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Comparison of different conservative treatments for idiopathic clubfoot: Ponseti's versus non-Ponseti's methods

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Abstract

Objective: Various methods are applied in the clinical treatment of idiopathic clubfoot. The purpose of this meta-analysis was to evaluate the efficacy of different conservative treatments.

Methods: Studies were pooled and odds ratio (ORs) with corresponding confidence intervals were calculated for evaluation of the results, relapses, and requirement for major surgery.

Results: A final analysis of 1435 patients from 9 eligible studies was performed. The combined OR indicated that significantly more fair and poor results were achieved and that major surgery was required significantly more often when using non-Ponseti's methods (OR = 3.33 and OR = 7.32, respectively), but no significant difference was detected in the occurrence of relapse (OR = 1.34). Pooled OR evaluation showed a significantly higher rate of fair and poor results, relapse, and requirement for major surgery when using Kite's method than when using Ponseti's method (OR = 3.93, OR = 2.53, and OR = 3.19, respectively), but no significant difference was detected between the French method and Ponseti's method (OR = 3.01, OR = 0.72, and OR = 1.26, respectively).

Conclusions: This meta-analysis indicates that Ponseti's method is safe and efficient for conservative treatment of clubfoot and decreases the number of surgical interventions required. It is recommended as the first-choice conservative treatment for idiopathic clubfoot.

Keywords

Idiopathic clubfoot, conservative treatment, Ponseti's method, Kite's method, French method

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List of abbreviations

OR, odds ratio
CI, confidence interval

Introduction

Idiopathic clubfoot is a severe congenital paediatric orthopaedic deformity that may lead to a handicapped status, an inability of the patient to pursue his or her vocation, and claudication when treatment is delayed or neglected.[1] Treatments involving splints, physical therapy, and corrective casts have been widely used, but these conservative treatments have been replaced by surgical operations such as soft tissue release during the past several decades.[2,3] For many years, extensive and complex operations were the major management techniques for clubfoot, but the long-term results were not excellent,[2,3] and surgical release procedures were used to lengthen the tight soft tissues on the medial and posterior aspects of the clubfoot.[4] Excellent results were not achieved until Ponseti introduced a novel casting method with which to correct the forefoot adduction, hindfoot varus, equinus, and cavus in patients with clubfoot. The classic surgical correction of clubfoot has been abolished because the resultant poor function and painful foot were thought to be a result of the surgical procedure itself,[5] and such treatment has been replaced by Ponseti's method.[6]

Ponseti's method is a nonsurgical technique that has been extensively proven to be safer and more efficient than surgery for the treatment of clubfoot.[7,8] Ponseti's method is now widely recommended as the gold standard for treatment of idiopathic clubfoot, and it has been approved on a worldwide basis. Although some other methods are still widely applied in the clinical setting, such as Kite's method and the French method,[9] few studies have compared the effects of these different conservative treatment methods for clubfoot, and no definitive conclusions have been reached. The purpose of this study was to determine whether Ponseti's method is the most efficient technique in the conservative treatment of congenital idiopathic clubfoot based on a meta-analysis of the current scientific literature.

Methods

Search strategy

Embase, Medicine, PubMed, and Web of Science were searched from an undefined beginning time point to 19 December 2016. The following search terms were used: "clubfoot," "Ponseti," and "treatment"; ((clubfoot) AND treatment) AND Ponseti). References of included articles and reviews were also manually investigated to avoid omission. In cases of duplication, the most recent or complete study was included. This meta-analysis was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement criteria.

Two independent reviewers assessed the eligibility of the studies by reviewing the titles and abstracts. The inclusion criteria were as follows:[1] conservative treatment of patients with clubfoot,[2] comparison between Ponseti's method and at least one non-Ponseti's method,[3] publication in English,[4] and enough data to calculate the odds ratio (OR) and 95% confidence interval (CI). The exclusion criteria were as follows:[1] similar studies including the same patients and[2] lack of comparison between those similar studies.

Statistical analysis

ORs were calculated to compare Ponseti's method and non-Ponseti's methods. Heterogeneity between the studies was considered statistically significant if the P value was <0.10; heterogeneity was also quantified using the I^2 metric ($I^2 = 0\%$, no heterogeneity; $I^2 < 25\%$, low heterogeneity;

$I^2 = 25\%–50\%$, moderate heterogeneity; and $I^2 > 50\%$, strong heterogeneity).[10–12] If heterogeneity was present, we used a random-effects model instead of a fixed-effects model.[12,13] All P values were two-sided. Review Manager (RevMan) software version 5.2 (The Cochrane Collaboration, The Nordic Cochrane Centre, Copenhagen, Denmark) was used for this meta-analysis.

Results

In total, 422 studies were identified using the research strategy (Figure 1). Of these, 413 conference abstracts, editorials, studies on unrelated topics, duplicate studies, or studies involving comparison with an operation method were excluded. Therefore, 9 studies[14–22] involving a total of 1435 patients were included in this meta-analysis (Table 1).

Non-Ponseti's methods versus Ponseti's method

Five studies involving a total of 973 feet treated with conservative methods were meta-analysed. Because of severe heterogeneity ($I^2 = 78\%$), a random-effects model was selected for the analysis. The pooled OR was 3.33 (95% CI, 1.34–8.27; $Z = 2.59$; $P = 0.010$), illustrating that non-Ponseti's methods resulted in more fair and poor correction results than did Ponseti's method ($P = 0.010$) (Figure 2(a)).

Five studies involving a total of 971 feet treated with conservative methods were meta-analysed. A random-effects model was selected for the analysis because severe heterogeneity was detected ($I^2 = 80\%$). The pooled OR was 1.34 (95% CI, 0.61–2.95; $Z = 0.73$), illustrating that no significant difference in relapse was present between non-Ponseti's methods and Ponseti's method (Figure 2(b)).

Eight studies involving a total of 1274 feet treated with conservative methods were meta-analysed. Due to severe heterogeneity ($I^2 = 93\%$), a random-effects model was selected for the analysis. The pooled OR was 7.32 (95% CI, 1.85–29.02; $Z = 2.83$; $P = 0.005$), illustrating that more operations with the exception of Achilles tenotomy

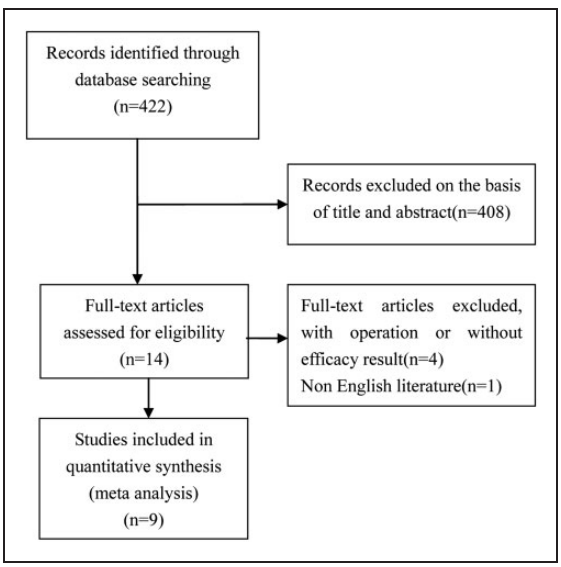

Figure 1. Flow diagram of selection process for studies included in the meta-analysis.

Table 1. Characteristics of eligible studies in this meta-analysis.

Authors/reference	Method	N	Dimeglio score	Duration	Cast
Herzenberg et al.[19]	Ponseti	34	Null	Null	Null
	Traditional cast	34	Null	Null	Null
Aurell et al.[20]	Ponseti	9	12.44 ± 2.19	Null	Null
	Copenhagen	19	9.95 ± 2.01	Null	Null
Cosma et al.[22]	Ponseti	74	10.7	5 ± 1w	4 ± 2
	Romanian	74	10.6	15 ± 6w	5 ± 2
Sud et al.[14]	Ponseti	36	14.39 ± 3.20	49.42 ± 18.9d	6.2 ± 2.3
	Kite	31	16.19 ± 2.80	91.24 ± 53.6d	10.71 ± 5.40
Richards et al.[17]	Ponseti	267	12.1	Null	Null
	French	119	12.8	Null	Null
Sanghvi and Mittal[15]	Ponseti	30	Null	10 ± 1w	7 ± 1
	Kite	34	Null	13 ± 2w	10 ± 1
Chotel et al.[18]	Ponseti	103	Null	Null	Null
	French	116	Null	Null	Null
Derzsi et al.[16]	Ponseti	106	12.14 ± 6.82	11.34 ± 5.87w	Null
	Kite	129	12.12 ± 7.34	20.13 ± 8.53w	Null
Saetersdal et al.[21]	Ponseti	160	Null	Null	Null
	Pre-Ponseti cast	134	Null	Null	Null

Null: data unavailable, d: day, w: week.

were needed after non-Ponseti's method than after Ponseti's method ($P = 0.005$) (Figure 2(c)).

Kite's method versus Ponseti's method

The rates of poor and fair results, relapse, and requirement for additional operations were investigated in three studies. The results showed that there were significant differences in all three factors between Kite's method and Ponseti's method (Figure 3). All three rates were significantly lower with Ponseti's method than with Kite's method. ($P < 0.05$) (Figure 3).

French method versus Ponseti's method

The rates of poor and fair results, relapse, and requirement for additional operations were investigated in two studies. The results showed that there were no significant differences in any of these three factors between the French method and Ponseti's method (Figure 4).

Discussion

Clubfoot, termed congenital talipes equinovarus, is a complex paediatric foot deformity with an incidence of about 1 in every 1000 births.[23] It is characterized by three-dimensional deformities such as forefoot adductus, midfoot cavus, hindfoot varus, and ankle equinus. Several surgical techniques (soft tissue release, arthrodesis) have been used to correct clubfoot in the past few decades. However, conservative treatment (physiotherapy, casts, and braces) is currently considered the most effective method and has been widely accepted by paediatric orthopaedic surgeons. Surgically treated clubfoot may be associated with many complications, including scar contracture, neurovascular injury, wound infection, and limb length discrepancy. Although conservative treatment is generally considered a

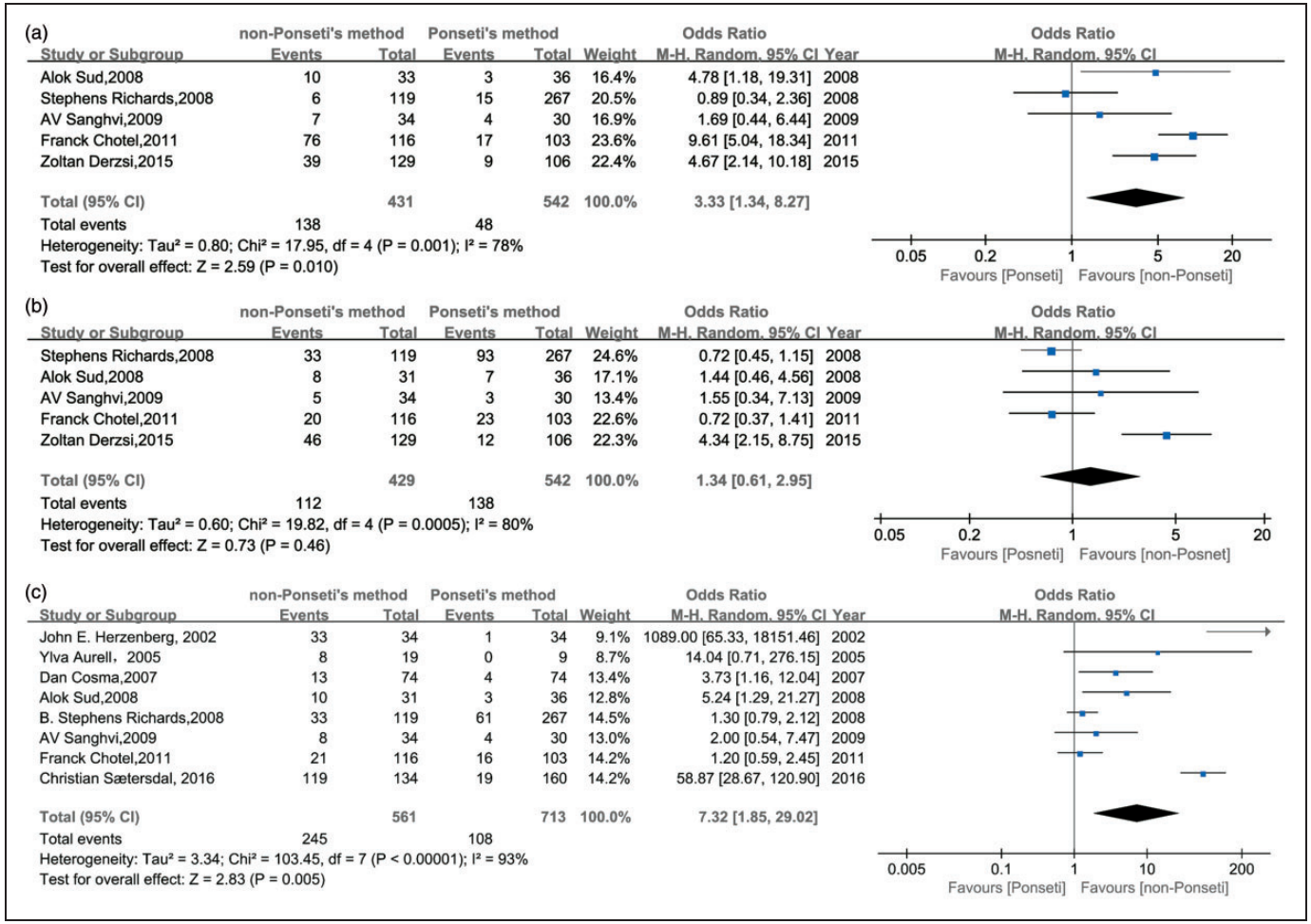

Figure 2. Forest plot of comparison between conservative methods. (a) Pooled analysis of fair and poor results. (b) Pooled analysis of relapse. (c) Pooled analysis of requirement for operations.

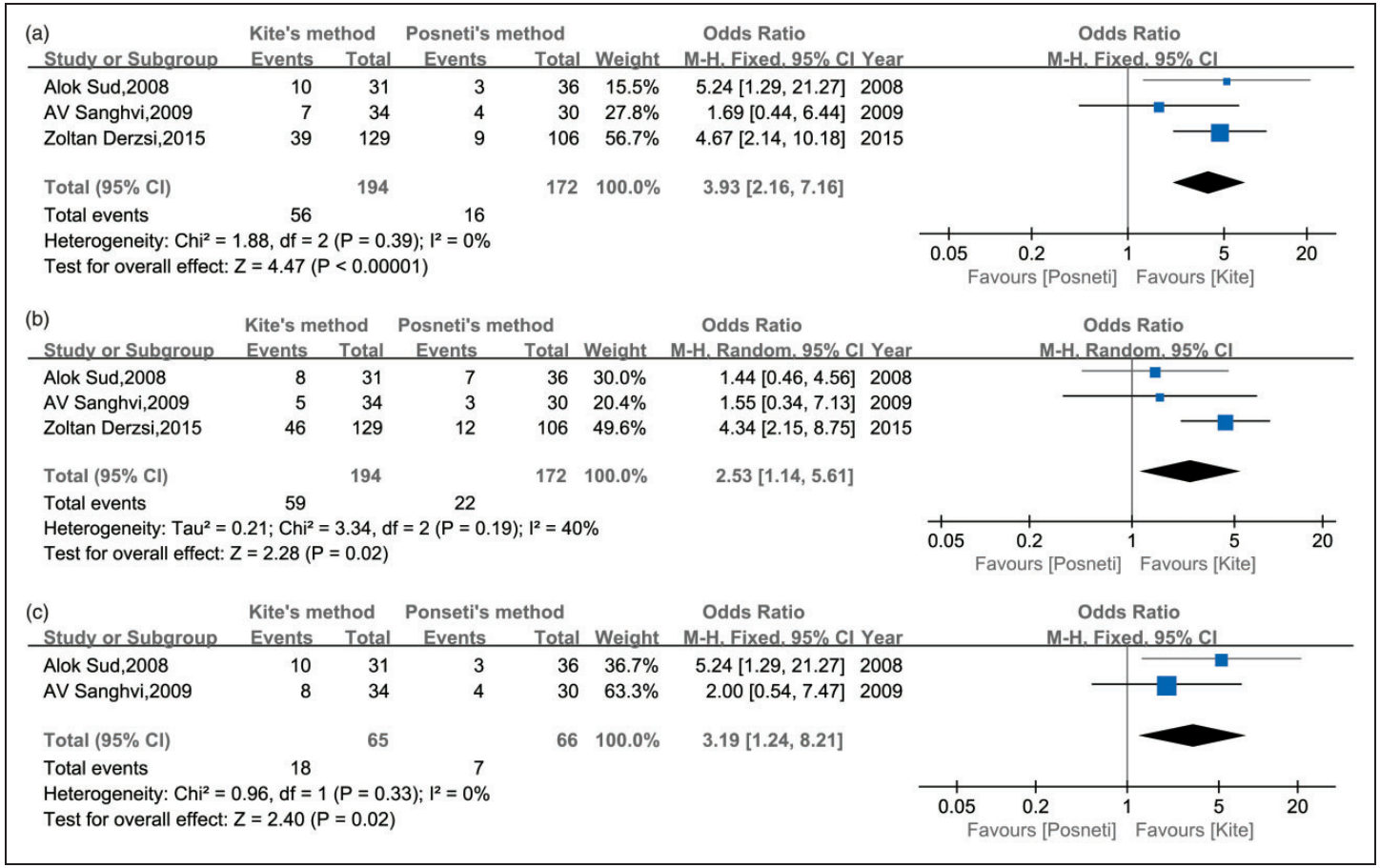

Figure 3. Forest plot of comparison between Ponseti's method and Kite's method. (a) Pooled analysis of fair and poor results. (b) Pooled analysis of relapse. (c) Pooled analysis of requirement for operations.

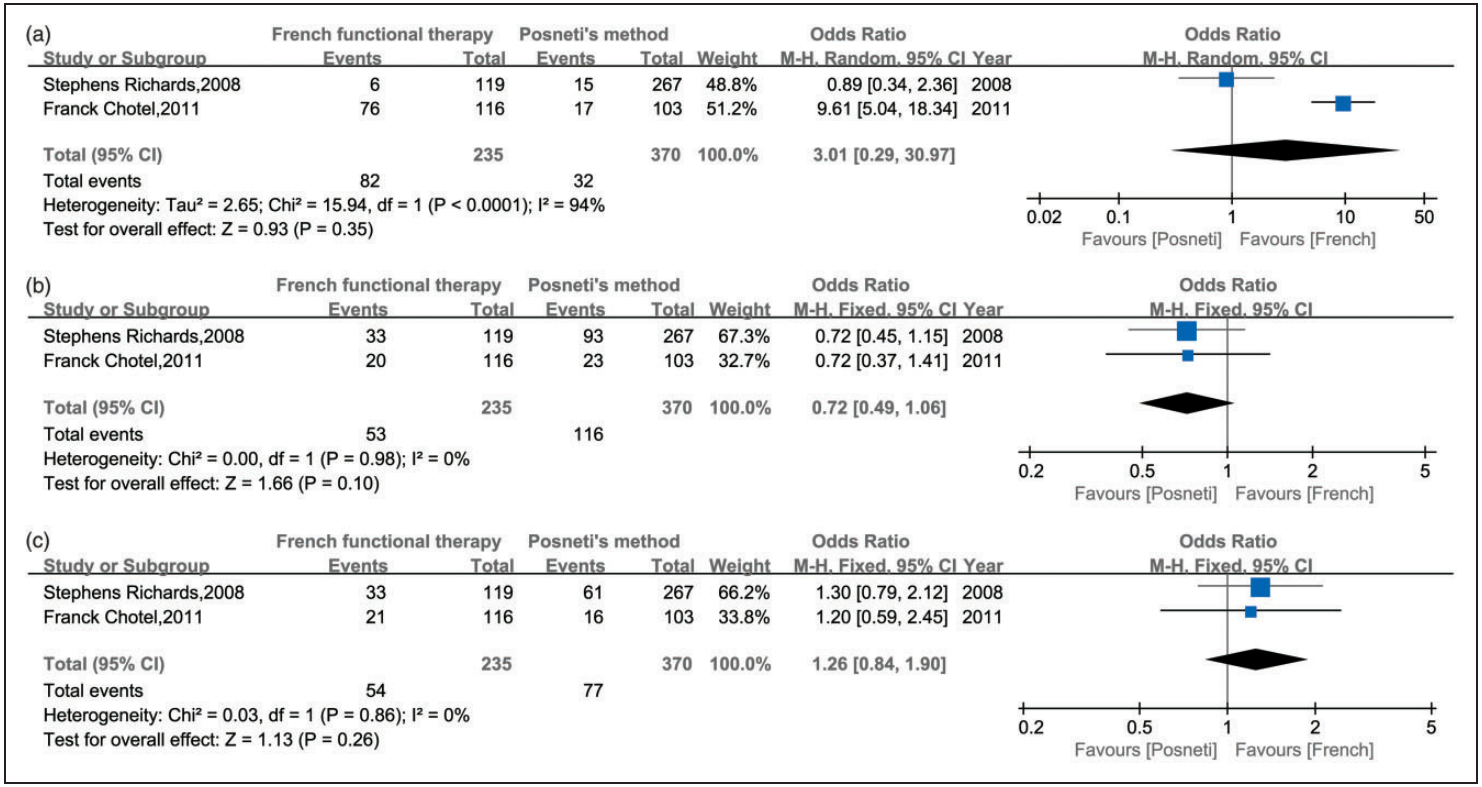

Figure 4. Forest plot of comparison between Ponseti's method and French functional therapy. (a) Pooled analysis of fair and poor results. (b) Pooled analysis of relapse. (c) Pooled analysis of requirement for operations.

good choice, treatment of clubfoot in its advanced stages remains challenging for paediatric orthopaedic surgeons. This meta-analysis suggests that the application of Ponseti's method appears to yield a lower likelihood of the need for major clubfoot surgery. Although we found no significant difference in relapse between Ponseti's method and non-Ponseti's methods, this meta-analysis of data from eight comparative studies showed that Ponseti's method is superior to non-Ponseti's methods with respect to better results and less need for additional operations.

Laaveg and Ponseti[4] claimed that 89% of patients who underwent treatment using Ponseti's method required no additional major surgical operations. Cooper and Dietz[24] reported that 78% of patients had an excellent or good functional prognosis in a retrospective study with a 30-year follow-up period after treatment by Ponseti's method. Although Ponseti's method is extensively recommended and has become widely used, this is the first meta-analysis to compare non-Ponseti's methods with Ponseti's method and the first meta-analysis to compare Ponseti's method and the French method.

Clubfoot was historically treated by a nonoperative casting method introduced by Kite.[19,25] The reported success rates were unsatisfactory, ranging from 11% to 58%.[19] The present meta-analysis showed significant differences in the correction, relapse, and operation rates between Kite's method and Ponseti's method (Figure 3). All three factors were significantly lower with Ponseti's method than with Kite's method ($P < 0.05$) (Figure 3). Moreover, the treatment duration was longer with Kite's method than with Ponseti's method,[14–16] and the need for casting was higher with Kite's method than with Ponseti's method[14,15] (Table 1). Considering all of these findings, Ponseti's method is a more effective conservative treatment technique than Kite's method for idiopathic clubfoot.

Functional treatment, also known as French physiotherapy, was described by Paul Masse in the 1970s and subsequently developed by several different paediatric orthopaedic surgeons.[18,26] The general philosophy is very progressive and gradual correction by daily manipulation; various elements of the deformity are corrected separately and in a specific order.[18] In contrast to Ponseti's method, a wide variety of results have been reported with French functional treatment.[26–28] The complexity and duration of the French method might account for this greater variation in outcomes. The technical skill and experience of the physiotherapist are major factors for successful treatment of clubfoot. A gait analysis of patients treated with the French method and Ponseti's method was performed.[29] The joint range of motion in the sagittal plane was better after the French method (65%) than after Ponseti's method (45%). However, the present meta-analysis showed no significant difference between Ponseti's method and French functional therapy in terms of the correction, relapse, and need for additional operations.

Ponseti's method has been widely accepted as a conservative treatment regimen because of the reported good results during long-term follow-up. The present meta-analysis showed that Ponseti's method avoided major surgery in an average of 84.9% patients among different institutions, succeed in an average of 75.6% patients among different institutions, and achieved an excellent or good functional prognosis in an average of 91.1% patients among different institutions. However, better correction and a lower relapse rate are still desired. Brace application is a useful method for preventing relapse after correction. Noncompliance with or nonadherence to the brace protocol has been considered the predominant risk factor for relapse of clubfoot, which is still a challenging problem.[9]

The differences in bracing and the duration of follow-up among different studies could have contributed to the differences in the reported results; the importance of bracing in Ponseti's method was widely highlighted, and the number of relapses with surgical indications increased as the follow-up period progressed.[30] An objective measure of clubfoot severity, such as the Dimeglio score, was not available in each study included in this meta-analysis. The overall severity of clubfoot treated may have differed among the different methods, thereby confounding the results. Additionally, Achilles tenotomy was commonly performed among the studies included in this meta-analysis. Thus, Achilles tenotomy also should have been considered a factor affecting the therapeutic efficacy for clubfoot.

Some limitations of this meta-analysis should be noted. First, the heterogeneity was quite high in this meta-analysis. The above-mentioned characteristics may make the pooled results less reliable. Second, some biases may have been introduced because studies in languages other than English were excluded. Thus, we could not perform a uniform analysis from the quite different results.

This meta-analysis has shown that Ponseti's method can be successfully used to correct idiopathic clubfoot and is the most effective of all conservative methods. Ponseti's method is a safe, efficient conservative treatment method for clubfoot and decreases the number of surgical interventions required.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

Declaration of conflicting interests

The authors declare that there is no conflict of interest.

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