Ponseti's vs. Kite's method in the treatment of clubfoot-a prospective randomised study

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Abstract Ponseti's and Kite's methods of conservative management in idiopathic congenital clubfoot were compared in a prospective randomised study consisting of 45 infants (67 feet) younger than 3 months, from March 2003 through February 2004. There were 36 and 31 feet that underwent treatment by Ponseti's and Kite's methods, respectively. After an average follow-up of 27.24 months in the Ponseti group, correction was achieved in 33 feet (91.7%), with only three patients requiring surgical management. There were seven relapses (21.1%), all of which were corrected conservatively. However, two of these required surgical intervention on showing a relapse again in the second year. In the Kite group, we achieved correction in 21 feet (67.7%) after an average follow-up of 24.8 months, with ten patients requiring surgical intervention. There were eight relapses of which only four could be corrected conservatively. We could also achieve correction in very severe feet (Dimeglio classification) in a significantly higher percentage using Ponseti's method, in significantly lesser time and with fewer casts. We are of the opinion that Ponseti's method is superior to Kite's method in achieving correction in idiopathic clubfeet in a relatively shorter period of time when used to treat young infants.

Résumé Les méthodes de Ponseti et de Kite dans le traitement conservateur du pied bot congénital sont comparées dans une étude prospective randomisée incluant 45 enfants (67 pieds), traités avant 3 mois, étude réalisée de

mars 2003 à février 2004. Trente-six pieds ont été traités selon la méthode de Ponseti et 31 selon la méthode de Kite. Le suivi moyen a été de 27.24 mois dans le groupe de Ponseti. La correction a été réalisée dans 33 pieds (91.7%), seulement 3 patients ont nécessité un traitement chirurgical. Il y a eu 7 récurrences (21.1%), tous les pieds ont été traités avec un traitement conservateur. Cependant deux pieds nécessitant un traitement chirurgical ont montré une récurrence dans la deuxième année. Dans le groupe Kite, la correction a été réalisée dans 21 pieds (67.7%) avec un suivi moyen de 24.8 mois, 10 patients ont nécessité un traitement chirurgical et 8 récurrences dont 4 ont bénéficié d'un traitement conservateur. Nous pouvons traiter les pieds sévères (classification de Dimeglio) avec un bon pourcentage et bon résultat en utilisant la méthode de Ponseti qui permet de diminuer le temps de traitement et le nombre de plâtre. Nous pouvons conclure que la méthode de Ponseti est supérieure à la méthode de Kite, elle permet un temps de traitement plus court dans le traitement des pieds bots varus équin de l'enfant.

Introduction

Most orthopaedic surgeons will agree that the initial treatment of a patient with clubfoot when presenting early in life should be conservative [1, 6, 9, 10, 16, 18]. We have been using Kite's method of manipulation and casting [11] since inception of the clubfoot clinic in our paediatric wing for over 15 years with a fair amount of success. The Ponseti method [19] was introduced to our clinic in 2002 and has given encouraging results with a comparatively smaller period of casting. This prompted us to compare the two methods of treatment in a prospective randomised study and compare various variables like percentage of feet corrected, time and number of casts required for correction

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achieved, percentage of cases showing relapse and the deformities that relapse in each method. We have also tried to analyse the failures and relapse on the basis of the philosophy of each method.

Materials and methods

The study was carried out in patients having classical idiopathic clubfeet who were less than 3 months of age (5 to 90 days) attending the clubfoot clinic in the paediatric wing of our hospital from March 2003 through February 2004. Older patients or those having non-idiopathic deformities were excluded from the study. None of the patients selected for the study had undergone prior conservative or operative management.

After an informed consent was taken from the parents, the patients were randomly assigned to either group (Ponseti and Kite) by one of the office clerks by alternately allocating successive patients to the Ponseti and Kite groups, in that order only. All the patients were assessed and followed up by a single surgeon (AS), who was unaware of the group to which a particular patient was assigned and was not involved in manipulation and casting. Manipulation and casting were done by two other authors (AT, DS) on the basis of the assigned group.

Of the 53 patients (81 feet) selected for the study, eight patients were lost to follow-up and hence were excluded from the study, leaving 45 patients with 67 feet (36 in the Ponseti group and 31 in the Kite group). There were 31 males (14 in the Ponseti and 17 in the Kite group) and 14 females (9 in the Ponseti and 5 in the Kite group) and the male: female ratio was 2.2:1. Twenty-two infants had bilateral pathology (13 in the Ponseti and 9 in the Kite group) while 23 patients had unilateral presentation (9 on the right side and 14 on the left side) (Table 1).

All the infants were classified prior to casting into benign, moderate, severe and very severe grades according to Dimeglio's classification [4]. The average score in the Ponseti group was 14.39 (SD 3.2), whereas that in the Kite group was 16.19 (SD 2.8).

The patients underwent weekly manipulation and casting starting the day of first presentation after birth in the clubfoot clinic. They underwent casting till they achieved correction or reached 1 year of age, whichever was earlier. Achieving no correction by 1 year was considered a failure, after which surgery was planned with the parents' consent.

The protocol followed in the first group was as described by Ponseti [19]. The last cast (with or without tenotomy) held the foot in 50° to 60° of external rotation and 15° dorsiflexion. A foot abduction bar [21], which holds feet in 50° to 60° of external rotation, was advised for maintenance

Table 1 Comparative observations and results of the two study groups

		Ponseti	Kite
Total no. of feet		36	31
Age (days)	Range	5 to 90 days	5 to 90 days
	Mean $\pm$ SD	31.75 $\pm$ 27.4	26.06 $\pm$ 21.4
Laterality	R	4	5
	L	6	8
	B/L	13	9
Dimeglio score	Range	5 to 19	9 to 19
	Mean $\pm$ SD	14.39 $\pm$ 3.2	16.19 $\pm$ 2.8
No. of casts*	Range	3 to 12	3 to 23
	Mean $\pm$ SD	6.2 $\pm$ 2.3	10.71 $\pm$ 5.4
Time taken (days) ^a	Range	21 to 96	28 to 210
	Mean $\pm$ SD	49.42 $\pm$ 18.9	91.24 $\pm$ 53.6
No. of feet corrected (%)*		33 (91.7%)	21 (67.7%)
No. of failures (%)*		3 (8.3%)	10 (32.3%)
% of relapse		21.1%	38.1%

* $p<0.05$ (statistically significant difference)

^a $p<0.001$ (statistically highly significant difference)

of the correction. It was worn full time for 2 to 3 months, followed by application only at night for 2 to 4 years.

The second group underwent manipulation and casting using Kite's method [11]. The foot once corrected was given a night brace that maintained correction in dorsiflexion and slight valgus [11].

The patients were followed up every month for the first year and every 3 months subsequently to assess range of motion, function and appearance of the ankle and foot.

The statistical analysis was done using SPSS (Version 12.0). Results were expressed as the mean and standard deviation (SD). A chi-square test and an unpaired *t*-test were applied for statistical analysis. The statistical difference was considered to be significant when $p<0.05$ and highly significant when $p<0.001$.

Results

After an average follow-up period of 26.04 months ($\pm$ SD 3.3), the results were as tabulated in Table 1. The rate of correction was found to be significantly higher with Ponseti's technique ($\chi^2=6.097$, $df=1$, $p=0.014$). With Ponseti's group, correction could be achieved in comparatively fewer days with a smaller number of casts. The statistical difference was found to be highly significant both in terms of time taken as well as the number of casts required for correction ($p<0.001$) (Table 1).

Ponseti's method also corrected a significantly higher number of very severe clubfeet (16 out of 18, 88.8%) than Kite's method (14 out of 24, 58.3%), in a smaller period of time (Table 2). However, age and sex had no

Table 2 Severity correlation of Ponseti and Kite methods in correction of clubfoot

	Severity of clubfoot (Dimeglio)	No. of feet	Feet corrected	No. of casts (mean $\pm$ SD) For correction	Time required (mean $\pm$ SD)	Relapses	Uncorrected feet
Ponseti	Benign	None	None	—	—	None	None
	Moderate	3	3	3.67 $\pm$ 1.1	32.6 $\pm$ 8.1	None	None
	Severe	15	14	6 $\pm$ 2.1	46.79 $\pm$ 17.3	4	1
	Very severe*	18	16 (88.8%)	6.88 $\pm$ 2.4	54.88 $\pm$ 20.1	3	2
	Total	36	33	6.2 $\pm$ 2.3	49.42 $\pm$ 18.9	7	3
Kite	Benign	None	None	—	—	None	None
	Moderate	1	1	6 $\pm$ 0	42 $\pm$ 0	None	None
	Severe	6	6	6.67 $\pm$ 2.32	52.17 $\pm$ 19.2	3	None
	Very severe*	24	14 (58.3%)	12.79 $\pm$ 5.5	111.5 $\pm$ 54.61	5	10
	Total	31	21	10.71 $\pm$ 5.4	91.24 $\pm$ 53.6	8	10

* $p < 0.05$ (statistically significant) in percentage of correction and time and number of casts required for correction

significant relationship to the outcome and relapse in either group ($p > 0.05$).

The mean follow-up in the Ponseti group was 27.24 months $\pm$ SD 3.1 (17 to 31 months). In the first year of life, seven feet had relapsed deformities in the Ponseti group. There was a relapse of all four deformities in three feet; cavus, adduction and varus in one foot; adduction and cavus in one foot; and varus and cavus occurring singly in one foot each. All the relapses occurred in the first year of age and could be treated conservatively on applying two to six serial casts. Of these, two feet relapsed again after the first year (in the 13th and 17th months, respectively, each showing a combination of adduction and varus deformities). There were no relapses seen in rest of the patients at final follow-up (Table 3).

In the Kite group, the mean follow-up was 24.84 months $\pm$ SD 3.5 (20 to 31 months). There were seven feet with relapsed deformities in the first year and one foot that relapsed in the second year (14th month). All four deformities relapsed only in one foot; cavus and varus in one foot; adduction and varus in two feet; varus alone in two feet; and equinus alone in one foot. The relapse occurring in the second year consisted only of varus of the heel (Table 3). However, the difference in percentage of relapse in the two groups is not statistically significant ($p > 0.05$). The relapses were neither related to the age at presentation nor to the severity in either group.

At final follow-up, the average range of motion at the ankle joint in the Ponseti group was 7.11° (dorsi-flexion) to 12.17° (plantar-flexion). The corresponding values in Kite's group were 6.13° (dorsi-flexion) to 10.16° (plantar-flexion). In both groups, the functional outcome in patients with corrected feet who had started walking without support (32 patients) was good. They could squat with heels touching the ground. None of the patients or parents reported any pain, callosity or difficulty in playing indoor/outdoor games suitable to their age.

Discussion

Manipulation and holding the foot in corrected position (with the help of resinous cerate) was identified as early as 400 BC by Hippocrates [5]. Several indigenous casting methods have evolved in the past based on pure logic to undo the deformity by producing the force in the opposite direction and reporting success rates varying from 15%–90% [1]. The huge percentage difference indicates a lack of a standard technique for manipulation and casting. Probably Kite was the most precise in describing his technique of manipulation and casting and reported a success rate of 90% in his patients [9] when treatment was started before

Table 3 Relapsed deformities in the two study groups

		Ponseti	Kite
No. of feet		7*	8 ^a
Age of first presentation in the clinic (days)	Range	15 to 45 days	5 to 60 days
	Mean	20.85	29.47
Age of presentation of relapse (days)	Range	73 to 113 days	47 to 247 days
	Mean $\pm$ SD	84.86 $\pm$ 16.8	102.63 $\pm$ 75.39
Sex	M	3	6
	F	4	2
Laterality	R	0	2
	L	3	6
	B/L	2	0
Dimeglio score	Range	12 to 19	11 to 19
	Mean $\pm$ SD	14.57 $\pm$ 3.1	15.5 $\pm$ 2.8
No. of feet corrected conservatively (%)		7 (100%)	4 (50%)
No. of casts applied	Range	2 to 6	2 to 4
	Mean $\pm$ SD	3.86 $\pm$ 1.3	3.5 $\pm$ 1

*All relapses occurred in the 1st year, two of which relapsed again in the 2nd year

^aSeven feet had relapsed deformity in the 1st year, while one foot in the 2nd year

1 year of age, and the duration of cast treatment ranged from 26–49 weeks [8]. However, when used by other orthopaedic surgeons, this method resulted in low correction and a high relapse rate. It was reported that surgery could be avoided only in 20% to 50% of patients treated by Kite's method [22].

Since 2002, several studies have surfaced demonstrating the successful use of the Ponseti method in clubfoot correction [6, 7, 13–15, 23], so much so that the method is becoming an accepted treatment of idiopathic clubfoot all over the world. Laaveg and Ponseti reported that 90% of their patients were satisfied with the function and appearance of their feet on long-term follow-up (average 19 years) [12]. Some of these patients who were followed up for 30 years showed no deterioration of the function or appearance of the feet [2]. It has been written rather convincingly by Cummings that he found Ponseti's method to be more effective in treating congenital clubfoot non-operatively, even though he had used Kite's technique successfully to correct this deformity [3].

This method has reported not only clinical correction, but has also shown correction of the individual tarsal anlage as well as their relationships on magnetic resonance imaging [17].

Although there are several retrospective cohort studies [6, 7, 23] to show the superiority of Ponseti's method over traditional and historical methods of casting, the authors could not find any prospective randomised study comparing Ponseti's method with Kite's method, which was hitherto the gold standard for the conservative management of classical idiopathic clubfoot. Our study compares the two methods in a prospective randomised fashion and tries to correlate the mechanism of correction to relapse and failure.

Having used both techniques in our study, it became evident that the success rate with Ponseti's method was significantly higher. It also corrected very severe feet in a significantly shorter time period, thereby reducing the agony and distress to patients as well as parents. Superior results may be attributed to correcting all deformities simultaneously, correcting the cavus in the supinated position (called the magic move of Ponseti) [22] and hyperabducting the entire foot under the talus without touching the heel [19].

Regardless of the treatment given, a clubfoot deformity tends to relapse until the child is about 7 years of age [18]. Although nothing can be said with certainty about the cause of relapse in our series, we doubt the compliance of the parents with using the foot abduction bar or night braces due to the low level of literacy and social factors affecting their families.

The profile of relapses demonstrates the effectiveness of either technique in undoing the individual deformities. It was noted on careful scrutiny that the majority of relapses in the Ponseti group consisted of all the deformities, which

shows that the force of correction applied or its maintenance in a corrected position was probably inadequate. When compared with the Kite group, relapses show a preponderance of varus of the heel (exclusive or in combination), which may indicate initial failure to correct the deformity completely and failing to recognise it while labelling the foot as corrected. This validates Ponseti's contention of Kite's error [20]. It shows the failure of the technique per se to correct the heel varus deformity, even though the forces were adequate and well placed to correct the other deformities. The talo-navicular joint is in extreme inversion in clubfoot, with the navicular at the most medial and plantar side of the head of the talus [5]. The aim of manipulation, therefore, should be to stretch the medial capsule and ligaments so as to draw the navicular laterally. Placing counter-pressure at the lateral aspect of the talar head rather than at the calcaneo-cuboid joint obviously can do this most effectively. In our opinion, this was the cardinal mistake in Kite's method, which leads to a delayed or low correction rate.

Another factor that can be held responsible for a poorer result in the Kite group in our study could be a significant difference in the mean severity scoring (Table 1). However, on analysing the effectiveness of the method in correcting only very severe deformities, it becomes quite evident that even by eliminating this variable the percentage of correction in the Ponseti group is significantly higher (Table 2).

Even though we have corrected several clubfeet with Kite's method, we find Ponseti's method to be far superior in correcting all deformities in a shorter period of time, thereby reducing the requirement of surgical intervention. Encouraged with the results of this short-term study, we will not hesitate to offer Ponseti's method of management as the first line of conservative treatment to the patients attending our clubfoot clinic.

In future, we would like to analyse the long-term results (function and appearance) of the patients corrected by Ponseti's method and compare them with those obtained by Kite's method.

References

1. Aronson J, Puskas CL (1990) Deformities and disabilities from treated club foot. *J Pediatr Orthop* 10(1):109–119
2. Cooper DM, Dietz FR (1995) Treatment of idiopathic clubfoot—a 30-year follow-up note. *J Bone Joint Surg* 77-A(10):1477–1489
3. Cummings RJ (2002) Letter to editor. *J Bone Joint Surg* 84-A(10):1890
4. Demeglio A, Bensahel H, Sanchet P et al (1985) Classification of clubfoot. *J Pediatr Orthop* (B) 4:129–136
5. McKay DW (1982) New concept of approach to clubfoot treatment. Section 1-Principles and morbid anatomy. *J Pediatr Orthop* 2(4):347–356

6. Herzenberg JE, Radler C, Bor N (2002) Ponseti versus traditional method of casting for idiopathic club foot. *J Pediatr Orthop* 22 (4):517–520
7. Ippolito E, Farsetti P, Caterini R, Tudisco C (2003) Long-term comparative results in patients with congenital clubfoot treated with two different protocols. *J Bone Joint Surg* 85 A(7):1286–1294
8. Herring JA (ed) (2002) Congenital talipes equinovarus (clubfoot) in Tachdjian's paediatric orthopaedics, vol. 2, 3rd edn. Philadelphia, Saunders p 927
9. Kite JH (1935) The treatment of congenital clubfoot. *Surg Gynaecol Obstet* 61:190–200
10. Kite JH (1939) Principles involved in the treatment of congenital clubfoot. *J Bone Joint Surg* 21:595–606
11. Kite JH (1972) Non operative treatment of congenital clubfoot. *Clin Orthop* 84:29–38
12. Laaveg SJ, Ponseti IV (1980) Long-term results of treatment of congenital clubfoot. *J Bone Joint Surg* 62-A:23–31
13. Lehman WB, Mohaideen A, Madan S, Scher DM, Van Bosse HJ, Iannaccone M, Bazzi JS, Feldman DS (2003) A method for the early evaluation of the Ponseti (Iowa) technique for treatment of idiopathic clubfoot. *J Pediatr Orthop (B)* 12:133–140
14. Morceunde JA, Dolan LA, Dietz FR, Ponseti IV (2004) Radical reduction in the rate of extensive corrective surgery for clubfoot using the Ponseti method. *Pediatrics* 113:376–380
15. Morceunde JA, Abbasi D, LA Dolan, Ponseti IV (2005) Results of an accelerated Ponseti protocol for club foot. *J Pediatr Orthop* 25(5):623–626
16. Nather A, Bose K (1987) Conservative and surgical treatment of clubfoot. *J Pediatr Orthop* 7(1):42–48
17. Pirani S, Zeznik L, Hodges D (2001) MRI study of congenital clubfoot treated with Ponseti method. *J Pediatr Orthop* 21(6):719–726
18. Ponseti IV (1992) Current concept review. Treatment of congenital club foot. *J Bone Joint Surg* 74 A(3):448–454
19. Ponseti IV (1996) Treatment. Congenital clubfoot-fundamentals of treatment. New York; Oxford University Press pp 61–81
20. Ponseti IV (1997) Common Errors in the treatment of congenital clubfoot. *Current Concepts, Int Orthop (SICOT)* 21:137–141
21. Ponseti IV (2000) Editorial club foot. *J Pediatr Orthop* 20(6):699–700
22. Scher DM (2006) The Ponseti method of treatment of clubfoot. *Curr Opin Pediatr* 18(1):22–28
23. Segev E, Keret D, Lokiec F, Yavor A, Wientroub S, Ezra E, Havek S (2005) Early experience with the Ponseti method for treatment of congenital idiopathic club foot. *Isr Med Associ J* 7(5):307–310