

# Ponseti Method Compared with Surgical Treatment of Clubfoot

## A Prospective Comparison

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*Investigation performed at Starship Children's Health, Auckland, New Zealand*

**Background:** Current trends in the treatment of idiopathic clubfoot have shifted from extensive surgical release to more conservative techniques. The purpose of the present study was to prospectively compare the results of the Ponseti method with those of surgical releases for the correction of clubfoot deformity.

**Methods:** We prospectively compared patients who had idiopathic clubfoot deformities that were treated at a single institution either with the Ponseti method or with below-the-knee casting followed by surgical release. The clinical records of the patients with a minimum duration of follow-up of two years were reviewed. All scheduled and completed operative interventions and associated complications were recorded.

**Results:** Fifty-five patients with eighty-six clubfeet were treated; forty feet were included in the group that was treated with the Ponseti method, and forty-six feet were included in the group that was treated with below-the-knee casts followed by surgery (with three of these feet requiring casting only). There was no difference between the groups in terms of sex, ethnicity, age at the time of first casting, pretreatment Pirani score (average, 5.2 in both groups), or family history. The average number of casts was six in the Ponseti group and thirteen in the surgical group. Of the feet that were treated with below-the-knee casts, forty-three underwent surgery, with forty-two undergoing major surgery (posterior release [eleven] or posteromedial release [thirty-one]). In the Ponseti group, fourteen feet required fifteen operative interventions for recurrences, with only one foot requiring revision surgery. Four of these fifteen were major (necessitating posterior [one] or posteromedial release [three]) while eleven were minor. Thirteen feet in the surgical group required fourteen surgical revisions. Two postoperative complications were seen in each group.

**Conclusions:** While both cohorts had a relatively high recurrence rate, the Ponseti cohort was managed with significantly less operative intervention and required less revision surgery. The Ponseti method has now been adopted as the primary treatment for clubfoot at our institution.

**Level of Evidence:** Therapeutic Level II. See Instructions to Authors for a complete description of levels of evidence.

Over the past two decades, the primary treatment of idiopathic talipes equinovarus has evolved from full surgical correction to less invasive methods of correction, primarily that developed by Ponseti<sup>1-3</sup>. Early promising results of surgical correction often have been shown to lead to later recurrences requiring additional surgery<sup>4,5</sup>. While the functional outcomes for many surgically treated feet are satisfactory<sup>6,7</sup>, similar or better results have been shown in association with the use of the Ponseti method with minimal operative intervention<sup>8-12</sup>. To our knowledge, no prospective

trial to date has compared the outcomes for clubfeet treated either surgically or with the Ponseti method.

Clubfoot is a common orthopaedic problem in New Zealand. The entire population of New Zealand is 4 million people. Of these, 750,000 people claimed Polynesian ethnic background in the 2001 census<sup>13</sup>. With an estimated incidence of 6.8 clubfeet per 1000 in Polynesian populations<sup>14</sup>, compared with one per 1000 in white European populations, pediatric orthopaedic surgeons in New Zealand treat a large number of clubfeet.

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Until quite recently, the definitive treatment of clubfoot in New Zealand has been primarily surgical. With the promising published results of Ponseti treatment and the large volume of surgical treatment of clubfeet in New Zealand, a prospective trial to compare treatments was developed at Starship Children's Health, the national children's hospital. The study was reviewed by a local ethical review board (Northern Region Ethics Committee, Number AKL/2000/214). Consent was only obtained for patients who were randomized, and consent was not required for patients who chose their treatment option.

### Materials and Methods

At the time of referral to Starship Children's Health for clubfoot treatment, a patient's family met with a dedicated clubfoot nurse coordinator (J.E.D.). Treatment options including either the Ponseti method or initial below-the-knee casting followed by surgical correction were discussed, with the risks and benefits of each method being explained in detail. The family was given informational handouts describing each clinical pathway and was directed to appropriate web sites<sup>15-17</sup>. Families were given the option of randomization or selecting their choice of treatment. Once a clinical pathway was chosen, the patients managed with the Ponseti technique were placed under the care of one senior author (H.A.C.) and those in the surgical arm were placed under the care of the other senior author (S.J.W.). Only nine families agreed to randomization. With this low level of recruitment, we proceeded to collect data as a prospective comparative study.

After approval had been obtained from the medical ethical board, all patients who were referred to our institution from November 2001 until January 2005 and who were offered the above options for clubfoot treatment were eligible for the present study. Only patients with idiopathic clubfoot and a minimum of two years of follow-up after the initial casting were included. Fifty-five patients (eighty-six clubfeet) met these inclusion criteria. Twenty-six patients (forty feet) were in the Ponseti group, and twenty-nine patients (forty-six feet) were in the below-the-knee casting and surgery group. Clinical data were collected prospectively at each clinical visit with use of a templated data sheet. At the time of presentation, the clubfoot deformities were graded by a senior author (H.A.C. or S.J.W.) with use of the validated 6-point scale of Pirani et al.<sup>18</sup>. This scoring system has been shown to have high interobserver reliability, with a Kappa value of 0.92<sup>19</sup>. Families were asked their ethnicity based on the predominant nationality of their blood, and the nationality of each patient was classified as Polynesian (including Pacific Islanders and Maori) or non-Polynesian. This distinction was made because of the high incidence of clubfoot deformity in the Polynesian peoples and the belief among the local orthopaedic community that these deformities may be more resistant to treatment than other clubfoot deformities.

In the Ponseti group, feet were treated at weekly intervals with above-the-knee casting as described by Ponseti<sup>12,20,21</sup>, followed by a percutaneous Achilles tenotomy and then with a final cast for three weeks. At the completion of cast treatment,

all patients were managed with an abduction orthosis. The open-toed, high-top shoes (M.J. Markell Shoe, Yonkers, New York) were fitted by the clubfoot nurse coordinator and were attached at shoulder width to a Denis Browne bar. Parents were emphatically instructed to ensure full-time brace wear for three months, followed by night and naptime wear until at least the age of two years. Any problem with casts, brace wear, and brace compliance was noted. As in our previous report, compliance was defined as full-time brace wear for three months followed by at least nine months of night and naptime use<sup>22</sup>.

In the surgical group, feet were treated with below-the-knee plaster casts applied over Tensoplast tape (BSN Medical, Auckland, New Zealand). These casts were applied with upward-directed pressure under the cuboid to evert the foot and to progressively correct the equinus deformity. These casts were changed weekly or biweekly until the patient was approximately six months of age. When indicated, surgery was then scheduled on the basis of the subjective findings of the treating surgeon. In more severe cases, the treating surgeon preferred earlier surgery to prevent more severe secondary deformity. The majority of these patients underwent a posterior or posteromedial release and subsequent cast changes. The surgical procedures were performed through a Cincinnati incision<sup>23</sup>. If the patient had isolated hindfoot equinus at the end of casting, a posterior release with lengthening of the Achilles tendon and releases of the tibiotalar joint and posterior subtalar joint was performed. Patients with both forefoot and hindfoot involvement underwent a full posteromedial release in which the talonavicular joint was always released. In the majority of posteromedial release cases, a Kirschner wire was used to hold the talonavicular joint reduced. The talocalcaneal joint was never pinned, and the subtalar interosseous ligament and the deep deltoid ligament were left intact. Patients typically had one subsequent cast or splint change under anesthesia following a posterior release and two following a posteromedial release. After final cast or splint removal, the patients in the surgical group were followed clinically but no additional bracing was prescribed. However, patients in whom the deformity was corrected after below-the-knee casting alone were managed with a similar orthosis as those in the Ponseti group. Patients were then followed at regular intervals as outlined in the study protocol or as the treating surgeon thought appropriate (Fig. 1).

All available clinical records, including the prospective clubfoot worksheet, clinic charts, electronic charts, and operative records of all patients in these groups, were reviewed. Age at the time of initial casting, sex, ethnicity, family history, Pirani score, number of casts, and any clinical complications associated with casting or orthosis wear were noted. All surgical interventions and complications associated with these deformities were noted. The primary outcome measure was the recurrence of deformity (with use of each foot as the core unit of analysis) requiring additional operative interventions. There were no set criteria for defining an operative recurrence; however, common clinical findings included heel equinus, hindfoot varus, adduction and dynamic supination of the forefoot, and subluxation of the talonavicular joint. All pro-

## Treatment Protocol

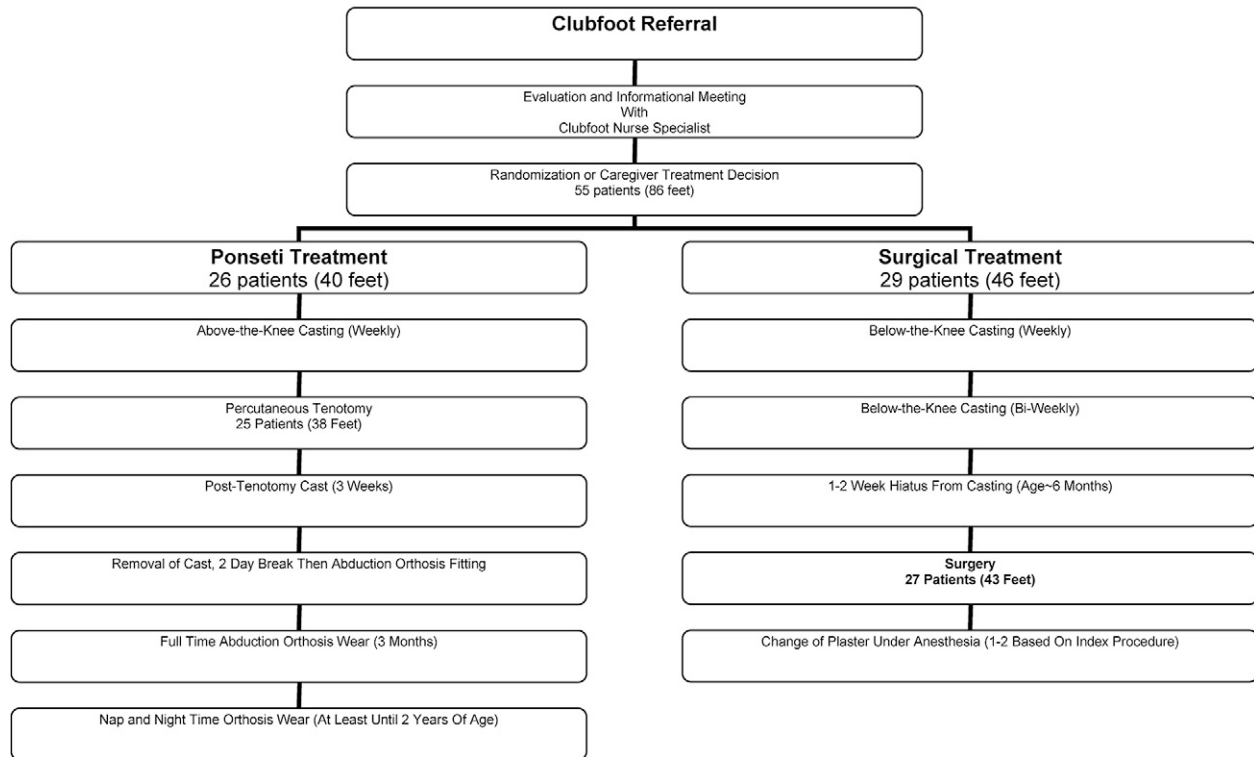


Fig. 1

Flowsheet describing treatment protocol.

cedures planned and performed to treat these recurrences at the time of our analysis were included in our statistical review. In a previous report, one author (H.A.C.) and colleagues defined surgical recurrences as minor and major<sup>22</sup>. Minor recurrences were those requiring an extra-articular soft-tissue procedure such as an open Achilles tendon lengthening. Major recurrences were defined as those that required an intra-articular surgical procedure. The definition of a major recurrence was modified for the present study to include those requiring, as subjectively determined by the treating surgeon, corrective osteotomies or an intra-articular surgical procedure. No patient in the previous study had required an osteotomy, and therefore osteotomy was not included in the original classification. The initial percutaneous Achilles tenotomy performed in the Ponseti group was not considered to be a primary surgical procedure but rather was considered to be part of the Ponseti method. All feet undergoing an initial surgical procedure that subsequently were found to have a recurrence requiring surgery were labeled as having revision surgery (Fig. 2).

**Statistical Analysis**

Statistical analysis was performed to compare the demographic characteristics between the two groups. The groups were compared with regard to sex, ethnicity, family history, bilaterality, and initial Pirani score. Clinical data, including the age at the time of the first cast, the number of casts, percutaneous or preoperative casting complications, postoperative

bracing complications, and the number of years of follow-up, were also compared. A Student t test was used for continuous variables, and a two-tailed Fisher exact test was used for categorical variables. Similarly, the number of recurrences and the difference in the severity of the recurrence were compared with use of a two-tailed Fisher exact test. Finally, with use of the individual as the core unit of analysis (with the most severely affected foot being chosen), a logistic regression was performed with treatment (Ponseti method or surgery), ethnicity (Polynesian or non-Polynesian), maximum Pirani score (with a score of 4 indicating moderate involvement and a score of >4 indicating severe involvement), and family history (yes/no) as the explanatory variables and recurrence (yes/no) as the response. A separate logistic regression was performed for the Ponseti group alone to test whether brace compliance made a significant difference. The individual was chosen in this analysis to eliminate any correlation between feet in patients with bilateral involvement. Ninety-five percent confidence intervals were used. A p value of  $\leq 0.05$  was defined as significant.

**Source of Funding**

No external funding was utilized for this study.

**Results**

We could identify no difference in terms of sex, ethnicity, family history, bilaterality, age at the time of first casting, average initial Pirani score, or number of years of follow-up

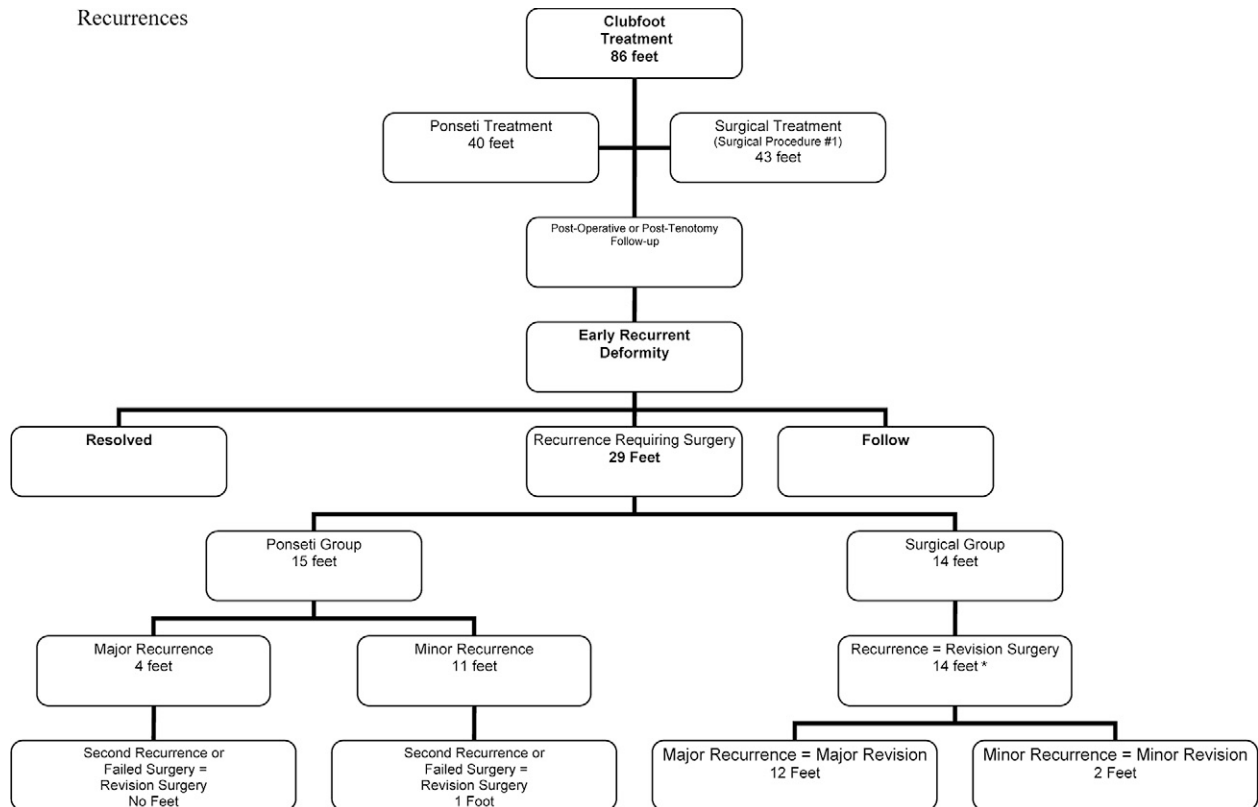


Fig. 2

Flowsheet describing treatment, recurrences, and revision surgery. \*One foot that had both a percutaneous Achilles tenotomy and a subsequent posterior release is counted twice.

between the two groups (Table I). Significantly more pretenotomy/preoperative casts were used in the surgical group than in the Ponseti group (eleven compared with five;  $p < 0.001$ ). Nineteen (66%) of the twenty-nine patients managed with below-the-knee casts and five of the twenty-six patients managed with above-the-knee casts had cast-related problems (irritation, early removal or problems necessitating reinforcement). The majority of these problems were poorly fitting casts (casts that were too tight or too loose) and minor skin irritations. The average age at the time of Achilles tenotomy in the Ponseti group was 2.4 months, whereas the average age at the time of surgery in the surgical group was 6.7 months (Table II).

Thirty-eight of forty feet in the Ponseti group underwent an Achilles tenotomy, whereas forty-three of forty-six feet treated with below-the-knee casts underwent surgery. Forty-six percent (twelve) of twenty-six patients in the Ponseti group ultimately required surgical intervention other than percutaneous Achilles tenotomy. A posterior release was performed in one foot in the Ponseti group and in eleven feet in the surgical group. A full posteromedial release was required in three feet in the Ponseti group and thirty-one feet in the surgical group. One patient who initially was managed with below-the-knee casting and bracing for the treatment of bilateral deformity underwent a later unilateral Achilles tendon lengthening and a tibialis anterior tendon transfer, and this procedure was included among the primary surgical procedures. Three patients

in the Ponseti group underwent recasting in an attempt to treat a recurrence, but two of the three had a failure and required additional surgery. Fourteen patients in the Ponseti group had minor problems (cast breakdown, kicking out of boots, skin irritation, sores, or blisters) with post-tenotomy casts and the abduction orthosis, whereas only four patients in the surgical group had similar problems. Two of the twelve patients requiring surgery in the Ponseti group and two of the twenty-seven in the surgical group had postoperative complications. In the surgical group, one postoperative urinary tract infection and one case of cellulitis were seen. In the Ponseti group, one patient undergoing a posteromedial release had subsequent wound slough and infection, and a second patient had an infection following a tibialis anterior tendon transfer. Only 35% (nine) of the twenty-six patients in the Ponseti group were compliant with post-tenotomy bracing, despite our requirement for only one full year of use (Table II).

After an average duration of follow-up of 3.5 years (range, 2.2 to 5.6 years) in the Ponseti group and 3.8 years (range, 2.2 to 5.7 years) in the surgical group, recurrences of clubfoot deformity occurred in both groups. Fourteen (30%) of the forty-six feet in the surgical group and fifteen (38%) of the forty feet in the Ponseti group were found to have recurrences requiring additional intervention. In terms of the number of patients (as opposed to feet), eight patients (thirteen lower extremities) required a total of fourteen additional

TABLE I Demographic Comparison Between Cohorts\*

Variable	Cohort		P Value
	Ponseti	Surgical	
No. of patients	26	29	
No. of clubfeet	40	46	
Bilateral involvement (no. of patients)	14	17	0.8
Sex (no. of patients)			1
Male	18	20	
Female	8	9	
Ethnicity (no. of patients)			0.6
Polynesian	17	16	
Non-Polynesian	9	13	
Positive family history (no. of patients)	13	13	0.8
Average Pirani score per foot (points)	5.2	5.2	0.9
Duration of follow-up† (yr)	3.5	3.8	0.2

\*Reproduced, with modification, from: Halanski MA, Huang JC, Walsh SJ, Crawford HA. Resource utilization in clubfoot management. *Clin Orthop Relat Res.* 2009;467:1171-9. Reprinted with permission. †The values are given as the average.

procedures (surgical revisions) in the surgical group (with one individual having two revisions), and twelve patients (fourteen feet) in the Ponseti group required a total of fifteen surgeries (with one of these feet requiring a revision tibialis anterior tendon transfer). While no significant difference was seen

between the groups in terms of the percentage of recurrence, the difference in the severity of recurrence was significant. Eleven (73%) of the fifteen recurrences in the Ponseti group and two (14%) of the fourteen recurrences in the surgical group were minor. Conversely, four (27%) of the fifteen recurrences in the Ponseti group and twelve (86%) of the fourteen recurrences in the surgical group were major. This difference in the severity of the recurrences was significant ( $p = 0.003$ ) (Table III).

There may be a concern that using the foot as the unit of analysis may ignore a potential confounding effect of individuals with bilateral clubfoot deformity. Therefore, the analysis was also run with use of the subjects as the unit of analysis. By this measure, eight (28%) of the twenty-nine patients in the surgical group and twelve (46%) of the twenty-six patients in the Ponseti group had recurrences requiring additional intervention. While no significant difference was seen in terms of the percentage of recurrence ( $p = 0.17$ ), the difference in the severity of recurrence remained significant ( $p \leq 0.03$ ). Nine of twelve patients in the Ponseti group and two of eight patients in the surgical group had a minor recurrence. Conversely, three of twelve patients in the Ponseti group and seven of eight patients in the surgical group had a major recurrence (with one patient in the surgical group having a minor recurrence and a later major recurrence involving the same foot).

Revision procedures were defined as those that were performed on feet that had already undergone a primary surgical procedure other than a percutaneous Achilles tenotomy. The percentage of feet that had a surgical revision in the surgical group was identical to the percentage of feet that had a recurrence (30%). Included in this figure is one patient who required two subsequent revisions (percutaneous tenotomy and open posterior release) after an initial posteromedial release. These were counted individually as two separate revi-

TABLE II Treatment Comparisons

Variable	Cohort		P Value
	Ponseti	Surgical	
Number of patients	26	29	
Age at first cast* (d)	21	18	0.1
Number of pre-tenotomy/preoperative casts*	5	11	<0.001†
Casting complications (no. of patients)	5	19	<0.001†
Age at tenotomy or surgery* (mo)	2.4	6.7	<0.001†
Surgery (other than percutaneous tenotomy) (no. of patients)	12	27	<0.001†
Postoperative complications (no. of patients)	2	2	0.57
Total number of casts (including post-tenotomy/postoperative and splints)*‡	6	13	<0.001†
Post-tenotomy/postoperative casting and abduction orthosis complications (no. of patients)	14 (11)§	4	0.003†
Abduction orthosis tolerance (no. of patients)	9	NA#	

\*The values are given as the average. †Significant. ‡Not including recasting or casting following surgery for the treatment of recurrence. §The number of patients with abduction orthosis problems is given in parentheses. #Not applicable.

TABLE III Comparison of Recurrences

	Cohort		P Value	
	Ponseti	Surgical	Comparison Based on Feet	Comparison Based on Patients
Number of feet (no. of patients)	40 (26)	46 (29)		
Surgical procedure for treating recurrences*	15 (12)	14† (8)	0.5	0.17
Surgical revisions*†	1 (1)	14† (8)	<0.001	0.03
Minor recurrences*	11 (9)	2 (2)	0.003	0.03
Percutaneous Achilles tenotomy§	0	1		
Open Z-lengthening Achilles tendon§	0	0		
Tibialis anterior tendon transfer§	9	1		
Combined soft-tissue procedures§	2 (1 tibialis anterior tendon transfer and posterior extra-articular release, 1 tibialis anterior tendon transfer and botulinum toxin [Botox])	0		
Major recurrences*	4 (3)	12 (7)	0.003	0.03
Posterior release (intra-articular)§	1	0		
Posteromedial release§	3	0		
Derotational osteotomy (tibia)§	0	6		
Combined procedures§	0	6 (1 posterior release and tibialis anterior tendon transfer; 1 tibialis anterior tendon transfer and lateral column shortening; 1 derotational osteotomy and posteromedial release; 1 derotational osteotomy, tibialis anterior tendon transfer, and lateral column shortening; 2 posteromedial release, tibialis anterior tendon transfer, and lateral column shortening)		

\*The data are given as the number of feet, with the number of patients in parentheses. †One foot that had both a percutaneous Achilles tenotomy and a subsequent posterior release is counted twice. Both of these procedures were performed following an initial posteromedial release. ‡Débridement for postoperative infection is not included in this total. §The data are given as the number of feet.

sions. Conversely, despite a relatively high overall recurrence rate (38% [based on the number of feet] or 46% [based on the number of patients]), only one patient in the Ponseti group required additional surgery (a revision tibialis anterior tendon transfer) after the development of a postoperative infection. The difference in revision rates was significant ( $p = 0.03$ ).

On multivariate analysis, the only significant explanatory variable was family history ( $p = 0.033$ ). On the average, a family history increased the odds of recurrence by a factor of 3.81 (95% confidence interval, 1.11 to 13.04). The  $p$  values for treatment type, race, and Pirani score were 0.15, 0.94, and 0.41, respectively. A separate logistic regression for the



Ponseti group alone showed that, with the numbers available, compliance with brace use was not a significant factor ( $p = 0.67$ ).

## Discussion

Initial nonoperative management is the preferred method for the treatment of clubfoot in many institutions today<sup>24</sup>, largely because of the promising short and long-term results reported by Ponseti and others<sup>2,8,25-29</sup>. Although most surgical series have shown satisfactory outcomes<sup>6,30</sup>, a substantial number of feet require subsequent surgery<sup>4,6,30</sup>, and the potential for surgical complications exists at each intervention. In New Zealand, surgical treatment of this deformity has been the standard of care primarily because of the perception that this deformity is more severe in the New Zealand population than in other populations and that, in our population, compliance with an abduction orthosis would be low. Few studies have prospectively compared the results of operative and nonoperative treatment of clubfoot. Herzenberg et al.<sup>2</sup> compared two different casting methods (traditional and Ponseti) and found the Ponseti method to be far superior, decreasing the need for operative intervention. In what we believe to be the only published report comparing the outcome of feet treated with a “Ponseti-like” technique and full surgical intervention, Ippolito et al.<sup>8</sup> found that the long-term functional results for the Ponseti group were better than those for patients managed with more extensive surgery.

At our institution, two surgeons had differing opinions regarding the treatment of clubfoot. After receiving informed consent and an offer of randomization, almost all of the caregivers for our patients had strong preferences for choosing their treatment, with nearly half choosing the surgical treatment and half choosing the Ponseti method. Although the study population was not randomized, our demographic data showed that these two cohorts were very similar. Most importantly, the severity of deformity in each group was the same, with an initial average Pirani score of 5.2. We were surprised that an equal number of parents would choose surgical intervention over a primarily nonoperative method. One explanation may be that with the high incidence of clubfoot deformity in New Zealand, many families knew of other children who had done well with surgical correction. Thus, the more familiar surgical treatment may actually appear to be the more “conservative” treatment in comparison with the “new” casting technique that was only recently introduced (less than ten years previously) in New Zealand. Another potential reason is that the families may have viewed the surgical treatment as the more sophisticated or advanced treatment that may correlate with a superior outcome. Finally, brace wear was emphatically discussed with the families and, despite lowering the recommended total brace wear from the age of three to four years (as recommended by Ponseti) to one year, we still noted poor compliance with orthotic wear and the surgical treatment did not require routine brace wear.

The purpose of the present study was to compare the surgical and Ponseti treatment methods with regard to early

outcomes in terms of recurrence and the need for additional surgery. Because we used preoperative casts in the surgical group, however, we can make comparisons between casting styles. The purpose of the below-the-knee casts that were applied in the surgical group was to help to stretch the feet for about six months in preparation for surgery. The goal of this casting was to partially correct the clubfoot deformity and to minimize the extent of surgery required. With 93% of these feet requiring surgery, 67% of the feet requiring a full posteromedial release, and 24% requiring only a posterior procedure, casting may have decreased the need for a full posteromedial release by as much as a third, but it is not possible to assess the effect that casting had on the subsequent surgery. What can be noted is the significant differences in terms of the number of casts, casting complications, and surgical requirements between casting styles. On the average, there were twice as many casts required and nearly four times as many cast-related problems (nineteen compared with five) in the surgical group. Despite the greater number of preoperative clinic visits and castings, a significantly higher percentage of patients required operative intervention (93% compared with 46%). These findings are similar to those that have been previously published<sup>2</sup>. The above-the-knee casts appear to hold the limb better, with fewer complications, and also perhaps help to derotate the tibia during the clubfoot correction.

Feet treated in both groups had a 30% to 40% rate of relapse, higher than that reported in the literature<sup>4,11</sup>, but similar to our previous report of a 41% rate of relapse<sup>22</sup>. This finding may reveal that some of the feet treated in New Zealand are more recalcitrant than those treated elsewhere. Lack of compliance with brace wear likely was a contributory factor in the recurrence rate in the Ponseti group<sup>11,22,25,31</sup>, despite attempts to improve compliance as reported previously by two of us<sup>22</sup>. This lack of compliance must be factored into clinical decision-making. If a patient population is not likely to be as compliant as those in previous reports, a reasonable portion of these deformities will recur, and results from other centers with high brace compliance rates do not provide a realistic comparison<sup>11</sup>. Although the rate of compliance with brace wear was low in the present study, it was not found to be a significant risk factor for recurrence in the logistic regression analysis, perhaps because of the small number of subjects in the Ponseti treatment group. Family history was found to be the only significant risk factor for recurrence in these cohorts.

An interesting point is the young age at which a major operative intervention was undertaken for the treatment of recurrence in the Ponseti group. Three of the four feet requiring major operative intervention were noted to have recurrences before the age of six months, and the other was noted to have recurrence by the age of eighteen months. These subsequently required major operative intervention at an average of nearly eighteen months of age. These cases may represent feet not fully corrected with the Ponseti method rather than true recurrences, as two were in a patient whose family was noncompliant with weekly casting.

In both groups, the question of undercorrection leading to later deformity as opposed to a true recurrence of a corrected deformity is difficult to address. For instance, the majority of the recurrences in the Ponseti group were not true recurrences of the deformity but rather were due to the dynamic action of the tibialis anterior muscle. The transfer of this muscle may not be considered to be a treatment of recurrence but rather a part of the initial Ponseti method as a long-term review of Ponseti's cases has shown the need for this tendon transfer in as many as 53% of cases<sup>26</sup>. We defined the need for these transfers as minor recurrences to allow for a more accurate comparison with feet that were treated surgically.

Statistically similar percentages of recurrences were found in both groups; however, with use of our modified classification system for recurrences, the extent of surgery that was needed to correct the recurrence in each group was different. This classification system is biased to the Ponseti method in that the treating surgeon for the Ponseti group (H.A.C.) attempted to avoid any intra-articular surgery unless absolutely necessary, whereas the treating surgeon for the surgical group (S.J.W.) did not attempt to limit this type of surgery if it would help to correct the deformity. Therefore, a selection bias may exist in the present study.

Any classification system has its strengths and weaknesses. The argument can be made that including a tibial derotational osteotomy in the major recurrence group is unfounded because the primary argument for this classification system is to measure the number of intra-articular procedures performed on the foot, which may in the long term cause foot stiffness. While we consider these long-bone osteotomies to be "major" surgery, their long-term effects on foot function and stiffness may not be as detrimental as repeated intra-articular surgery. Thus, if only intra-articular procedures (including those involving the use of a Kirschner wire to immobilize joints as in a lateral column lengthening) are considered (and extra-articular tibial derotational osteotomies are not), the significant difference in the types of recurrences is lost; however, the significant difference in surgical revision rates between groups remains.

While major surgical procedures are often more invasive than minor procedures, the difference in functional outcome between these types of interventions is not known. As the feet in the surgical group had undergone primary surgery, all subsequent procedures to correct recurrent deformities were by definition revision surgery. Conversely, all surgical procedures in the Ponseti group, except for the one revision tibialis

anterior tendon transfer, were primary procedures. Following the long-term function of these revised feet will be important. Likewise, while the average duration of follow-up was 3.5 years for the Ponseti group and 3.8 years for the surgical group, many of the patients were quite young at the time of analysis. The deformities in these children may recur over time to require further operative intervention.

The present study is an early report comparing the treatment of idiopathic clubfoot. The findings in our New Zealand population indicate that the Ponseti treatment of clubfoot was associated with a decrease in the need for revision surgery when compared with primary surgical treatment. The percentages of feet that had a recurrence were similar in both groups, despite the fact that the majority of the feet in the surgical group underwent primary surgery and the finding that the majority of patients in the Ponseti group were non-compliant with abduction orthosis wear. In a recent parallel study, we showed the cost-effectiveness of the Ponseti method over the surgical method with use of these same cohorts<sup>32</sup>.

While the initial findings of the present study are important, long-term functional data on our patients are needed. In combination with other published findings, the results of the present study have caused changes at our institution. Currently, the casting method of choice is the Ponseti method throughout the institution. ■

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