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Bilateral congenital idiopathic clubfoot treatment with the Ponseti technique in Umuahia: A comparison of individual foot characteristics

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Abstract
Background: Clubfoot is the commonest musculoskeletal congenital deformity affecting the foot. The idiopathic variety is the most common type and worldwide the agreed treatment method is the Ponseti method. In bilateral cases, the feet may have different anthropometric characteristics. These differences were evaluated in this study.
Objective: To assess the effect of the differences in the anthropometric parameters of the legs and feet (Calf circumference, foot length, degrees of cavus, adduction and equinus and Pirani score) in a child with bilateral clubfoot on the treatment outcome and recurrence of the deformity.
Method: This was a prospective study that analyzed idiopathic bilateral clubfoot patients aged 0-5 years and treated using the Ponseti Technique at Federal Medical Center, Umuahia from October 2019 to September 2020. The Pirani scores, the lengths of the feet, the calf circumferences and degrees of cavus, adduction and equinus were measured at initial presentation, commencement of bracing and 3 months after commencement of treatment. These measurements were then compared.
Results: A total of 47 patients participated in the study with a male preponderance. The right calf circumference and length of the right foot were consistently bigger than the left at each measurement; and these differences were statistically significant. The degrees of cavus, adduction and equinus were significantly worse on the right foot at presentation. Thirty-six patients (76.6%) had the same Pirani score on both feet at presentation. The differences in anthropometry parameters did not predict the number of casts needed to correct the deformity, the need for tenotomy nor the recurrence of the deformity.
Conclusion: Although there were differences in the lower limb anthropometry of children with bilateral clubfoot, they did not predict deformity correction nor recurrence.

Keywords: Clubfoot, bilateral, characteristics, ponseti technique

Introduction
Clubfoot is a complex developmental deformity of the foot characterised by equinus of the hindfoot, adduction of the midfoot and forefoot, varus deformity through the subtalar complex and cavus deformity through the midfoot such that the affected foot appears like a hockey stick [1-3]. Bilaterality is seen in about 50% of clubfoot patients [4, 5].
The Ponseti method comprises serial manipulation and casting, tenotomy (when indicated) and use of foot abduction braces (FAB) [6]. The treatment goal is to attain a functional, pain-free, plantigrade and shoeable foot, with good mobility [7].
In bilateral clubfoot, the feet are usually difference in terms of the severity of the deformity, the foot length, the cavus degree, adduction and equinus, as well as the response of each foot throughout manipulation and casting. These differences should be considered while treating bilateral clubfoot in order to reduce the complication which could arise from poor knowledge, assessment and/or treatment [1].

Patients and Methods
It was a hospital-based prospective study conducted at Federal Medical Centre Umuahia from over a year period (October 2019 to September 2020). All children with bilateral congenital idiopathic clubfoot aged 0 to 5 years who presented during the study period and who have not had any form of standard treatment for clubfoot were recruited.

Ethical clearance was obtained from the health research and ethics committee of the hospital and consent was obtained from the parent(s) or caregiver of each recruited child.

Each foot's length was measured from the heel to the second toe tip using a meter rule and recorded in centimetres. The calf circumference was measured at a point obtained by getting the same distance from knee joint line bilaterally using a measuring tape and recorded in centimetres.

The degree of foot adduction was measured with goniometer centered at the midfoot dorsally and allowing the goniometer's limbs to be parallel to the forefoot and hindfoot. The value was recorded in degrees. Equinus was measured by placing the goniometer at the ankle laterally and allowing the goniometer's limbs to be parallel to the leg and foot with the foot in attempted dorsiflexion. The value was recorded in degrees. The cavus degree was measured by placing a goniometer at the heightened medial arch and allowing the goniometer's limbs to be parallel to the forefoot and hindfoot. The value obtained was recorded in degrees. A table was provided for weekly recording and comparison of the Pirani scores of both feet.

The Ponseti method was used for all patients.

The anthropometric parameters were assessed again at full correction of the clubfoot by a trained personnel other than the author before foot abduction brace was fitted. The brace review was done at two weeks, four weeks and six weeks (3months) intervals.

The anthropometric parameters were obtained again at three months of use of foot abduction brace by a trained personnel other than the author to help determine the early outcome of treatment.

Data were entered, coded and analysed with Statistical Package for the Service Solutions (SPSS) of IBM SPSS statistics for windows, version 20. Data were expressed as frequencies for categorical variables and mean ± standard deviation for continuous variables. The comparison of the parameters between the two legs and feet was made with a paired samples t-test. Multiple linear regression was used to analyse if the parameter differences could predict the number of casts needed for correction. Binary logistic regression was used to assess if the parameter differences could predict the need for a tenotomy or the recurrence of the deformity. All the tests were two-tailed and a p-value less than 0.05 was deemed significant.

Results

Forty-seven bilateral clubfoot patients met the inclusion criteria and were recruited. The mean age of the patients was 13.79 ± 13.39 months (3 weeks to 50 months). Only six patients, 12.8%, had a positive family history of clubfoot. Males were 34 whereas females were 13, giving a male: female ratio 2.6:1.

Both feet were similarly affected, i.e., having the same Pirani score, in 36 cases, 76.6%, while the right and left feet were more severely affected in 8 and 3 cases respectively. This finding is statistically significant, χ^2 (2, N=47) = 40.38, p<0.001.

Table 1: Comparison of the mean calf circumferences of the two legs at presentation, at bracing and 3 months of use of brace. Standard deviations of the means are enclosed in brackets

	Right leg	Left leg	Mean difference	Std error	95% CI	T-Stat	P-Value
Mean calf circumferenceat presentation (cm)	14.12 (2.32)	13.97 (2.39)	0.15	0.07	(0.01 to 0.29)	2.16	.036*
Mean calf circumferenceat bracing (cm)	16.45 (2.35)	16.28 (2.41)	0.17	0.06	(0.05 to 0.29)	2.91	.005*
Mean calf circumference 3 month after bracing (cm)	18.46 (2.40)	18.29 (2.45)	0.17	0.06	(0.05 to 0.29)	2.66	.011*

*=significant at 0.05.

Table 2: Comparison of the mean feet length at presentation, at bracing and 3 months of use of brace. Standard deviations of the means are enclosed in brackets

	Right foot	Left foot	Mean difference	Std error	95% CI	T-Stat	P-Value
Mean foot length at presentation (cm)	9.44 (2.31)	9.20 (2.37)	0.24	0.07	(0.10 to 0.37)	3.50	.001*
Mean foot length at bracing (cm)	11.46 (2.33)	11.51 (2.43)	0.15	0.07	(0.01 to 0.29)	2.11	.041*
Mean foot length 3 months of bracing (cm)	13.68 (2.16)	13.51 (2.21)	0.17	0.07	(0.04 to 0.31)	2.67	.011*

*=significant at 0.05.

The degrees of cavus, adduction and equinus were worse on the right at presentation with p-values of 0.001, 0.024 and 0.022 respectively.

Table 3: Comparison of the mean number of casts before readiness for tenotomy. Standard deviations of the means are enclosed in brackets

	Right foot	Left foot	Mean difference	Std error	95% CI	T-Stat	P-Value
Mean number of casts before readiness for tenotomy	4.95 (1.50)	5.28 (1.59)	-0.33	0.16	(-0.64 to -0.01)	-2.10	.042*

*=significant at 0.05.

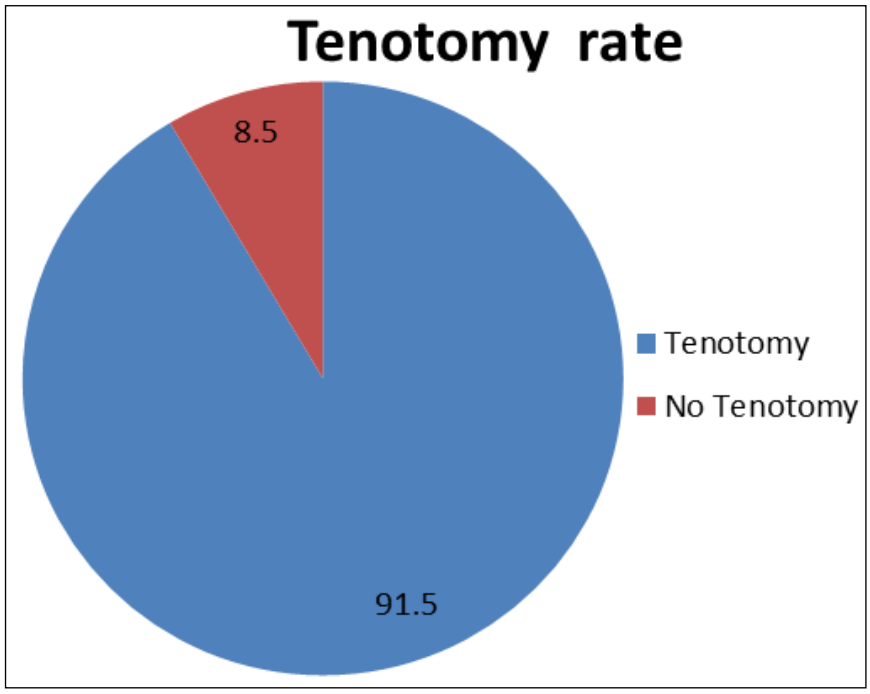

Fig 1: Tenotomy rate

Three patients had pressure ulcer from the cast during treatment. All the ulcers were on the left foot and this distribution of foot ulcers was statistically significant, χ^2 (1, N=47) = 35.77, p<0.001.

Table 4: The incidence of deformity recurrence in the feet

Foot involved	N	%
Right foot (alone)	0	0%
Left foot (alone)	4	8.5%
Both feet	2	4.3%

The distribution of recurrence in the feet was significant, χ^2 (2, N=47) = 47.00, p<.001.

Table 5: Multiple linear regression analysis on predicting the number of casts required to correct the deformity

Difference in parameters	B	S.E.	t-statistics	P-Value	95% C.I.
Calf circumferences	-0.116	0.075	-1.537	0.132	-0.27 to 0.04
Feet length	0.041	0.072	0.566	0.574	-0.11 to 0.19
Cavus angles	0.002	0.006	0.336	0.738	-0.01 to 0.02
Feet adduction angles	0.004	0.007	0.602	0.550	-0.01 to 0.02
Dorsiflexion angles	0.012	0.007	1.681	0.101	-0.00 to 0.03
Pirani scores	0.034	0.056	0.611	0.545	-0.08 to 0.15

Table 6: Binary logistic regression analysis on the prediction for an Achilles tenotomy

Difference in parameters	B	SE.	Wald-statistics	P-Value	O.R.
Calf circumferences	-2.95	2.77	1.13	.288	0.05
Feet length	0.33	2.66	0.02	.901	1.39
Cavus angles	-0.11	0.25	0.19	.666	0.90
Feet adduction angles	0.14	0.24	0.32	.572	1.15
Equinus angles	0.25	0.29	0.72	.398	1.28
Pirani scores	9.70	5.01	3.76	.053	16.35

Table 7: Binary logistic regression analysis on the recurrence of the deformity

Difference in parameters	B	SE.	Wald-statistics	P-Value	O.R.
Calf circumferences	-0.13	1.87	0.01	0.944	0.88
Feet length	0.41	1.49	0.08	0.780	1.51
Cavus angles	-0.05	0.17	0.09	0.769	0.95
Feet adduction angles	0.20	0.18	1.17	0.279	1.22
Dorsiflexion angles	0.41	0.22	3.69	0.055	1.51
Pirani scores	0.94	1.02	0.85	0.357	2.55

Discussion

The Ponseti method has been accepted globally as the standard of treatment whose goal is to achieve a functional, pain-free, plantigrade and showable foot, with good mobility [7]. This was demonstrated in this study.

Adegbehingbe OO *et al*. [11] who studied neglected clubfoot

noted that late presentation might be caused by financial burden of the treatment, inadequate publicity and people's beliefs. This may be true in our study as the mean age at first contact was higher than those seen in reviewed literatures [1, 8-12].

Male preponderance was observed in our study (see figure 1) which was similar to works done by other authors [8-10, 13] (see figure 1). Singh S *et al*. [14] in India thought that increased attention towards male children in developing world might play a significant role in having increased male affectation since the studies (including ours) were hospital-based. Palmer RM [15] also noted that males have increased chances of developing clubfoot than females.

The right calf circumference was significantly higher than the left calf circumference, and this difference was consistent at presentation, bracing and three months of brace use (see table 1). We found no studies that stated the reason for this difference; however, it is a common knowledge that paired organs are usually not precisely the same. The right calf circumference may have been higher because of right limb dominance in the majority of the populace. Sutton A, *et al*. [16] has also suggested that it is more appropriate to consider paired organs separately during analysis as the factors affecting them may not be precisely the same. Chesney D *et al*. (2007) [17] has also shown that objective grading of the functional outcome of clubfoot treatment can be designed using the foot length, calf circumference and range of movement of the ankle, however, there was no attempt made in their study to compare the calf circumferences of patients with bilateral clubfoot.

The mean length of the right foot was consistently longer than the contralateral left foot at presentation, bracing and three months of use of brace. This difference was noted to be statistically significant (see table 2). This can also be explained with the same common knowledge of paired organs not having precisely the same size and supported by work done by Sutton A *et al*. [16]. The finding in this study differs from the work done by Agarwal A *et al*. (2018) [18] in India who measured the foot length of all patients treated for clubfoot using the Ponseti technique with an average follow-up of 22.2 months and noted that there was no statistically significant difference between the foot length of the bilateral cases in their series, however, the foot length was measured only once unlike our study that measured the foot length at three difference times, also only one operator measured all the feet and this may cause bias.

In this study, the initial mean cavus angle, degree of adduction and degree of equinus of the right foot were more severe than the left foot, and the differences were statistically significant. We could also not find any study that tried to compare the severities of these individual deformities which make up the clubfoot in patients with bilateral clubfoot. However, the reason for these differences may be coincidence since the difference in the mean Pirani score of both feet at presentation was not statistically significant.

Only three patients pressure ulcer during the treatment and they had them on the left foot. Attempting to forcefully accelerate the treatment of the left foot is implicated in this complication [1, 19]. The left foot's poor manipulation by right-handed manipulators may also contribute to the increased complications on the left [6, 19].

In our study, we noted a higher tenotomy rate compared to other studies [10, 21, 20]. We treated children with higher age bracket which could play a role in the need for tenotomy [11]. Adewole OA *et al*. [21] also suggested that higher age at presentation increases the chances of Achilles tenotomy.

The recurrence rate we recorded was statistically significant on the left (see table 4). Adewole OA *et al*. [21] recorded 5.6% recurrence rate after one year of follow-up and attributed it to poor brace compliance. The increased recurrence rate on the left foot also points to poor manipulation by right-handed trained providers [19].

None of the differences in the measured parameters at presentation (Pirani score, foot length, calf circumference, degrees of cavus, adduction and equinus) predicted the number of casts needed for correction of the deformity, Achilles tenotomy and recurrence of the deformity (see tables 4, 5 and 6). Gray K *et al*. [10] in their retrospective comparison of the feet of 33 patients with bilateral clubfoot noted that bilateral clubfoot are highly correlated in initial Pirani score, the number of casts required to correct initial deformity, the need for Achilles tendon percutaneous tenotomy and the rate of relapse. This observation agrees with our study.

Conclusion

There was a statistically significant difference between the anthropometric measurements (Foot length, calf circumference, degrees of cavus, adduction and equinus) of the two legs and feet of patients with bilateral clubfoot, however, this difference was not clinically significant because it did not predict the number of casts needed to correct the deformity, the need for tenotomy and the probability of recurrence of the deformity.

Limitations of the study

The study population was small and therefore, might not be the true representative of the population.

It was a centre-based study, a multi-centre study would help validate the findings in this study.

Conflict of interests

The authors have not declared any conflicts of interests.

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