

IDIOPATHIC CLUBFOOT: COMPARISON OF DIFFERENT CONSERVATIVE TREATMENTS, PONSETI'S VERSUS NON – PONSETI'S METHODS

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Abstract

Objective

The clinical treatment of club foot uses various approaches. This meta-analysis was done to evaluate the efficacy of various conservative treatments. Various studies were collected and odd's ratio (ORs) with the corresponding confidence intervals were calculated for the evaluating the results, relapses and requirement for major surgery. A meta-analysis of 1400 cases from 9 relevant studies were performed. The combined odd's ratio suggested that significantly more fair and poor results were achieved and major surgery was required more often when using non Ponsetti's methods where the odd's ratio was 3.12 and 7.26 respectively, but there was not any considerable difference detected in the occurrence of relapse, where the odd's ratio being 1.25. The collective odd's ratio evaluation had shown a significantly higher rate of fair and poor results, relapse and requirement of surgery while using Kite's method while using Ponseti's method where the odd's ratio being, 3.52, 2.47, and 3.06 respectively. But there wasn't any considerable difference between French method and Ponseti's method, where the odd's ratio was 3.03, 2.27, and 3.04 respectively. The analysis of all the methods states that the Ponseti's method is safe and efficient for the conservative treatment of clubfoot and it decreases the number of surgical interventions required for the treatment. It is the first choice conservative treatment for the idiopathic clubfoot.

Keywords: Idiopathic clubfoot, conservative treatment, Ponseti's method, Kite method, French method.

INTRODUCTION

Congenital talipes equinovarus or idiopathic club foot is a severe pediatric orthopedic deformity that might turn the patient handicapped. The patient may have the problem in leading his / her vocation and also it may to claudication if the treatment is delayed or neglected¹. It is the most common musculoskeletal birth defects that account for 1 per 5 per 1000 live new borns². The following four components get involved with club foot: ankle equinus, hindfoot varus, forefoot adduction and midfoot cavus³. Most clubfeet are isolated defects are often considered as idiopathic, while around 20% of the clubfeet are caused by the neuromuscular conditions and genetic syndromes. Without proper treatment the deformed foot may lead to disabled condition for the patient⁴. Various treatments including splints, physical therapy and corrective casts have been widely used, but since past several decades these conservative treatments have been replaced by the surgical operations such as soft tissue release^{5,6}. For many years the complex and extensive surgical procedures were used as the major management techniques for club foot. The results of these procedures were not excellent^{5,6} and also surgical release procedures were required to lengthen the tissue over the medial and posterior aspects of the club foot⁷. With the introduction of Ponsetti's novel casting method to correct the forefoot adduction, hindfoot varus, equinus and cavus in patients with club foot, excellent results have been achieved. The classic surgical correction of the clubfoot has been abolished due to the result if poor function and the painful foot due to the surgery⁸ and thus it is replaced by Ponseti's method.⁹ Thus this method was replaced by Ponseti's method, which is a non-surgical technique and is extensively proven to be the safer and more efficient than the surgery for the treatment of club foot^{10,11}. Ponseti's method is widely recommended as the gold standard for the treatment of idiopathic clubfoot and is approved worldwide. Other methods like Kite's method and French method¹² are also widely accepted in the clinical settings. The purpose of this study was to determine whether the Ponseti's method is the most efficient technique amongst the conservative treatments of idiopathic club foot, by undergoing the meta-analysis of the scientific literature.

METHODOLOGY

Embase, Medicine, Pubmed and Web of science were searched for the following keywords: clubfoot, Ponseti and treatment. The references of the related articles were manually investigated to avoid any kind of omission.

In case there was any duplication, the most recent or complete study was included. Preferred Reporting Items for Systematic Reviews and Meta – Analyses (PRISMA) statement criteria were used to perform the meta-analysis.

Two independent reviewers assessed the eligibility of the studies by reviewing the titles and the abstracts. Following were the inclusion criteria for the study, the conservative treatment of patients with clubfoot, comparison between Ponseti's method and at-least one non Ponseti's method, English publication, and enough data to calculate the odd's ratio (OR) and 95% Confidence Interval (CI). The exclusion criteria being similar studies including the same patients and the studies in which comparison could not be made. Statistical Analysis.

The odd's ratios were calculated to compare the Ponseti's and non Ponseti method. The studies the heterogeneous and it was statistically significant if the P value was less than 0.10 and the heterogeneity was quantified using the I^2 where $I^2 = 0\%$ indicated no heterogeneity, $I^2 < 25\%$ indicates low heterogeneity, $I^2 = 25\% - 50\%$ moderate heterogeneity, $I > 50\%$ indicated strong heterogeneity^{13,14,15}. Instead of fix effects model the random effects model was used if heterogeneity was present^{15,16}. All the P values were two sided and Rev Man or the Review manager software version 5.2 was used for the meta-analysis.

RESULTS

Total of 400 studies were reviewed using the research strategy, Figure 1. Out of these 391 unrelated topics, duplicate studies or studies that involve comparison with an operation method were excluded. Thus 9 studies that involved 1400 cases and 1500 feet were included in this meta-analysis¹⁷⁻²⁵, Table 1.

Non Ponseti's method versus Ponseti's method

Five studies involving a total of 926 feet treated with conservative methods were studied via meta-analysis. There was severe heterogeneity where in $I^2 = 75\%$, thus a random effects model was selected for the analysis. The collective OR was 3.12 with 95% CI, 1.29 – 8.15 $Z=2.59$, $P=0.010$, showing that the non Ponseti's method had more fair and poor correction results than Ponseti's method ($P=0.010$). (Table 2 (a))

Five studies with a total of 950 feet treated with conservative methods were meta-analyzed. A random effects model was used for the analysis as there was severe heterogeneity with an $I^2 = 82\%$). The collective odd's ratio was 1.25 and it was shown that there was not any difference in the relapse of Ponseti's and non – Ponseti's methods Table 2(b)).

There were 8 studies with a total of 1250 feet that were treated with conservative methods and were meta-analyzed. $I=91\%$, showing severe heterogeneity thus a random effects model was selected for the analysis. The collective odd's ratio being 7.26 (95% CI, 1.81 – 28.76, $Z=2.75$, $P = 0.005$), it shows that more surgeries with an exception of Achilles tenotomy were required after the non Ponseti's method than after the Ponseti's method where $P = 0.005$). (Table 2(c))

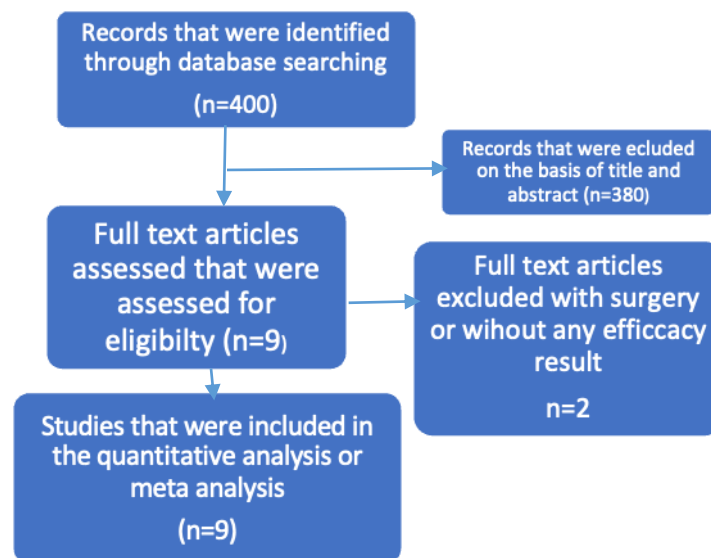


Figure 1: Flow chart for the selection process for studies that were included in the meta-analysis

Table 1: Characteristics of studies included in the meta-analysis

Author/Reference	Method	N	Dimeglio score	Duration	Cast
Herzenberg et al ²² .	Ponseti	32	Null	Null	Null
	Traditional cast	32	Null	Null	Null
Aurell et al ²³	Ponseti	8	12.41+/-2.12	Null	Null
	Copenhagen	17	9.91+/-2.02	Null	Null
Cosma et al ²⁵	Ponseti	73	10.4	5+/- 1 w	4+/-2 w
	Romanian	73	10.3	15+/-6 w	5+/-2 w
Sud et al ¹⁷	Ponseti	35	14.35+/-3.18	49.27+/-18.3 d	6.1+/-2.1
	Kite	30	16.05+/-2.67	90.87+/-52.8 d	10.69+/-5.3
Richards et al ²⁰	Ponseti	265	12.08	Null	Null
	French	119	12.6	Null	Null
Sanghvi and Mittal ¹⁸	Ponseti	32	Null	10+/-1w	6+/-1
	Kite	35	Null	12+/-2w	10+/-2
Chotel et al ²¹	Ponseti	102	Null	Null	Null
	French	115	Null	Null	Null
Derzsi et al ¹⁹	Ponseti	103	12.13+/-6.57	11.23+/-5.78 w	Null
	Kite	132	12.13+/-7.23	20.12+/-8.45	Null
Saetersdal ²⁴	Ponseti	157	Null	Null	Null
	Pre-Ponseti cast	140	Null	Null	Null

Null – data unavailable, d – day, w-week.

Kite's Method versus Ponseti's method

Three studies were conducted for the rates of poor and fair results, relapse and requirement for additional operations. The results had shown that there were significant differences in all three factors between Kite's method and Ponseti's method, **Table 3** For Ponseti's method all the three rates were considerably lower than the Kite's method, **Table 3**.

French method versus Ponseti's method

Two studies were done to calculate the rates of poor and fair results, relapse, and requirement of additional operations. The results had shown that there wasn't any considerable differences amongst these three factors in the French and Ponseti's method, **Table 4**

Table 2 : Comparison between the conservative methods (a) Combined analysis of poor and fair results (b) Combined analysis of relapse (c) Combined analysis of additional surgeries

a)Study	Non-Ponseti's method		Ponseti's method		Odd's Ratio
	Events	Total	Events	Total	
Alok Sud 2008	9	30	2	35	4.74 (1.15, 19.29)
Stephen's Richard 2008	5	119	14	265	0.87 (0.32, 2.32)
AV Sanghi 2009	7	35	3	32	1.65 (0.43, 6.42)
Franck Chotel 2011	72	115	14	102	9.58 (5.03, 18.26)
Zoltan Derzsi 2015	37	132	7	103	4.65 (2.13, 10.16)
Total (95% CI)		431		537	3.12 (1.25, 7.26)
Total events	130		40		
Heterogeneity: Tau ² =0.80, Chi ² =17.95, df = 4 (P=0.001), I ² =75%					
Test for overall effect : Z=2.59 (P=0.010)					
b)Study	Non-Ponseti's method		Ponseti's Method	Event	Odd's Ratio
	Events	Total			
Stephen's Richard 2008	31	119	90	267	0.70 (0.42, 1.13)
Alok Sud 2008	7	30	5	35	1.41 (0.43, 4.47)
AV Sanghi 2009	4	35	3	32	1.51 (0.35, 7.12)
Franck Chotel 2011	18	115	21	102	0.71 (0.33, 1.38)
Zoltan Derzsi 2015	43	132	10	103	4.23 (2.13, 8.72)

Total (95% CI)		431		539	1.25 (0.58, 2.82)
Total events	103		129		
Heterogeneity: Tau ² =0.60, Chi ² =19.82, df = 4 (P=0.005), I ² =82%					
Test for overall effect : Z=0.73 (P=0.46)					
c)Study	Non-Ponseti's method		Ponseti's Method		Odd's Ratio
	Events	Total	Event	Total	
John E Hezenberg 2002	30	32	2	32	1083 (64.12,1848.43)
Yiva Aurell 2005	7	17	1	8	13.97(0.65, 273.17)
Dan Cosma 2007	11	73	3	73	3.67(1.13,12.01)
Alok Sud 2008	9	30	4	35	5.21 (1.17, 21.18)
B Stephens Richards 2008	31	119	56	265	1.27 (0.68, 2.13)
AV Sanghvi 2009	7	35	3	32	2.01 (0.51, 7.38)
Frank Chotel 2011	20	115	101	102	1.16 (0.53, 2.36)
Christian Saetersdal	116	140	16	157	1.16 (0.55, 2.39)
Total (95% CI)		561		704	
Total events	231		182		
Heterogeneity: Tau ² =3.31, Chi ² =103.45, df = 7 (P=0.00001), I ² =91%					
Test for overall effect : Z=2.73 (P=0.005)					

Table 3 : Comparison between the Ponseti's method and Kite's method (a) Combined analysis of poor and fair results (b) Combined analysis of relapse (c) Combined analysis of additional surgeries

a)Study	Kite's method		Ponseti's method		Odd's Ratio
	Events	Total	Events	Total	
Alok Sud 2008	8	30	2	35	5.24 (1.25, 21.22)
AV Sanghi 2009	6	35	2	32	1.62 (0.41, 6.41)
Zoltan Derzsi 2015	36	132	8	103	4.64 (2.11, 10.13)
Total (95% CI)		197		170	3.89 (2.14,7.15)
Total events	50		12		
Heterogeneity: Chi ² =1.88, df = 2 (P=0.39), I ² =0					
Test for overall effect : Z=4.43 (P<0.00001)					
b)Study	Kite's method		Ponseti's Method		Odd's Ratio
	Events	Total	Event	Total	
Alok Sud 2008	7	30	6	35	1.41 (0.44, 4.53)
AV Sanghi 2009	4	35	3	32	1.51 (0.35, 7.11)
Zoltan Derzsi 2015	43	132	10	103	4.23 (2.16, 8.73)
Total (95% CI)		431		539	2.46 (1.12, 5.52)
Total events	103		129		
Heterogeneity: Tau ² =0.21, Chi ² =3.34, df = 2 (P=0.19), I ² =38%					
Test for overall effect : Z=2.28 (P=0.02)					
c)Study	Kite's method		Ponseti's Method		Odd's Ratio
	Events	Total	Event	Total	
Alok Sud 2008	9	30	2	35	5.22 (1.26, 21.24)
AV Sanghvi 2009	7	35	3	32	2.02 (0.53, 7.46)
Total (95% CI)		65		67	
Total events	16		5		
Heterogeneity: Chi ² =0.96, df = 1 (P=0.33), I ² =0%					
Test for overall effect : Z=2.40 (P=0.02)					

Table 3 : Comparison between the Ponseti's method and French functional therapy (a) Combined analysis of poor and fair results (b) Combined analysis of relapse (c) Combined analysis of additional surgeries

a)Study	French functional therapy		Ponseti's method		Odd's Ratio
	Events	Total	Events	Total	
Stephen's Richards 2008	5	119	13	265	0.89 (0.31, 2.32)
Franck Chotel 2011	73	115	14	102	9.58 (5.04, 18.36)

Total (95% CI)		234		367	3.02 (0.26, 30.86)
Total events	78		27		
Heterogeneity: $Tau^2 = 2.65$ $Chi=15.94$, $df = 2$ ($P=0.39$), $I^2=94\%$					
Test for overall effect : $Z=0.93$ ($P=0.35$)					

b)Study	French functional		Ponseti's Method		Odd's Ratio
	therapy Events	Total	Event	Total	
Stephen's Richards 2008	31	119	92	265	0.73 (0.43, 113)
Franck Chotel 2011	18	115	21	102	0.73 (0.34, 1.40)
Total (95% CI)		234		367	0.73 (0.45, 1.04)
Total events	49		113		
Heterogeneity: $Chi^2=0.00$, $df = 1$ ($P=0.84$), $I^2=0\%$					
Test for overall effect : $Z=1.66$ ($P=0.26$)					
c)Study	French functional		Ponseti's Method		Odd's Ratio
	therapy Events	Total	Event	Total	
Stephen's Richards 2008	32	119	59	265	1.28 (0.78, 2.11)
Franck Chotel 2011	19	114	14	102	1.21 (0.34, 1.40)
Total (95% CI)		234		367	1.24 (0.83, 1.89)
Total events	51		73		
Heterogeneity: $Chi^2=0.03$, $df = 1$ ($P=0.86$), $I^2=0\%$					
Test for overall effect : $Z=1.13$ ($P=0.26$)					

DISCUSSION

Clubfoot is termed as congenital talipes equinovarus, it a complex paediatric foot deformity which has an incidence of about 1 in every 1000 births²⁶. Many surgical techniques such as soft tissue release, arthrodesis have been used for the correction of the clubfoot in the past few decades. But the conservative treatments like physiotherapy, placement of casts and braces have been currently considered the best and the most effective methods and are widely accepted by the most paediatric orthopedic surgeons. There are many complications associated with the surgically treated clubfoot, these include scar contracture, neurovascular injury, wound infection and limb length discrepancy. In advanced stages the treatment of clubfoot is challenging for the paediatric orthopedic surgeons. The current study with meta analysis suggests that the Ponseti's method has less likelihood of the need of the major clubfoot surgeries. There wasn't any considerable difference in the relapse between Ponseti's method and non Ponseti's methods. The data from the comparative studies has shown that Ponseti's method is superior to non-Ponseti's.

Leavell and Ponseti⁷ through their studies claimed that 89 % of the patients that had undergone the treatment using Ponseti's method required no additional major surgeries. While Cooper and Dietz²⁷ had reported that 78 % of the patients had an excellent or good functional prognosis in a retrospective study with 30 years old followup period after taking treatment by Ponseti's method. This meta analysis compares non Ponseti's methods with the Ponseti's methods, also Ponseti's methods with French method, also Ponseti's methods with Kite method^{22,28}.

Kite method is non-operative casting method which was used historically for the treatment of clubfoot^{22,28}. The success rate which was reported was quite unsatisfactory and it ranges from 11 to 58 %²². The current study shows that there are significant differences in the correction, relapse and the operation rates between the Kite's method and Ponseti's method, **Table 3**. These three factors were considerably lower in the Ponseti's method than the Kite's method where $P<0.05$, **Table 3**. While the treatment duration given in the Kite's method is longer than the Ponseti's method^{17,18}, **Table 1**. Thus considering all these factors, Ponseti's method is the most effective conservative treatment as compared to Kite's method for the idiopathic clubfoot.

Functional treatment or French physiotherapy as described by Paul Masse in the year 1970s and was further developed by the paediatric orthopedic surgeons^{21,29}. The general physiology of the therapy is that its very progressive and gradual correction by daily manipulation, various elements of the deformity are treated separately in specific order.²¹

As compared to Ponseti's method a widevariety of results were seen in the French functional treatment²⁷⁻³⁰. French functional treatment is complex and is of longer duration hence these might be the reasons for the variations in outcomes. The technical skill and the expertise of the physiotherapist are the major factors affecting the success of the French functional treatment. Gait analysis of the cases treated with Ponseti's and French method was done³¹. The range of movement in the sagittal plane was better French treatment i.e. 65% than the Ponseti's method which was 45%. The current analysis had shown that there was not any significant difference between the Ponseti's method and the French functional therapy as far as correction, relapse and the requirement for additional operations is concerned.

Ponseti's method has been widely accepted as a conservative treatment as it has reported good results during the long term follow up of the patients. Brace application is a useful method to prevent relapse after correction. Non compliance or non adherence to the brace protocol is condered as the major risk factor in the relapse of the clubfoot and is challenge in itself¹².

Limitations of the study include, the hetrogeneity was quite high in the meta analysis. Thus combined results can be less reliable. There were some biases in the study as the studies in languages other than English were not included. Thus a uniform analysis could not be performed.

The study has shown that Ponseti's method can be used successfully to correct idiopathic clubfoot and is the most effective of all the conservative methods. Ponseti's method is a safe, efficient, conservative treatment method for clubfoot and it also decreases the number of surgical interventions.

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