Midterm results of the Ponseti method in the treatment of congenital clubfoot

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Abstract

Purpose The Ponseti method has become the gold standard for clubfoot treatment. Although promising short-term results have been published, only a few studies report results at the end of the bracing period. We aimed to evaluate the functional midterm results, rate of recurrence and need for subsequent surgery.

Methods Patients from our prospective database of clubfeet treated with the Ponseti method with a minimum age of three years were identified. Exclusion criteria were syndrome or neurogenic association, address in a foreign country, presentation after six weeks of age, more than three casts applied elsewhere and correction with less than three casts. A total of 125 patients met the inclusion criteria. The Pediatric Outcomes Data Collection Instrument (PODCI), the disease-specific instrument (DSI) questionnaire and an invitation for a clinical examination were sent out. For patients not presenting for evaluation, data from the last follow-up were extracted.

Results Seventy questionnaires (56 %) of patients with a mean age of 5.7 years (3.3–8.9 years) were returned. The DSI score ($n=65$) was 85.3 (± 13.01 SD) and the PODCI score ($n=59$) was 95.5 (± 6.3 SD). A total of 113 of 125 patients (90.4 %) with 182 clubfeet were examined in the study or seen in follow-up. During a mean follow-up of 5.2 years (range 3–8.5 years) a repeat tenotomy was performed in 4 % of cases, a percutaneous Achilles tendon

lengthening in 3 %, a tibialis anterior tendon transfer in 13 % and open joint surgery in 5 %. The mean dorsiflexion with knee extended was 15.9° (range 0–32°; SD ± 5.5) with 16 feet (9 %) presenting less than 10°.

Conclusions The functional scores indicate that the Ponseti method results in mostly pain-free feet not limiting age-appropriate activity. In this consecutive case series open joint surgery could be avoided in 95 % of cases with a good functional and anatomic outcome.

Introduction

The Ponseti method of clubfoot treatment has been established as the gold standard of care in most paediatric orthopaedic centres worldwide. This led to a significant reduction in the rate of open joint surgery for congenital clubfoot [1]. Dr. Ponseti's cases have been carefully evaluated and superior short-term, midterm and long-term results have been reported [2–5]. Additionally, initial results in patients treated outside of Iowa have been very promising in many centres and in different countries [6–8]. Only a few study groups outside of Iowa describe midterm outcomes of the Ponseti method, with generally very favourable results [9–11]. On the other hand high rates of recurrence [12, 13] and the need to surgically correct persistent deformities [14] have been reported.

We published our first series of idiopathic congenital clubfeet in 2006 with an initial correction rate of 95 % [15]. A total of 59 idiopathic clubfeet in 37 patients were treated using the Ponseti method with treatment initiated within the first three weeks of life. In the limited follow-up 93 % of all cases (55 feet) were corrected without open joint surgery. A recurrence was seen in one patient with bilateral clubfoot (3.6 %) [15].

In this study we aimed to evaluate the rate of recurrence and the rate and type of subsequent surgery in the midterm follow-up in our patient population. Additionally, we wanted to evaluate the functional outcome in this patient group.

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Materials and methods

Patients with unilateral or bilateral idiopathic clubfoot treated at our institution according to the Ponseti treatment protocol were selected consecutively from our prospective database of clubfoot patients. We included only patients treated between the beginning of 2003 and end of 2007 with a minimum age of three years at the time of initiation of the study. Exclusion criteria were syndrome association, neurological affection, address outside of the country, beginning of treatment after the sixth week of life and positional clubfoot defined by correction with less than three casts.

A total of 125 patients with 199 clubfeet met the inclusion criteria and were sent an invitation to participate in this study including a survey letter with the Pediatric Outcomes Data Collection Instrument (PODCI) [16] and the disease-specific instrument (DSI) questionnaire [17]. For patients not presenting for the examination, data of the last follow-up visit were extracted from the medical records. We used a standardised follow-up protocol including passive dorsiflexion measured with a handheld goniometer with the knee extended. Static and dynamic signs of recurrence with special attention to heel valgus or varus and dynamic adduction were noted as such.

All feet were evaluated at presentation using the Pirani score [18]. The rate and timing of percutaneous Achilles tenotomy (pAT) as well as recurrence necessitating recasting or different types of surgical interventions were analysed.

The Ponseti method was strictly followed as described by Dr. Ponseti [19]. However, contrary to the originally described regime percutaneous tenotomy was performed under general anaesthesia. Abduction bracing was undertaken using a custom-made foot abduction orthosis with 60–70° of abduction on the affected and 45° of abduction on the non-affected foot (Fig. 1). The study was reviewed and approved by the municipal Ethics Committee.

Fig. 1 A custom-made foot abduction brace according to the recommendations of Ponseti was used in all of our patients. The heel is well defined which gives room for growth and protects the foot from slipping out of the brace. The soft inner cushion lining securely encloses the foot and prevents pressure sores

Results

The questionnaires of 70 of 125 patients (56 %) with a mean age of 5.7 years (range 3.3–8.9 years) were returned. Because of incorrect completion of the questionnaires 5 DSI and 11 PODCI questionnaires had to be excluded. The total DSI score ($n=65$) was 85.3 (± 13.01 SD) of 100 points with a satisfaction subscale of 85.1 and a function subscale of 85.6 points. The paediatric global function of the PODCI score ($n=59$) was 95.5 (± 6.3 SD) of 100 points.

A total of 113 of 125 patients (90.4 %) with 182 clubfeet were examined in the study or seen during regular routine follow-up. The 113 patients consisted of 83 male (136 feet) and 30 female patients (46 feet) with 69 bilateral and 44 unilateral clubfeet. Treatment was started at a mean age of eight days (two to 41 days) and the mean Pirani score at presentation was 4.8 [3–6]. The mean follow-up after the last cast after tenotomy or the last cast in cases where tenotomy was not necessary was 5.2 years (range three to 8.5 years). A pAT was performed in 96 % of feet (174 of 182 feet) at a mean age of 8.5 weeks (range four to 16 weeks). A repeat tenotomy was performed in 4 % of cases (seven of 182 feet), a percutaneous three cut Achilles tendon lengthening in 3 % (six of 182 feet), a tibialis anterior tendon transfer (TATT) in 13 % (24 of 182 feet) and open release surgery in 5 % (nine of 182 feet). TATT was performed at a mean age of 5.2 years (range 3.5–7.2 years), and the described percutaneous three cut Achilles tendon lengthening and the TATT were done in the same operation in five cases (Fig. 2a–c). Open release surgery was performed at a mean age of 1.7 years (range 0.5–4.7 years). Recasting was performed with a mean number of four casts (range: two to six casts) in 30 % of feet (55 of 182 feet) at a mean age of 3.2 years (range one to 6.2 years). Recasting was performed in 41 cases (23 %) in association with one of the listed surgical procedures and in 14 cases (8 %) as the only intervention. No subsequent surgery was performed in 77 % (141 of 182 feet) and 95 % (173 of 182 feet) were managed without open joint surgery.

The mean dorsiflexion with the knee fully extended at the last follow-up was 15.9° (range 0–32°; SD ± 5.5) with 16 feet (9 %) presenting less than 10° and five feet (3 %) less than 5° of dorsiflexion. None of our patients presented with equinus or structural fixed adduction. We found no heel varus in standing but signs of dynamic adduction in 33 feet (18 %).

Discussion

The functional scores indicate very good function, only little limitation in daily activities and high satisfaction with the treatment result. In this consecutive case series an open joint surgery could be avoided in 95 % of cases with a good functional and anatomic outcome.

Fig. 2 Treatment was started in this female baby with a unilateral idiopathic clubfoot with a Pirani score of 5.5 at the age of 4 days (a). A good clinical result was seen nearly two years after Ponseti casting followed by pAT and abduction bracing. (b). At the age of five years

recurrence with loss of dorsiflexion to 5° and adduction was observed and treated with four casts, TATT and percutaneous three cut Achilles tendon lengthening. At the age of seven years the girl presented with a good clinical outcome, a DSI score of 97 and a dorsiflexion of 18° (c)

The response rate of 56 % of the questionnaires was satisfying; however, there is still a non-response bias. Our exclusion criteria enabled us to analyse a very homogeneous group of patients but unfortunately led to a relatively low number of cases. Another bias of this study is the limited follow-up with the possibility of an increasing rate of subsequent surgery in a longer follow-up. Longer follow-up will most likely increase the rate of TATT but not the rate of open joint surgery which was performed in our series at a young age and mainly represents our learning curve with the Ponseti management of relapse.

The DSI score in our series was of 85.3 (± 13 SD) of 100 points. The DSI score was introduced by Roye et al. [17] and was validated by Dietz et al. [20]. The latter [20] compared the DSI of 62 clubfoot patients after joint-invasive surgery and joint-sparing treatment at an age between five and 12 years. They reported a DSI score of 75 points for the joint-invasive group and 85.1 points for the joint-sparing treatment group. Our results were comparable to the joint-sparing treatment group. Bor et al. [9] reported on 74 clubfoot patients treated with the Ponseti method with a mean age of 6.3 years (five to nine years) with a DSI being available for 68 of those patients. Unfortunately, the total score was not reported which makes a direct comparison difficult. Looking at the separate questions the results are quite similar except for the questions regarding pain, where our patients scored mildly less favourably.

In our series the paediatric global function of the PODCI score ($n=59$) was 95.5 of 100 points. Zwick et al. [21] compared the results of open joint surgery in 16 feet versus

Ponseti treatment in 12 feet after a mean follow-up to 3.5 years of age. They described a PODCI score of 94.8 points in the Ponseti treatment group and a score of 94.4 points in the open joint surgery group. The difference was not significant, which does not seem surprising given the relatively low number of cases and short follow-up. Haynes and Sullivan [16] reported the PODCI score of 29 healthy children aged two to ten years. They suggested that scores on any of the functional domains that are not in the middle 80s to 90s potentially reveal decreased levels of function. According to this suggestion more than 90 % of the children in our series had a normal score.

Our clinical results compare favourably with those reported in the literature. Abdelgawad et al. reported on 137 clubfeet with a minimum follow-up of two years treated with the Ponseti method [22]. In nine feet (7 %) early open joint surgery was performed in cases that failed to achieve initial correction with the Ponseti method. During a minimum follow-up of three years (mean 3.3 years) of 70 feet an additional four feet (6 %) required posteromedial release (PMR) and eight feet (11 %) needed open Achilles tendon lengthening, which resulted in a rate of open joint surgery of 18 % (13 of 70 feet) [22]. In our series 5 % (nine of 182 feet) required open joint surgery with 2 % (four feet) operated on before walking age. While the mean age at the time of follow-up is higher in our series (5.2 versus 3.3 years), in the series of Abdelgawad et al. the mean age at initiation of treatment was 8.6 weeks compared to eight days in our series. In our series no cases were over the age of six weeks or had more than three casts applied elsewhere due to the exclusion criteria.

Bor et al. reported their results after a minimum follow-up of five years (mean 6.3 years, range five to nine years) [9]. Again the age at initiation of treatment was higher with 9.6 weeks (0.1–90 weeks) compared to our series. Of 111 feet, 23 feet (20.7 %) had TATT, eight feet (7.2 %) had posterior capsulotomy and four feet (3.6 %) had major surgery (PMR in two feet, Taylor spatial frame in two feet) [9]. Open joint surgery was only performed in 9 % of cases despite the older age at presentation. Dorsiflexion of 5° or greater was found in 97 of 109 feet (89 %) in their series compared to 177 of 182 feet (97 %) in our series. They did not find a difference in mean dorsiflexion between feet with an age at presentation of 28 days or less ($n=74$; mean dorsiflexion 10.2, range 0–25°) versus feet with an age of over 28 days ($n=36$; mean dorsiflexion 10.7, range 5–18°) [9].

Eberhardt et al. reported an initial correction rate in the years 2004–2009 of 94 % with 6 % needing open joint surgery [10]. During a mean follow-up of 6.3 years (five to 7.1 years), 49 patients with 69 clubfeet were evaluated and a mean dorsiflexion of 13.9° (0–25°) was found. They found a varus heel position in standing in six of those feet (9 %) [10]. Dorsiflexion was comparable to our series, whereas we did not find heel varus in any of our patients but dynamic adduction in 33 feet (18 %). As in our series the rate of open joint surgery was very low with only 4 % (three of 69 feet).

In a multicentre study Sætersdal et al. reported the results of 116 children with 162 congenital idiopathic clubfeet who were treated with the Ponseti method at eight hospitals [11]. Treatment was started on average on the second day of life (range zero to nine days) and 78 % of the feet were treated with a semi-rigid fibreglass cast. In 37 of the 116 patients (32 % of cases) a unilateral above the knee brace was used which is not in concordance with the Ponseti method. Nonetheless, the mean dorsiflexion in 153 feet was 24° and only 8 % (12 of 153 feet) had a dorsiflexion of less than 15°, which is superior compared to our series with 9 % of our cases presenting dorsiflexion less than 10°.

In our consecutive case series open joint surgery was avoided in 95 % of cases in the midterm follow-up. Our rate of TATT was quite low with only 13 %. On the other hand we found mild dynamic adduction in 33 feet (18 %), which might indicate that we are quite reluctant to indicate TATT and that the rate of TATT might still increase with longer follow-up. We see the absolute indication for TATT in cases with distinct dynamic adduction and increased heel varus in walking especially at the time of initial heel contact. If clinical observation is not conclusive we perform gait analysis. All of our open joint surgeries were performed in patients belonging to our initial series representing our learning curve with the Ponseti method and especially the management of relapse. In all our later cases relapse was treated successfully with recasting with or without TATT and with or without pAT or percutaneous three cut Achilles tendon lengthening. Abduction bracing is

the most challenging part of the Ponseti method in the follow-up period. Compliance can be ensured by supporting the parents and especially by regular follow-up. Regular follow-up enables early detection of problems with the braces and signs of relapse. If relapse is detected early and treated with casting open surgery can usually be avoided. Following the Ponseti treatment regime of manipulation and casting, abduction bracing and treatment of relapse results in a very low rate of open surgery even in the midterm and in mostly pain-free feet not limiting age-appropriate activity.

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