Original Article

Calf Circumference in Clubfoot: The Effect of Patient Gender, Age, Laterality and Brace Duration

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Abstract

Calf circumference is reduced in the leg affected by clubfoot. The effect of brace duration and whether calf circumference increases with age has not been studied in the Indian population. We conducted a cross sectional study on 156 children with idiopathic non-operated clubfeet treated by serial Ponseti casting method. The mean age was 32.7 months (range, 2-120 months). We found significant calf circumference difference in legs with clubfoot which increased with age. The duration of bracing did not significantly affect calf circumference.

Keywords: CTEV; Clubfeet; Calf circumference.

Introduction

Idiopathic congenital clubfoot is caused by genetic and developmental factors that involve the lower leg in addition to the ankle and foot, resulting in limb length and calf girth discrepancy [1-3]. MRI studies have shown reduced muscle mass especially in posteromedial compartment of leg, increased subcutaneous fat content and a slight reduction in the length of tibia and fibula with hypoplasia of arteries of affected clubfoot legs [4, 5]. Previous studies have reported calf circumference difference of 2.69% to 11.6% and calf volume difference from 8.7 to 38.4% (Table 1) [1, 5-12]. In unilateral clubfoot, the difference in calf circumference was between 0.76 cm to 3.56 cm [1, 9].

The reduced size of the affected leg and whether such differences will persist over time is a cause for parental concern. Evidence on age-related disparity in calf size in clubfoot patients is also lacking. The effect of mode of treatment (Ponseti versus surgery) on calf size has been reported previously. However, the effect of duration of brace wear following Ponseti treatment on calf size has not been studied [1, 7]. The aims of this study were: (1) To compare calf circumference difference in children with unilateral clubfoot, (2) To compare calf circumference difference in unilateral and bilateral cases, (3) To evaluate the effect of age and brace duration on calf circumference difference in clubfoot patients.

Table 1: Comparative analysis of previous published series on clinical calf girth differences in clubfoot [1, 6, 7, 8]

Authors	No. of patients	Mean age	Measurement method	Treatment	Result
Aronson and Puskarich, 1990	29 (all unilateral)	13 years	Measured at distance of 25% of total leg length from knee joint	Ponseti casting- 13, Surgery- 16	10% difference, unrelated to time spent in cast
Shimode et al., 2005	38 (all unilateral)	11.8±4.4 years (range, 3-24 years)	Calf girth at the maximum point	Ponseti casting-13, Surgery-25	Calf girth decreased by 9.1±3.1% in those with surgery and by 5.8±3.7% in those without surgery
Barker et al., 2012	104; 48 bilateral, 53 unilateral	-	Digital photography and tape	-	Mean difference 2.69% and 2.84% respectively for left and right leg; for bilateral - 0.15%
Fulton et al., 2015	35 (all unilateral)	Ponseti- 3.1± 1.7 years ; PMSTR - 10.9± 4.3 years	Gulick anthropometric tape measure	Ponseti casting-69%, PMSTR-31%	Calf ratio in surgery group - 90.8%± 3.5%; Ponseti - 94.4%± 3.3% ; average 3 to 10% smaller

Subjects and Methods

This cross-sectional study was performed at a tertiary care pediatric center. The center runs a twice-weekly dedicated clubfoot clinic. We included unilateral and bilateral idiopathic clubfeet treated by Ponseti method. Non-compliant patients, syndromic, neuromuscular clubfeet and children requiring soft-tissue release were excluded. The bracing protocol was 23 hours per day for an initial period of 3 months followed by night and nap time bracing up to 3 years of age. Calf circumference was measured at its maximum girth with the knee extended and the ankle in a neutral position. Due to the lack of a control group for bilateral cases, only the unilateral group was categorized according to age and brace wear duration. In unilateral clubfeet, comparison was made with the contralateral leg. Patients in the unilateral group were divided into three age groups: ≤ 24 months (home ambulator), 25-60 months (preschool community ambulator) and >60 months (school going) for comparing calf girth at different ages. According to the total brace duration, unilateral cases were divided into 3 groups of ≤ 12 months (early brace wearer), 13-36 months (accustomed brace wearer) and >36 months (post brace wearer). In bilateral cases, only one limb (randomly chosen) was measured to avoid bias [13, 14]. The bilateral and unilateral groups were age matched for intergroup comparisons (p=0.743). Informed consent was obtained from the parent or carer for measurement of calf circumference.

The data was entered in MS Excel software® and results were statistically compared using student 't-test' by online GraphPad software® and online 'ANOVA test' (https://www.danielsoper.com/statcalc/default.aspx).

Results

156 patients were enrolled in the study comprised of 79 bilateral and 77 unilateral cases. There were 130 boys and 26 girls. The mean age was 32.7 months (range 2-120 months) and the median age was 30 months. Number of patients in the age groups ≤ 24 months, 25-60 months and > 60 months was 32, 38 and 7 respectively. Number of patients in groups according to the duration of brace wear of ≤ 12 months, 13-36 months and >36 months was 31, 34 and 12 respectively. The main results are summarized in Tables 2 and 3.

1. Unilateral affected versus non-clubfoot leg

The difference of calf circumference between the affected and contralateral unaffected leg was 5.64% (1.04cm) (p<0.0001).

2. Bilateral versus unilateral legs

Mean age for bilateral and unilateral group were 32±24.8 and 33±24.0 months respectively (age matched; p=0.743). Calf circumference in bilateral and unilateral affected legs were 17.1±2.1 cm and 17.4±2.1 cm respectively (p=0.369). The mean calf circumference in "non-clubfoot" unilateral patients was 18.4±2.5 cm. When comparison was made between bilateral clubfoot and non-clubfoot legs, calf circumference was significantly less 7.28% (p=0.0004) in bilateral affected legs.

3. Effect of gender on calf circumference

Calf size was significantly reduced on affected side in both genders in unilateral cases with mean calf circumference of 17.6±2.0 cm in affected leg and 19.2±2.4 cm in non-clubfoot legs in case of females (p=0.0004). In males it was

Table 2. Effect of laterality and gender on calf girth circumference and their comparisons in various groups

	Laterality								Gender			
	Bilateral affected v/s age matched unilateral affected		Bilateral affected v/s age matched unilateral unaffected		Intragroup bilateral affected right v/s left side		Intragroup unilateral affected v/s unaffected		Female		Male	
	Affected bilateral	Affected unilateral	Affected bilateral	Unaffected	Right	Left	Affected	Unaffected	Affected	Unaffected	Affected	Unaffected
Mean	17.1	17.4	17.1	18.4	17	17.1	17.4	18.4	17.6	19.2	17.3	18.3
SD	2.1	2.1	2.1	2.5	2.1	2.2	2.1	2.5	2	2.4	2	2.4
N	79	77	79	77	79	79	77	77	10	10	67	67
P	0.369		0.0004		0.254		0.0004		0.0004		<0.0001	

Table 3: Effect of age and total brace duration (follow up) on calf circumference

	Age Influence (Unilateral cases)						Effect of brace duration (Unilateral cases)					
	≤24 months		25-60 months		>60 months		<12 months		13-36 months		>36 months	
	Affected	Unaffected	Affected	Unaffected	Affected	Unaffected	Affected	Unaffected	Affected	Unaffected	Affected	Unaffected
Mean	16.4	16.9	17.7	18.9	20.2	22.3	16.41	17.2	17.55	18.64	19.45	20.93
SD	1.7	1.7	1.7	1.9	2.5	2.8	1.75	2.19	1.8	2.07	1.94	2.18
N	32	32	38	38	7	7	31	31	34	34	12	12
P	<0.0001		<0.0001		0.004		<0.0001		<0.0001		0.0005	

17.3±2.0 cm in affected legs and 18.3±2.4 cm in non-clubfoot legs with p<0.0001.

4. Effect of age

Children with unilateral clubfoot were included for this analysis. When compared with contralateral "non-clubfoot" leg, we found significant difference in all age groups with mean difference of 0.5 cm (3%), 1.2 cm (6.79%) and 2.1 cm (10.33%) in age group ≤ 24 months, 25-60 months and > 60 months respectively. Calf size difference worsened with increasing age of child (p <0.0001; ANOVA test).

5. Effect of brace wear duration

Patients whose brace duration was <12 months, 13-36 months, and >36 months were compared in unilateral cases. The calf size was significantly different (p<0.001) in all the groups, indicating that prolonged brace use did not influence calf girth.

6. Intragroup comparison of bilateral cases

There was no difference (p=0.2539) between calf circumference of both legs in bilateral cases with mean circumference on one side being 17.0±2.1cm and on other side 17.1±2.2cm.

Discussion

Decreased calf muscle volume is a basic defect in clubfoot. Ippolito confirmed leg muscle atrophy in fetuses and newborns with severe unilateral congenital clubfoot prior to commencement of treatment [3]. Previous studies have compared the effect of various treatment methods on foot size. Fulton found that the average calf ratio in children who underwent surgery for clubfoot was significantly less at 90.8%±3.5% compared with 94.4%±3.3% in the Ponseti group [7]. Gamble implicated the intrinsic abnormality as a cause of reduced calf size, as he found no significant effect of treatment mode on the calf size [10]. The present study showed significant calf girth differences in non-clubfoot, unilateral and bilateral clubfoot.

Aronson mentioned normal growth potential of a clubfoot [6]. But other studies have contradicted this view, demonstrating visible differences in foot and leg size. Although muscle mass depends on activity level of a person, and the more active clubfoot children may gain some volume, recovery is seldom complete [8]. In the present study, calf size differences worsened with increasing age of child and brace use did not lead to calf girth recovery. This supports the finding that calf circumference difference is inherent to the disease and it is not affected by bracing duration [1, 3, 11, 12].

In the present study, the mean calf circumference difference was 5.64% and 7.28% in unilateral and bilateral legs respectively and matches with previous reports of 3-10% [7]. Further, our study showed no gender or intragroup bilateral clubfoot differences.

Our study has several limitations. It is a cross sectional study and we therefore did not evaluate calf muscle development in the same child over a period of time. Severity of disease which can also affect calf muscle atrophy was not taken as confounding factor for our study. We used the unilateral 'unaffected' leg as a control for comparing bilateral affected legs, but they were age-matched. We did not include a subjective assessment score

to grade parental satisfaction and did not assess functional outcome of calf atrophy. Muscle function can also impact calf size and this factor was not considered in the study.

This is the first study in Indian children with idiopathic clubfoot to compare calf circumference differences in clubfoot patients. Both unilateral and bilateral clubfoot patients were included and to decrease bias, one foot was considered at random for statistical analysis in bilateral cases (as previous studies have suggested that both feet are similar in severity in bilateral clubfoot) [13, 14]. Age and brace wear duration effect on calf circumference were performed only in unilateral cases, where an unaffected foot was available for comparison. In conclusion, calf girth of affected legs in both unilateral and bilateral cases was significantly decreased compared to the unaffected side. This difference did not improve with the advancing child's age or with brace wear duration, suggesting an inherent defect in the development of the leg in idiopathic clubfoot.

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