Original Article Journal of Karnataka Orthopaedic Association 2019 Jan-April;7(1):9-15

Comparison of Functional and Radiological Outcome of Children Aged 5-10 years with Clubfoot Treated Previously Either by Ponseti Method or Surgical Release - A Minimum 4-year Follow-up (Case Series of 28 Children as Cross-sectional Study)

M Ajith Kumar[1], Shah Jay Rajesh[1]

Abstract

Aim: This study aims to compare the functional outcome in children aged 5-10 years with clubfoot previously treated by either Ponseti or posteromedial soft tissue release (PMSTR) with minimum follow-up of 4 years following final casting.

Objectives: The objectives of this study were as follows: (1) To compare the functional outcome between the two methods, (2) to determine whether correlation exists between functional outcome and radiographic measurements of both groups, and (3) to compare results with the literature.

Materials and Methods: The study was conducted in Tejasvini Hospital and SSIOT. Medical records of clubfoot patients operated between January 2008 and December 2011 were reviewed. Communication was sent to them and scheduling of appointments for the assessment was made. 28 patients with 45 feet who met the inclusion criteria were assessed. Objective evaluation was made using standard standing AP/lateral foot radiographs and subjective evaluation was made using Laaveg-Ponseti 100-point scoring system includes subjective and objective questionnaire and tabulated. The observation was subjected to statistical analysis.

Results: (1) Of 45 foots, Laaveg-Ponseti score showed excellent in 18 feet, good in 16 feet, moderate in 4 feet, and poor in 7 feet, (2) patient managed with Ponseti has higher excellent/good outcome as compared to PMSTR (90.5% and 62.5%, respectively) but not to the point of statistically significant with P = 0.152, (3) lower talo-1st metatarsal lateral (TMT-LT) (P = 0.004), lower TMT anteroposterior (AP) (P = 0.001), lower calcaneum-5th metatarsal AP (P = 0.005), and high talocalcaneal angle in lateral (P = 0.015) angles are correlated with excellent/good functional outcome with statistically significant P < 0.05, and (4) there were no other significant correlations between the functional and radiographic outcomes.

Conclusion: (1) Our study supports the routine use of radiography during follow-up and using wide range of parameters instead of anyone radiologic parameter, (2) serial manipulation and casting are the preferred initial treatment of choice for idiopathic clubfeet, and soft tissue release is reserved for clubfeet that cannot be completely corrected as it will lead to stiff painful foot and low functional outcome. A strict brace compliance remains the major challenge of the Ponseti method.

Key words: Forefoot adduction on weight-bearing, Calcaneal varus on weight-bearing, Anteroposterior, Lateral, Left, Right, Female, Male, Talus-1st metatarsal angle (LATERAL), 1st–-5th metatarsal angle (LATERAL), Talus-1st metatarsal angle (anteroposterior), Calcaneus-5th metatarsal angle (anteroposterior), Talocalcaneal angle (anteroposterior), Talocalcaneal angle (LATERAL), Congenital talipes equinovarus (clubfoot).

[1]Department of Orthopaedics, Tejasvini Hospital and SSIOT, Mangalore, Karnataka, India.

Address of correspondence :
Dr. Shah Jay Rajesh,
Tejasvini Hospital and SSIOT, Kadri Road, Mangalore, Karnataka, India.
Email: Shah.jay.003@gmail.com

Introduction

Clubfoot is the most common disorder of foot in infants known to us with an incidence of 0.64-6.8/1000 live births [1]. Moreover, various treatment protocols have been implicated since the time of Hippocrates. The primary treatment has ranged from gentle manipulation to aggressive surgical management. Since the development of good results with Ponseti method, various studies have been done to compare Ponseti treatment with other surgical and non-surgical methods. Almost all studies focused on immediate or long-term outcome, only few studies are done on midterm outcome. The purpose of this

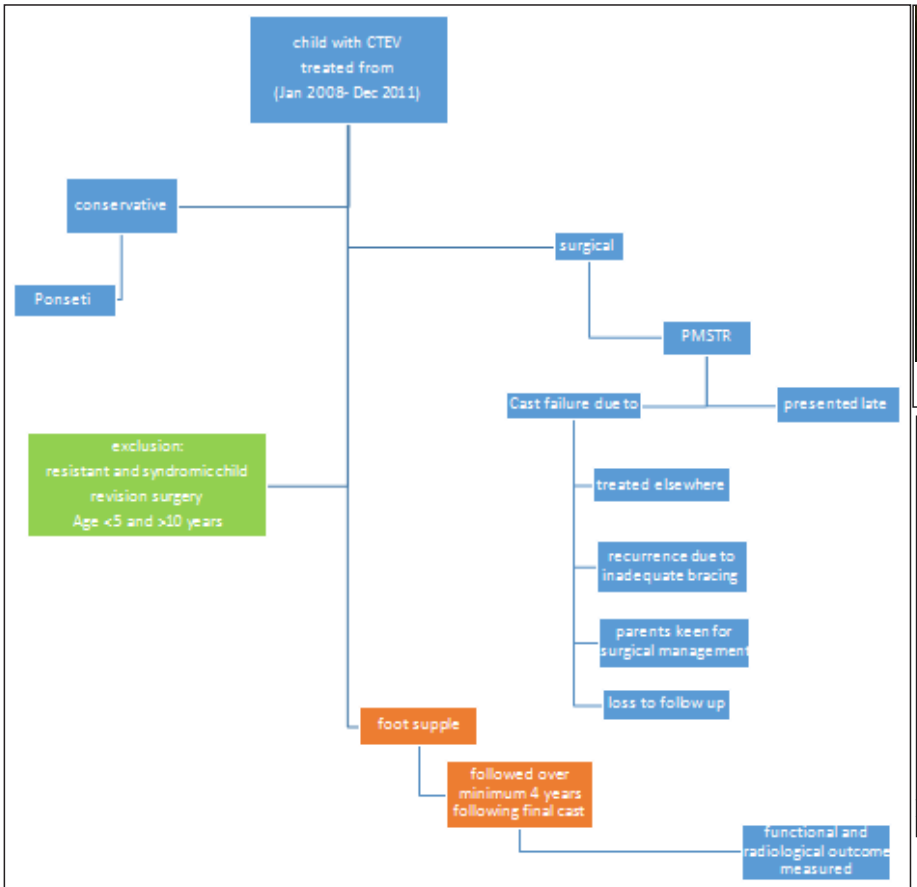

Figure 1: Patient selection.

Figure 2: Calcaneal varus on standing.

Figure 3: Metatarsus adductus on standing.

Figure 4: Talocalcaneal angle.

Figure 5: Calcaneal-5th metatarsal angle.

cross-sectional study is to analyze the functional outcome of clubfoot treated either conservatively or surgically and compare the functional and radiological parameters as there is very few study done in Indian population supporting the midterm outcome between the two treatment options.

Aim of the study

- This study aims to compare the functional outcome in children aged 5-10 years with clubfoot previously treated by either Ponseti or posteromedial soft tissue release (PMSTR) with minimum follow-up of 4 years following final casting.

Objectives

The objectives of this study were as follows:

- To compare the functional outcome between the two methods.
- To determine whether correlation exists between functional outcome and radiographic measurements of both groups.
- To compare results with the literature.

Materials and Methods

Child with idiopathic clubfoot with age >5 years and <10 years treated with Ponseti/PMSTR who has Dimeglio score severe on starting treatment and

Figure 6: Talus-1st metatarsal angle.

minimum 4-year follow-up following final cast was included in this study. Resistant congenital talipes equinovarus (CTEV), syndromic child atypical clubfoot, and previously (revision) operated foot were excluded from the study.

Methodology

All children between the age group of 5 and 10 years with idiopathic clubfoot who underwent treatment for CTEV with either PMSTR or Ponseti were included in this study with minimum follow-up of 4 years following final casting and patient undergoes physical examination, radiologic examination, and functional scoring system using Laaveg-Ponseti score (100-point score system).

Data collection (Fig. 1)

In both study groups, case records were drawn from MRD of Tejasvini Hospital and SSIOT from January 2008 to December 2011, and Dimeglio score was noted and tabulated. In our institute, since 2004, Ponseti method is the preferred initial treatment, and surgical management has been done who presented late or lost to follow-up following conservative treatment, parents keen for surgical management, recurrence following Ponseti, noncompliant follow-up, and syndromic and resistant clubfoot. Only those children who met the inclusion criteria, had Dimeglio score between 10 and 15 at the start of treatment, and those children with supple feet at the end of treatment with either Ponseti method/surgical management were compared at the end of minimum of 4 years and their following parameters were noted.

Physical examination

All children examined thoroughly and following parameters have been noted:

- Age
- Sex
- Side.

Position of foot: (On standing)

- Calcaneal inversion/eversion/normal (Fig. 2)
- Forefoot abduction/adduction/normal (Fig. 3).

Range of motion: (Passive)

- Dorsiflexion
- Plantar flexion.

Gait pattern

- Normal
- Equinus
- Planovalgus.

Functional outcome (using Laaveg-Ponseti score) [10]

A. Satisfaction (20 points)
B. Function (20 points)
C. Pain (20 points)
D. Position of the foot while standing (10 points)
E. Passive motion (10 points)
F. Gait (10 points).

The Laaveg-Ponseti score is a 100-point evaluation system:

- With scores between 90 and 100 considered as excellent,
- 80 and 89 as good,
- 70 and 79 as moderate,
- And <70 as poor.

Radiographic assessment

Standardized AP and lateral weight-bearing radiographs were taken and scanned [11]. Lines were drawn on the AP projection longitudinally through the osseous nucleus of the talus parallel to its medial border and through the calcaneus parallel to its lateral border. Additional lines were drawn through the longitudinal axis of the 1st and 5th metatarsals. In the lateral roentgenogram, projection lines were drawn longitudinally through the

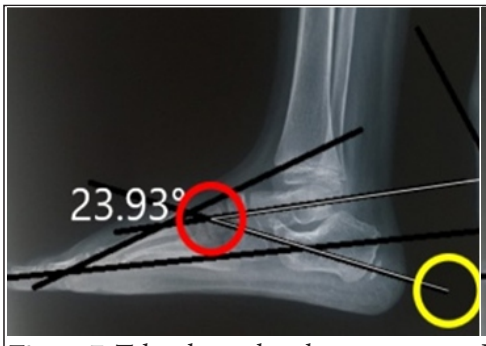

Figure 7: Talocalcaneal angle.

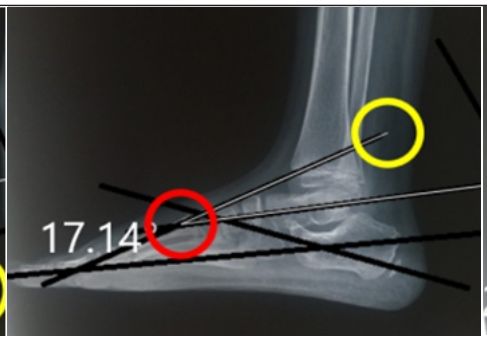

Figure 8: Talus-1st metatarsal angle.

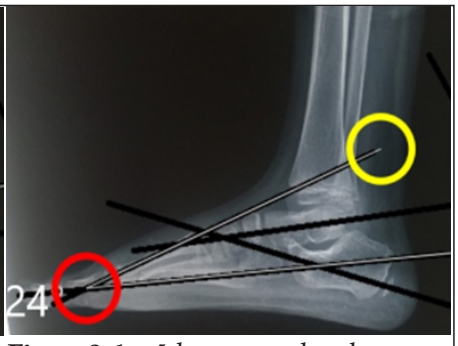

Figure 9: 1st-5th metatarsal angle.

Table 1: Demography of parameters in Ponseti and PMSTR

Group	*n*	Mean	*P* value
Age			
Ponseti	21	6.33	0.779
PMSTR	24	6.2	
TMT-LT			
Ponseti	21	8.07	0.003
PMSTR	24	14.46	
MTT-LT			
Ponseti	21	11.79	0.027
PMSTR	24	15.39	
TMT-AP			
Ponseti	21	6.78	0.001
PMSTR	24	13.89	
CMT-AP			
Ponseti	21	6.85	0.024
PMSTR	24	11.05	
TCA-AP			
Ponseti	21	25.61	0.029
PMSTR	24	29.11	
TCA-LAT			
Ponseti	21	30.84	<0.001
PMSTR	24	23.14	
Functional score			
Ponseti	21	87.95	0.017
PMSTR	24	75.79	

PMSTR: Posteromedial soft tissue release, TMT-LT: Talo-1 st metatarsal lateral, MTT-LT: 1-5th metatarsal angle in lateral, TMT-AP: Talo-1st metatarsal anteroposterior, CMT-AP: calcaneum-5th metatarsal anteroposterior, TCA-AP: Talo-calcaneal angle in anteroposterior, TCA-LAT: Talo-calcaneal angle in lateral

Table 2: Functional score

Study	Size (feet)	Ponseti	Size (feet)	PMSTR	Significance
Ippolito *et al* . [5]	49	86.3	47	74.7	Significant
Laaveg *et al* . [2]	104	87.5			Significant
Cooper *et al* . [4]	71	85.4			Significant
Dobbs *et al* . [6]			73	65.3	Significant
Fridman *et al* . [7]			71	86.86	Significant
Singh *et al* . [8]			33	87.1	Significant
Prasad *et al* . [9]			50	78.07	Not significant
Munshi *et al* . [10]			50	87.3	Significant
Our study	21	87.95	24	75.79	Significant

PMSTR: Posteromedial soft tissue release

central axis of the talus and parallel to the lower border of the body of the calcaneus. An additional line was drawn through the axis of the 1st and 5th metatarsal.

Following radiologic parameter assessment

In AP projection, we evaluated (Fig. 4, 5, 6)

- Talocalcaneal angle (Fig. 4)
- Calcaneal-5th metatarsal angle (Fig. 5)
- Talus-1st metatarsal (TMT) angle (Fig. 6).

In lateral projection, we evaluated (Fig. 7, 8, 9)

- Talocalcaneal angle (Fig. 7)
- TMT angle (Fig. 8)
- 1st-5th metatarsal angle (Fig. 9).

Their final outcome measured using above-mentioned criteria and result noted in Excel sheet with their short history.

Statistical analysis

All these data were recorded and analyzed into Microsoft Excel and Microsoft Word 2010 and statistical analysis was done using SPSS software v20. All measurements were made by single observer using SURFACE protractor v 1.1 (using C++). Statistical analysis was done using unpaired Student's t-test with pooled variance for functional and radiological outcome, and correlation between functional and radiologic outcome has been done using one-way ANOVA and post hoc Tukey test.

Results

All the children who met with an inclusion criteria were included in the study group. A total of 14 children in each group were identified and analyzed. Independent Student's t-test for comparison of age, radiological parameters, and functional outcome score.

Functional outcome (Table 1)

At the final follow-up, functional outcomes, as measured with the Laaveg-Ponseti score, show statistically significant difference between patients treated with Ponseti method and patients treated with soft tissue release with P = 0.017. However, when compared categorically (Table 2), patients managed with Ponseti method did have a higher rate of excellent or good outcome than patients treated with open surgery, but not quite to the point of statistical significance with P = 0.152. Comparison of the functional score between the two groups shows that functional score is higher in Ponseti group with t = 2.498 and is statistically significant with P = 0.017. Comparison of the age between the two groups shows that age is higher in Ponseti group with t = 0.283 and is statistically non-significant with P = 0.779.

Radiological outcome (Table 3)

The radiographs taken at the time of the final follow-up statistically significant differences were noted between patients managed with the Ponseti method and patients treated with open surgery in the following angles: The talocalcaneal angle in AP (TCA-AP) and the TCA in lateral (TCA-LAT) reflect the anatomic relationship between the talus and the calcaneus, TCA-AP angle measures the heel varus, TMT lateral (TMT-LT) and 1-5th metatarsal angle in lateral (MTT-LT) angles measure midfoot cavus deformity, TMT anteroposterior (TMT-AP), and calcaneum-5th metatarsal AP (CMT-AP) angles are expressions of forefoot adduction that characterizes clubfoot. TMT angle in AP projection in Ponseti group is 6.78° while PMSTR is 13.89° with statistically significant P = 0.001, TCA-LAT projection with mean of 30.84° in Ponseti and 23.14° in PMSTR with statistically significant P < 0.001, talocalcaneal angle in AP projection (TCA-AP) with average angle is 25.61° and 29.11° in Ponseti and PMSTR, respectively, with statistically significant P = 0.029, CMT angle in AP projection is 6.85° in Ponseti and 11.05° in PMSTR with statistically significant P = 0.024, TMT angle in lateral projection with mean of 8.07° and 14.46° in Ponseti and

Table 3a: AP-TCA			
Study	Ponseti	PMSTR	Significance
Laaveg *et al* . [2]	14.5		Not significant
Cooper *et al* . [4]	17		Not significant
Dobbs *et al* . [6]		12.8	Not significant
Fridman *et al* . [7]		20.8	Not Significant
Singh *et al* . [8]		28.4	Not significant
Prasad *et al* . [9]		18.5	Significant
Herbsthofer *et al* . [11]		16.1	Not significant
Abulsaad *et al* . [12]		16.4	Not significant
Our study	25.61	29.12	Significant
b: LAT-TCA			
Laaveg *et al* . [2]	20.9		Significant
Cooper *et al* . [4]	30		Not significant
Dobbs *et al* . [6]		23.3	Significant
Fridman *et al* . [7]		22.5	Not significant
Singh *et al* . [8]		30.9	Not significant
Prasad *et al* . [9]		27.4	Significant
Herbsthofer *et al* . [11]		23	Not significant
Abulsaad *et al* . [12]		21.4	Not significant
Our study	30.84	23.14	Significant
c: AP-TMT			
Cooper *et al* . [4]	1		Not significant
Dobbs *et al* . [6]		15.95	Significant
Fridman *et al* . [7]		3.97	Significant
Singh *et al* . [8]		11.9	Significant
Prasad *et al* . [9]		6.92	Not significant
Herbsthofer *et al* . [11]		10.29	Not significant
Abulsaad *et al* . [12]		-5.43	Significant
Our study	6.78	13.89	Significant
d: LAT-TMT			
Cooper *et al* . [4]	5		Not significant
Dobbs *et al* . [6]		7.68	Not significant
Singh *et al* . [8]		15.7	Significant
Prasad *et al* . [9]		18.54	Not significant
Our study	8.07	14.46	Significant
e: MTT-LAT			
Laaveg *et al* . [2]	14.7		Not significant
Cooper *et al* . [4]	16		Not significant
Dobbs *et al* . [6]		18.1	Not significant
Singh *et al* . [8]		28.2	Significant
Prasad *et al* . [9]		46.2	Not significant
Our study	11.79	15.39	Significant
f: CMT-AP			
Laaveg *et al* . [2]	-4.9		Not significant
Cooper *et al* . [4]	-8		Significant
Dobbs *et al* . [6]		10.32	Significant
Fridman *et al* . [7]		1.32	Significant
Prasad *et al* . [9]		5.8	Not significant
Herbsthofer *et al* . [11]		9.95	Not Significant
Our study	6.85	11.05	Significant

PMSTR: Posteromedial soft tissue release, TMT-LT: Talo-1 st metatarsal lateral, MTT-LT: 1-5th metatarsal angle in lateral, TMT-AP: Talo-1st metatarsal anteroposterior, CMT-AP: calcaneum-5th metatarsal anteroposterior, TCA-AP: Talocalcaneal angle in anteroposterior, TCA-LAT: Talocalcaneal angle in lateral

PMSTR, respectively, with statistically significant P = 0.003, and MTT-LT projection with statistically significant P = 0.027 (mean 11.79 [Ponseti] and 15.39 [PMSTR]). Comparison of the TMT-LT between the two groups shows that TMT-LT is higher in PMSTR group with t = −3.251 and is statistically significant with P = 0.003, comparison of the MTT-LT between the two groups shows that MTT-LT is higher in PMSTR group with t = −2.291 and is statistically significant with P = 0.027, comparison of the TMT-AP between the two groups shows that TMT-AP is higher in PMSTR group with t = −3.735 and is statistically significant with P = 0.001, comparison of the CMT-AP between the two groups shows that CMT-AP is higher in PMSTR group with t = −2.356 and is statistically significant with P = 0.024, comparison of the TCA-AP between the two groups shows that TCA-AP is higher in PMSTR group with t = −2.263 and is statistically significant with P = 0.029, and comparison of the TCA-LAT between the two groups shows that TCA-LAT is higher in Ponseti group with t = 4.474 and is statistically significant with P < 0.001. On correlating functional outcome with radiological outcome, we found from this study that lower TMT-LT (P = 0.004), lower TMT-AP (P = 0.001), lower CMT-AP (P = 0.005), and high TCA-LAT (P = 0.015) angles are correlated with excellent/good functional outcome with statistically significant P < 0.05 while MTT-LT (P = 0.28) and TCA-AP (P = 0.176) are not statistically significant.

Discussion

Idiopathic clubfoot or CTEV is the most common congenital orthopedic condition which has been managed since the time of Hippocrates with unsatisfactory results. The primary treatment has ranged from gentle manipulation to aggressive surgical management. Surgical management of clubfoot was popularized during the 1960s, but long-term studies show poor outcome following surgical release due to painful, stiff foot, and early arthritic changes. In view of the above-mentioned surgery-related complications and poor results with Kite's method of conservative treatment, Dr. I.V. Ponseti, in 1968, devised his own method of CTEV correction which combines manipulation and casting with/without Achilles tenotomy. In 2000, Ponseti described his method of CTEV correction in detail with a very favorable long-term result [4]. Since then worldwide there is shift of CTEV treatment towards conservative Ponseti treatment. Although there is no evidence to support sex linkage, males are affected more commonly than females in all ethnic groups. In our study, we reported male-to-female ratio of 1:1. In our study, we reported the left unilateral CTEV 18%, and right unilateral CTEV 21% and bilateral in 61% cases. This difference in the demographic data may be due to lack of data collection in Asian Population.

Functional score

Ponseti group

In our study with 28 patients and 45 feet, we found 52.4% excellent and

38.1% good result with mean of Laaveg Ponseti score of 87.95 at 6.3-year follow-up with a statistically significant P = 0.017.

PMSTR group

In this study with 28 patients and 45 feet, we found 29.2% excellent and 33.3% good result with mean of Laaveg Ponseti score of 75.79 at 6.2-year follow-up with a statistically significant P = 0.017. "Our study which is an intermediate outcome study was in agreement with these findings, suggesting that foot function deteriorates over time in patients treated with open surgery due to post-operative stiffness and contracture, early arthritic changes." This difference in the radiographic parameters is mainly due to the fact that difficulties in obtaining standardised radiographical X-rays, difference in inclusion criteria, result may deteriorate with time, most of the study are long term while our study is intermediate, radiographic evidence of degenerative changes in the foot and ankle have been noted in patients with clubfoot who were followed to skeletal maturity after having been treated with either primary cast immobilization or an extensive soft tissue release. On correlating functional outcome with radiological outcome, on comparing the Ponseti treatment with PMSTR, we found that lower TMT-LT indicating cavus deformity, lower TMT-AP and lower CMT-AP indicating forefoot adduction, and high TCA-LAT indicating heel varus are correlated with excellent/good functional outcome with statistically significant P < 0.05 while MTT-LT indicating cavus deformity and TCA-AP indicating heel varus are not statistically significant.

Limitation

i. The patients were assessed clinically and radiologically by one reviewer, which makes this study open for bias, so interobserver bias cannot be validated; however, the reviewer was not the surgeon who did the primary procedure.
ii. We have not followed up these patients beyond skeletal maturity; therefore, we are unaware whether their feet will continue to function well throughout adulthood.
iii. The total number of patients is small and the loss of some patients at final follow-up may skew the results.
iv. The possibility of selection bias does exist in the design of this study.

Recommendation

i. In early age group, Ponseti method of treatment is the treatment of choice for patient with CTEV.
ii. Although the Ponseti method outcome is good, follow-up protocol to wear brace will decide the final outcome. These early results may translate into improved long-term outcomes if the initial clubfoot correction is maintained and the patients require fewer surgical procedures.
iii. The radiographic parameters that reflect the foot alignment proved to be valuable in the evaluation system.

Conclusion

Although the underlying pathoanatomy is well understood, still controversy exists regarding the timing and best method of the treatment for clubfoot. The Ponseti technique has become the standard for the treatment of clubfoot, so it is difficult to perform a randomized controlled trial comparing the clubfeet treated with Ponseti and surgical release. Many children following PMSTR developed post-operative stiffness, pain, early arthritic changes, and overcorrection following surgery which produces planovalgus gait pattern and leads to poor functional/radiological outcome. Although some amount of forefoot adduction and heel varus persist in Ponseti method, their functional outcome and radiological parameters are showing good to excellent results. While poor outcome is mainly related to noncompliant brace protocol following casting. TMT-AP, TCA-LAT, TMT-LT, and CMT-AP are strongly associated with statistically significant P value and correlated well with functional outcome. Our study supports the routine use of radiography during follow-up and using wide range of parameters instead of any one radiologic parameter. The angles that reflect the foot alignment proved to be helpful in the evaluation system. From this study, we concluded that serial manipulation and casting are the preferred initial treatment of choice for idiopathic clubfeet, and soft tissue release is reserved for clubfeet that cannot be completely corrected as it will lead to stiff painful foot and low functional outcome. A strict brace compliance remains the major challenge of the Ponseti method.

References

1. Phillips D. Incidence, Prevalence and Challenges of Managing CTEV in the Top End. 13th National Rural Health Conference.
2. Laaveg SJ, Ponseti IV. Long-term results of treatment of congenital club foot. J Bone Joint Surg Am 1980;62:23-31.
3. Simons GW. A standardized method for the radiographic evaluation of clubfeet. Clin Orthop Relat Res 1978;135:107-18.
4. Cooper DM, Dietz FR. Treatment of idiopathic clubfoot. A thirty-year follow-up note. J Bone Joint Surg Am 1995;77:1477-89.
5. Ippolito E, Farsetti P, Caterini R, Tudisco C. Long-term comparative results in patients with congenital clubfoot treated with two different protocols. J Bone Joint Surg Am 2003;85-A:1286-94.
6. Dobbs MB, Gurnett CA. Update on clubfoot: Etiology and

treatment. Clin Orthop Relat Res 2009;467:1146-53.

7. Fridman MW, de Almeida Fialho HS. The role of radiographic measurements in the evaluation of congenital clubfoot surgical results. Skeletal Radiol 2007;36:129-38.
8. Singh BI, Vaishnavi AJ. Modified turco procedure for treatment of idiopathic clubfoot. Clin Orthop Relat Res 2005;438:209-14.
9. Prasad P, Sen RK, Gill SS, Wardak E, Saini R. Clinico-radiological assessment and their correlation in clubfeet treated with postero-medial soft-tissue release. Int Orthop 2009;33:225-9.
10. Munshi S, Varghese RA, Joseph B. Evaluation of outcome of treatment of congenital clubfoot. J Pediatr Orthop 2006;26:664-72.
11. Herbsthofer B, Eckardt A, Rompe JD, Küllmer K. Significance of radiographic angle measurements in evaluation of congenital clubfoot. Arch Orthop Trauma Surg 1998;117:324-9.
12. Abulsaad M, Abdelgaber N. Correlation between clinical outcome of surgically treated clubfeet and different radiological parameters. Acta Orthop Belg 2008;74:489-95.

Conflict of Interest: NIL
Source of Support: NIL

How to Cite this Article

Ajith M, Shah J R. Comparison of Functional and Radiological Outcome of Children Aged 5-10 years with Clubfoot Treated Previously Either by Ponseti Method or Surgical Release - A Minimum 4-year Follow-up (Case Series of 28 Children as Cross-sectional Study).. J Kar Orth Assoc. Jan-April 2019; 7(1): 9-15.