Predicting the Need for Tenotomy in the Ponseti Method for Correction of Clubfeet

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Abstract: The purpose of this study was to determine how to predict the need for tenotomy at the initiation of the Ponseti treatment. Fifty clubfeet (35 patients) were prospectively rated according to Pirani and Dimeglio scoring systems. Tenotomies were performed in 36 of 50 feet (72%). Those that underwent tenotomy required significantly more casts ($P = 0.005$). Of 27 feet with initial Pirani scores $\geq$5.0, 85.2% required a tenotomy and 14.8% did not; 94.7% of the Dimeglio Grade IV feet required tenotomies. Following removal of the last cast, there was no significant difference between those that did and did not have a tenotomy. Children with clubfeet who have an initial score of $\geq$5.0 by the Pirani system or are rated as Grade IV feet by the Dimeglio system are very likely to need a tenotomy. At the end of casting, feet were equally well corrected whether or not they needed a tenotomy.

Key Words: clubfoot, Ponseti, Achilles, casting

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Ponseti and Smoley initially reported the technique of gentle manipulation, serial casting, and the use of a foot abduction orthosis in 1963.[10] This technique differed from previously reported ones, such as that described by Kite, in several ways.[4,5] Among these is the initial inversion of the forefoot at the time of the first cast, the abduction of the forefoot distal to the talus while avoiding forced pronation and the use of a percutaneous Achilles tenotomy to correct the equinus in approximately 70% to 80% of patients prior to application of the final cast. Ponseti has described the use of several carefully molded casts, avoiding pressure under the metatarsals, to correct the equinus without the use of a tenotomy. However, a percutaneous tenotomy, done under local anesthesia, can facilitate the correction and minimize the risk of rocker-bottom deformity. It is recommended that a tenotomy be performed when 15° of dorsiflexion has not been obtained after correction of the forefoot and heel varus.

We were interested in determining whether one might be able to predict the likelihood of needing a tenotomy at the outset of treatment based upon the severity of the deformity. Many scoring systems have been developed to rate clubfeet, but these scores have never been used to assist in treatment decisions or to predict the need for components of treatment. The systems by Dimeglio et al and Pirani et al have been validated and proven reliable to accurately quantify the severity of a clubfoot deformity[2,3] (abstract from Pirani et al. A method of evaluating the virgin clubfoot with substantial inter-observer reliability, POSNA Annual Meeting, 1995). These systems are now routinely used in describing the outcomes of treatment but not to aid in its selection. The purpose of this study was to determine whether one might be able to predict the need for tenotomy at the initiation of the Ponseti treatment and, furthermore, to evaluate the results of its use.

MATERIALS AND METHODS

Fifty clubfeet in 35 patients were treated with serial casting performed at weekly intervals. Each foot was rated according to the Dimeglio et al and Pirani et al scoring systems[2] (abstract from Pirani et al. A method of evaluating the virgin clubfoot with substantial inter-observer reliability, POSNA Annual Meeting, 1995). Scores for each foot were obtained at each visit, prior to cast application and following removal of the final cast. The Dimeglio system characterizes the flexibility of the foot for each of eight different components: equinus, varus, rotation of the talocalcaneal-forefoot unit, forefoot adduction, a posterior crease, a medial crease, cavus, and the presence of abnormal musculature. The scale is from zero to 20 points and is stratified into four grades, which we recorded as Grade I, Grade II, Grade III, or Grade IV. A higher score or higher number grade reflects a more severely deformed foot. The Pirani system registers the deformity of six different components of the clubfoot. These are divided into the hindfoot components: posterior crease, empty heel, and rigid equinus, and the midfoot components: medial crease, curvature of the

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lateral border of the foot, and the position of the head of the talus. Each component is given a score of 0, 0.5 or 1.0 and, consequently, the scale is from 0 to 6 points, with 6 representing the most severe deformity.

Casting was performed according to the method described by Ponseti.[7,8–10] Feet were gently manipulated prior to cast application and then placed in toe-to-groin plaster casts with the knee flexed 90°. The first cast was applied with the forefoot inverted and the first ray elevated to correct the cavus deformity. Subsequent casts were then applied while gently abducting the forefoot, navicular, and cuboid around the talus, allowing correction of the adductus as well as the heel varus. Casts were applied at weekly intervals until the adductus and heel varus were corrected. The final cast was applied with the foot in 15° of dorsiflexion. A percutaneous Achilles tenotomy was performed if the foot could not be dorsiflexed to 15 prior to application of the final cast.

Tenotomies were performed as an office procedure under local anesthesia. EMLA topical anesthetic cream was placed on the skin overlying the Achilles tendon, covered with an occlusive dressing, and left in place for 30 to 60 minutes. While an assistant was holding the foot in a position of maximal dorsiflexion, the posterior ankle was then prepped with betadine solution. The skin and subcutaneous tissues overlying the Achilles tendon were then infiltrated with 1% lidocaine. Using a long cataract blade, a subcutaneous tenotomy was performed, completely transecting the tendon just above its insertion and allowing 15° of dorsiflexion. A sterile gauze pad was then placed over the incision, and the final cast was applied with the foot dorsiflexed 15°.

RESULTS

Tenotomies were performed on 36 of 50 feet, comprising 72% of the feet treated (Fig. 1). The mean number of casts required was significantly greater ($P = 0.005$) for the group that required a tenotomy, 5.7 casts (range 4–9) than the group that did not require a tenotomy, 4.7 casts (range 3–6). The distributions of the initial scores, according to the system by Pirani, and the initial grades, according to the Dimeglio system, are listed in Figures 2 and 3, respectively. Among the 27 feet with a Pirani score greater than or equal to 5.0 at initial presentation, 85.2% required a tenotomy and 14.8% did not. Of the 18 feet with a Pirani score between 3.0 and 4.5, 61.1% required a tenotomy and 38.9% did not. Finally, only 40% of the 5 feet with initial scores between 1 and 2.5 needed a tenotomy. Among the 19 feet that were rated as Dimeglio Grade IV at initial assessment, 94.7% required a tenotomy. There were 23 feet in the Grade III group, of which 65.2% required a tenotomy, and 8 feet in the Grade II, of which 37.5% required a tenotomy. According to the χ^2 test, there were significantly more feet that required a tenotomy than feet that did not among the Dimeglio Grade IV feet ($P = 0.0001$) and feet with Pirani scores greater than or equal to 5.0 ($P = 0.0003$). At the time of initial evaluation, the Mann-Whitney U test demonstrated a significantly higher score for those requiring a tenotomy than those that did not for the following individual components of the Pirani score: posterior crease ($P = 0.004$), empty heel ($P = 0.004$), and rigid equinus ($P = 0.04$).

Following the removal of the final cast, no significant differences were found between those that did have a tenotomy and those that did not according to both the Pirani and the Dimeglio classifications overall. The median Pirani scores at this time were 0.5 for both those that required tenotomy and those that did not. The distribution of feet according to Dimeglio grades following the final cast is depicted in Figure 4, along

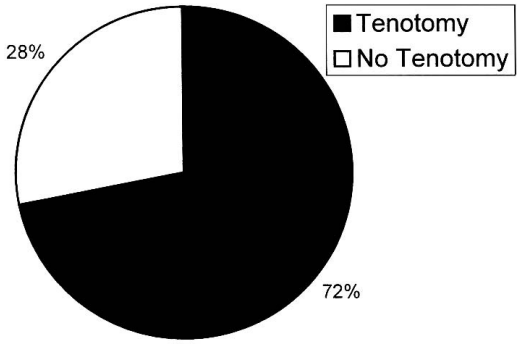

FIGURE 1. Total number of feet treated (n = 50).

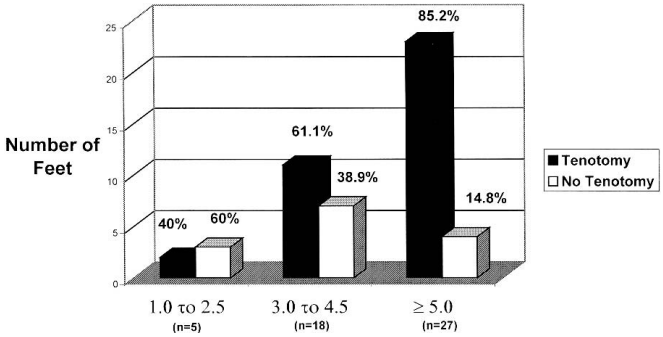

FIGURE 2. Pirani score at initial evaluation.

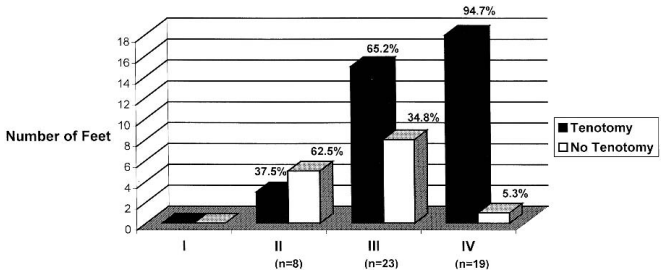

FIGURE 3. Dimeglio grade at initial evaluation.

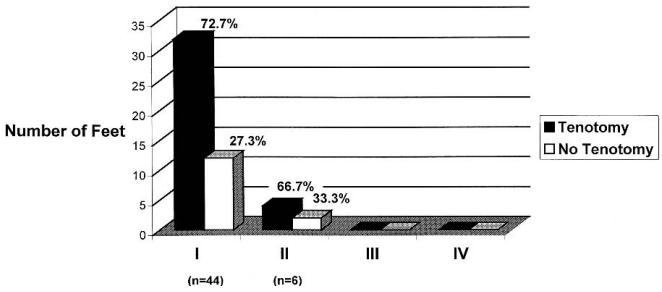

FIGURE 4. Dimeglio grade following last cast.

with the percentages of each grade that required tenotomies. Of the feet that had a tenotomy, 89% were ultimately rated as Grade I and 11% as Grade II (Fig. 5). Of the feet that did not have a tenotomy, 86% were ultimately rated as Grade I and 14% as Grade II (Fig. 6). However, when the individual components of the Pirani scoring system were examined independently, the "empty heel" score was significantly greater for those that had a tenotomy (median score = 0.5) in comparison to those that had not (median score = 0.0, $P = 0.02$).

DISCUSSION

Tenotomy of the Achilles tendon is an integral part of Ponseti's technique for the treatment of clubfeet. The indication for tenotomy has been clearly described and is reported to be necessary in approximately 70% to 80% of patients.[1,7–9] Tenotomy to correct the equinus deformity, after the cavus, adductus, and heel varus have been corrected, allows more expeditious correction of the clubfoot deformity, decreasing the number of casts and the overall duration of treatment. Although the effectiveness of the Ponseti technique has been made clear in multiple publications over the past 30 years, the specific role of the Achilles tenotomy has not been addressed. This study is an attempt to determine which factors might predict the need for a tenotomy at the outset of treatment and also to determine the results of its use in relation to those feet not requiring tenotomy.

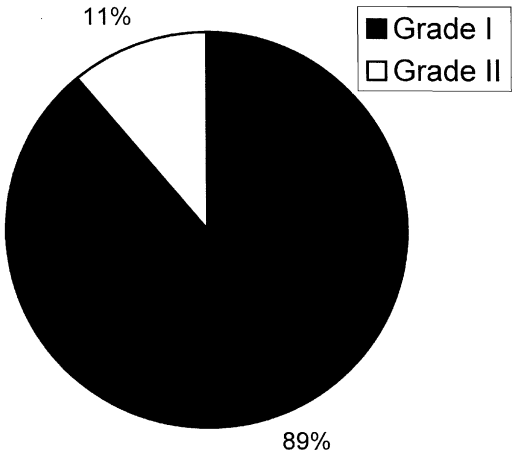

FIGURE 5. Tenotomy group—final Dimeglio grades.

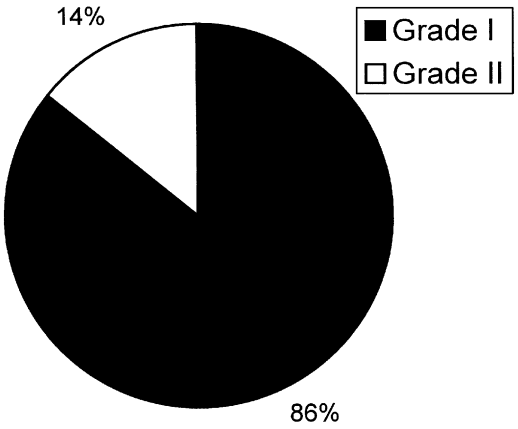

FIGURE 6. No tenotomy group—final Dimeglio grades.

We found that a significantly greater percentage of the more severely deformed feet, based upon two previously validated scoring systems, required a tenotomy. Specifically, the overwhelming majority of feet that scored greater than or equal to 5.0 on the Pirani clubfoot score and that were rated as Grade IV feet according to the Dimeglio classification required a tenotomy. This may come as no surprise, in light of the fact that equinus is one of the components measured in these scores and, with increasing severity of equinus, the scores become worse. However, we found that the other components of the hindfoot deformity, according to the Pirani score, were also significantly worse in those requiring a tenotomy. The elements comprising the hindfoot component of the Pirani score reflect both the severity and the rigidity of the hindfoot contracture. Consequently, it is likely that both the severity and rigidity of the hindfoot contracture contribute to the need for Achilles tenotomy.

Further evidence that the likelihood of tenotomy relates to the overall rigidity of the deformity, rather than just its absolute severity, lies in the fact that the feet that had tenotomies required significantly more casts than those that did not. It follows that the feet ultimately requiring tenotomies were in fact stiffer during the entire casting process in addition to being more severely deformed at the outset. Their response to manipulation and casting appears to have been slower and less facile. A recent biochemical analysis of collagen from clubfeet demonstrated differences in the biochemical structure of the collagen correlating with the foot's Dimeglio classification.[6] Collagen from clubfeet and matched controls was analyzed for post-translational modifications. Not only did these authors find less total collagen content and differences in certain cross-links between clubfeet and controls, but they also found that "the degree of hydroxylation of lysine follows the Dimeglio-

classification." These authors' data support the theory that differences in the ease of correction by manipulation and casting may relate to biochemical differences in the collagen itself.

Perhaps the most important conclusion to be drawn from this study is the recognition that feet requiring tenotomies were equally well corrected at the end of casting as those that did not require tenotomies. This conclusion reinforces the notion that even severe idiopathic clubfeet can be successfully treated using proper application of the Ponseti technique and the need for a tenotomy does not suggest a poorer result. Evaluation of the data did reveal some persistence of an "empty heel" in those children who underwent a tenotomy. The median Pirani score for the empty heel in this group at the end of treatment was 0.5, reflecting some softness to the heel pad. This is most likely a consequence of the equinus being more severe in these feet prior to treatment and did not detract from the overall final score. At the end of casting, feet from both groups had equivalent overall scores, according to both scoring systems, reflecting supple and plantigrade feet. This information may be reassuring to the parents of children undergoing the Ponseti technique, who may be apprehensive when told that their child requires a tenotomy, hoping to avoid any form of surgery. These parents can be reassured that the need for a tenotomy does not predict a worse outcome at the end of casting.

Clearly, the true functional outcome of these two groups cannot be determined until the child has completed growth, and perhaps not until later in life. Other important measures that could clarify our comparison between the groups could include the need for further treatments, the appearance and function of the feet at walking age, and the appearance and function during adulthood. Still, the results of treatment at the end of casting, using these validated scoring systems, allow an accurate assessment of the ability of casting and Achilles tenotomy to correct the clubfoot to a supple, plantigrade position.

In conclusion, our data suggest that the need for a tenotomy can be predicted at the outset of treatment. In addition, the rigidity of the foot, and not just the overall severity of the initial equinus, is an important factor in predicting the need for a tenotomy. Finally, when properly indicated, feet requiring tenotomies are as well corrected at the end of casting as those not requiring tenotomies.

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