or fewer [1]. There was no linear relationship between initial Pirani scores and number of corrective casts in this study. In another study by Chu et al. (185 feet; mean age 15.3 days), the mean number of casts required were 5.1 [2]. The average Pirani scores versus number of casts were 2/2, 4/3, 5/4, 5.5/5, 5.5/6, 5.5/7, and 6/8. The initial Pirani scores correlated poorly (r=0.33) with number of casts required for clubfoot correction [2].

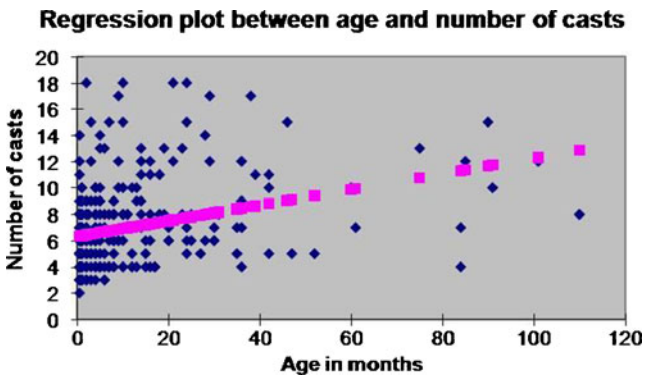

Fig. 2 The X variable 1 line-fit plot depicting the regression analysis between age and the number of corrective casts. The pink dots show the predicted number of casts on the basis of age and the blue dots show the actual number of casts. The point from where the pink dots start is the intercept which is the average minimum number of casts

In a study on the use of Ponseti method in clubfoot in toddlers, the number of casts in younger children was less compared to older children (one to two years, six to ten casts; two to three years, nine to12 casts) [15]. With older children, the casts showed a trend to increase. In a series by Khan and Kumar, in children with mean age 8.9 years, the average number of casts were 12.1 [16]. In a contradiction to above findings, Spiegel et al. used the Ponseti method for children aged one to six years (n=260) [17]. They found no differences in the number of casts required when comparing the different age groups or initial Pirani scores (age one year: Pirani 5.15, no. of casts six; two years: Pirani 5.23, no. of casts six; three years: Pirani 5.55, no. of casts seven; four years: Pirani 4.86, no. of casts seven; five years: Pirani 4.55, no. of casts seven) [17]. There is another study supporting this finding in younger children by Alves et al. where the number of casts

required was 5.3 and 4.3 when mean age at beginning of treatment was 22.4 days and 402.8 days, respectively [6].

Our study confirmed the weak but positive correlation between initial Pirani score and age on the number of corrective casts (see equations above) [15, 17–19]. The Pirani scoring was ten times more predictable for number of casts when compared to age. The correlation was more useful when both Pirani scoring and age were taken into account (r^2=0.20). Thus, the foot correction is probably also affected by other factors beyond Pirani scoring and age.

There were several limitations of this study. It is a retrospective study with a heterogeneous (age and Pirani variable) group under study. The study excluded clubfeet not requiring tenotomy as these possibly form another cohort with suppler soft tissues correctable by casts. Several authors have reported the decreased significance of Pirani scoring in the older child [17, 20]. The long-term follow up was not available to ascertain whether the initial correction obtained could be maintained. The present series had 52/442 (11.76 %) feet beyond two years achieving initial correction using Ponseti method, and this is encouraging. The study thus indirectly reemphasizes the effectiveness of the Ponseti method in both younger and older age groups and it's usefulness in developing countries [16, 17, 20]. Although parents may be given an estimate about the average number of cast at counselling, they need to be reemphasized that number of casts is highly variable.

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