The Ponseti Method for Clubfoot Correction

David M. Scher, MD

The Ponseti technique is rapidly becoming the most widely practiced method for initial treatment of congenital clubfeet in infants. It is an easy technique to learn and, when applied accurately, yields excellent results. It consists of gentle manipulation and casting of the feet at weekly intervals. The first cast is applied with the foot supinated and attention directed to elevating the first ray. Subsequent casts are applied to abduct the foot around the head of the talus, taking care never to directly manipulate the calcaneus. At the time of the final cast, the overwhelming majority of infants require a percutaneous Achilles tenotomy to allow sufficient dorsiflexion. The final cast remains in place for three weeks, at which time the infant is placed into a foot abduction orthosis. The orthosis is worn 23 h per day for 3 months and then at night for several years. Good results have been demonstrated at multiple centers and long-term results indicate that foot function is comparable with that of normal feet.

Oper Tech Orthop 15:345-349 © 2005 Elsevier Inc. All rights reserved.

KEYWORDS congenital clubfoot, Ponseti method, casting, clubfoot recurrence

Ignacio V. Ponseti can be credited with developing a comprehensive technique for treating congenital clubfoot in the 1940s.1-4 This technique is based on his experiences with the myriad of treatments being applied at that time and his observations in the clinic and operating room, as well as his anatomic dissections and analysis by cineradiography. One of the major principles of this technique is the concept that the tissues of a newborn's foot, including tendons, ligaments, joint capsules, and unossified tarsal bones, will yield to gentle pressure over time. This process recently has been demonstrated by Pirani and coworkers, who used magnetic resonance imaging (MRI) to characterize the change in shape of the talus, navicular, calcaneus, and cuboid during the casting process.5 Furthermore, this general concept frequently is encountered throughout orthopedics, where it is implicated in the etiology of some conditions and used to treat others. The Heuter–Volkman law describes the process by which deforming forces can alter bone growth, such as is the case in Blount’s disease. The Ilizarov technique takes advantage of the ability of soft tissues to yield to stretch and lengthen during limb-lengthening procedures and deformity correction. Using these principles and his understanding of clubfoot anatomy and kinematics, Dr. Ponseti began using this technique in 1948. Since that time, many publications by different centers have corroborated its success.6-8 By applying these techniques to clubfeet within the first few weeks of life, physicians should be able to successfully correct most cases of clubfeet without resorting to major reconstructive surgery.

The treatment process using the Ponseti technique can be logically divided into 2 phases: the treatment phase during which time the deformity is corrected completely, and the maintenance phase, during which time a foot abduction orthosis is used to prevent recurrence. During each of these phases, attention to the details of the technique is essential. It has been shown that treatment errors can lead to iatrogenic deformities, incomplete correction and recurrences.9 The treatment phase should begin as early as possible, optimally within the first week of life. Gentle manipulations are performed followed by casting on a weekly basis. During these manipulations, the components of the clubfoot deformity are corrected simultaneously, except for equinus, which is corrected at the final cast application. Generally 5 to 6 casts are required to fully correct the foot and, in a large majority of cases (70% or higher) a percutaneous Achilles tenotomy is performed. At the end of casting, when the maintenance phase begins, the child must wear an orthosis that keeps the feet abducted and the ankle slightly dorsiflexed, according to a strict wearing protocol. Failure to use this type of device has been shown to be associated with recurrence of the clubfoot deformity.10,11

Manipulation and Casting

The manner in which the foot is first manipulated and the first cast applied is one of the several unique elements of the
Ponseti technique that makes it quite distinct from other casting methods. The cavus is corrected with the first cast application by aligning the forefoot with the hindfoot. Even though the forefoot appears to be supinated with respect to the horizontal, it is in fact pronated with respect to the heel, because the heel is typically in more varus than the forefoot. This relative pronation of the forefoot with respect to the heel creates the cavus. This phenomenon has been likened to wringing out the foot as one would wring out a towel. Consequently, this component of the deformity can be corrected by supinating the forefoot to bring it in line with the heel and then elevating (ie, dorsiflexing) the first metatarsal (Fig. 1). In doing so, the cavus is corrected, typically after one cast (Figs. 2 and 3). In one’s early experience with this technique, it usually is easiest to apply the cast in 2 stages, first a short-leg cast to just below the knee, which is then extended above the knee once the plaster sets. This method also is preferable in older children (ie, older than 2 to 3 months) who are stronger and less easily consoled during the casting. Ponseti emphasizes the importance of long-leg casts, which are essential in maintaining a strong external rotation force of the foot beneath the talus. Long-leg casts allows adequate stretching of the medial structures, especially the posterior tibial tendon and superficial deltoid ligament. Because of the cylindrical shape of an infant’s leg, a short-leg cast cannot be adequately molded to prevent internal rotation of the foot.

One week after application, the first cast is removed and, after a short period of manipulation lasting approximately 1 min, the next toe-to-groin plaster cast is applied (Fig. 4). This manipulation and casting is focused on abducting the foot around the head of the talus. Care is taken to maintain the forefoot in a supinated position and to avoid imparting any pronation to the foot. With one’s thumb on the head of the talus (left thumb for a right clubfoot and right thumb for a left clubfoot), the navicular can be felt reducing over the talar head during these manipulations. This maneuver should be practiced several times to both stretch the medial structures and also to know how the foot will be manipulated after the plaster is applied. Another crucial point in the Ponseti technique, which is radically different than the Kite technique, is that the heel is never directly manipulated. The kinematics of
the hindfoot and midfoot are such that the heel will naturally move into valgus as the midfoot is abducted. With reduction of the talar head beneath the navicular, the correction of the talus, navicular and cuboid cause the calcaneus to abduct and evert. This element in the correction is accomplished without ever directly manipulating the calcaneus.

Manipulation and casting is continued on a weekly basis for the next 2 to 3 weeks to gradually abduct the foot around the head of the talus. It warrants emphasis that the foot should never be actively pronated. However the amount of supination is gradually decreased over these next several casts until the forefoot is in neutral position relative to the longitudinal axis of the foot. (Fig. 5) After 4 or 5 casts have been applied, the thigh-foot axis approaches 70° of external rotation. At this point, the talar head should no longer be palpable at the anterolateral aspect of the ankle and the heel should be clearly in valgus. The foot can now be dorsiflexed since the calcaneus is no longer locked beneath the talus. This principle can be easily demonstrated in the normal foot as one unsuccessfully attempts to dorsiflex the foot while inverted, and then successfully does so with the foot everted.

The final cast is applied with the foot in the same maximally abducted position and dorsiflexed 15°. In the majority of clubfeet (greater than 70% and as high as 90% in some series) the Achilles tendon is contracted, thereby restricting dorsiflexion of the otherwise corrected foot. To prevent development of a rocker-bottom deformity, a percutaneous Achilles tenotomy is performed during which the tendon is completely sectioned approximately 2 cm above its insertion, which typically is performed under local anesthesia through a small medial puncture using a cataract scalpel blade, a number 11 scalpel blade or a round ended blade.12 (Figs. 6 and 7) The foot is then casted in the final position of approximately 70° abduction and 15° dorsiflexion for 3 weeks (Fig. 8).

As mentioned previously, the casts are always long-leg plaster casts applied from the toes to the groin. They can be applied in 1 or 2 sections based on the experience of the individual and the demeanor of the infant. It is essential to apply a thin layer of cotton padding beneath the cast, overlapping the roles by half, so that there is about 2 layers of cotton padding between the plaster and the skin. Thin padding allows the cast to be closely fitting and well-molded to

A typical cataract blade used for the tenotomy.
the foot. In addition, care should be taken to extend the cast beyond the end of the toes so that the toe flexors are stretched as the foot is corrected. A total of five or six casts are typically needed to correct the foot. More are very rarely needed in only the most severely deformed or teratologic feet.

**Maintenance Phase**

On removal of the final cast, the infant is placed into a brace that maintains the foot in its corrected position. This brace is frequently referred to as a Denis Browne bar; however, it differs substantially from that device. The purpose of splinting in the Ponseti method is to maintain the foot abducted and dorsiflexed. This is accomplished with a brace consisting of shoes mounted to a bar in a position of 70° external rotation and 15° of dorsiflexion. (Figs. 9 and 10) If the child has a unilateral clubfoot, then the sound foot is set to approximately 45° of external rotation. The width of the shoes is set to approximately 1 inch wider than the width of the infant’s shoulders. This position represents more external rotation and greater width between the shoes than a typical Denis Browne bar, which is also typically made with the shoes flat on the bar rather than dorsiflexed. A more accurate term for this device is the foot abduction orthosis.

The brace is worn 23 hours per day for the first 3 months after casting and then while sleeping for several years to follow, usually until around the age of 3 or 4. Two recent studies have demonstrated the high risk for recurrence if the brace is not worn according to this protocol. The reasons for recurrence in feet that appear to be fully corrected have not yet been clearly elucidated, although Ponseti postulates that persistent retracting fibrosis of the medial structures may contribute to this. Regardless of the cause, recurrence appears to be close to zero when the bracing protocol is followed accurately.

**Management of Recurrence**

The risk of recurrence persists for several years after the casting is completed. Ponseti reported a recurrence rate of approximately 50% in his early series but noted a decrease with greater emphasis placed on the use of the foot abduction orthosis. Early recurrences usually present with mild equinus and heel varus and are best treated with several long-leg plaster casts applied at 2-week intervals. The first cast may require some dorsiflexion of the first ray if there is cavus present. Subsequent casts abduct the foot around the talus head, thereby correcting the varus, and ultimately allowing ankle dorsiflexion. An Achilles tendon lengthening may be necessary if there is insufficient dorsiflexion and a tibialis anterior tendon transfer may be performed in older children to help maintain the correction.

**Tibialis Anterior Tendon Transfer**

In children who have persistent medial displacement of the navicular, the axis of the tibialis anterior tendon may cause it to impart a strong supination force during ankle dorsiflexion. By transferring the tendon laterally, this force is centralized without having to disturb the joints of the midfoot. The tendon is transferred to the lateral cuneiform once it is ossified, usually after 2.5 years of age. The transfer involves releasing the tibialis anterior tendon from its insertion, opening its sheath and the inferior extensor retinaculum, and freeing the tendon to the level of the superior extensor retinaculum, which is not incised. The tendon is not released from beneath the superior extensor retinaculum and is not brought into the lower leg. Rather, the distal stump is transferred subcutaneously to the level of the lateral cuneiform. Through a second lateral incision, the extensor digitorum tendons are retracted laterally and the lateral cuneiform is identified. A hole is drilled centrally in the lateral cuneiform and the tendon is transferred to and secured in this hole. The child is then placed in a long-leg cast for four weeks with the foot in neutral position.

For older children with a more severe deformity, Ponseti advocates a procedure that he credits Dr. Reginald R. Cooper with developing. This procedure can be performed in a child who has a recurrent deformity that includes cavus, but is flexible with the Coleman block test. In these cases, in addition to a tibialis anterior tendon transfer, a plantar fascia release is performed along with a first metatarsal dorsiflexion.
The published results of the Ponseti technique are among the longest follow-up in the clubfoot literature. A group of patients with clubfeet treated between 1950 and 1967 has been studied at averages of both 18.8 years and 34 years and the reports describe their function, range of motion and radiographic findings. In the most recent study published in 1995 by Cooper and Dietz, a group of 45 patients was studied by measuring foot range of motion, plantar pressures during gait and radiographic findings regarding alignment of the tarsal bones and any deformities or arthritis present. In addition the answers these patients provided in a questionnaire were compared with those given by 97 age-matched controls who had no congenital foot deformities. Their findings included good-to-excellent function in 78% of the patients with clubfoot versus 85% of patients in the comparison group. Among the clubfoot patients, 45% had an occupation that placed a high demand on the foot, compared with 24% in the comparison group, and 54% participated in sports at least once per week compared with 40% in the comparison group. When unilateral clubfeet were compared with contralateral controls, there were objective differences in passive and active range of motion and some differences in foot pressures in the heel and midfoot. Importantly, however, there were only mild degenerative changes on radiographs consisting of osteophytes at the dorsal talus, anterior tibia or talonavicular joint in 35% of patients, only 4% of which had increased in the 13 year interval between studies. An important point stressed by the authors was the presence of several radiographic deformities, including increased lateral talocalcanal angle and navicular wedging, in comparison to contralateral normal feet, which did not correlate with function. The results of this long-term follow-up study demonstrate that there is some decrease in motion of clubfeet treated by the Ponseti technique compared with normal feet and a perfect anatomic correction based on radiographic evaluation is not obtained. However, these differences from a normal foot are minimal and the patients self-reported activities and function are similar to patients with normal feet.

Some critics have questioned whether this technique can be easily applied at institutions other than the inventor’s, several recent reports addressing this confirm that it can. Studies from centers in Maryland, New York, and Israel have recently been published documenting early success rates from 92% to 97%. Ippolito and coworkers, have recently reported their long-term results of the Ponseti technique, implemented in 1979, which have proven to be superior to the historical series of patients treated by posteromedial release at their institution.

Other recent reports on the technique have identified factors which help determine its success. Among these is the use of the foot abduction orthosis, which Ponseti has emphasized in all of his reports. Dobbs and coworkers found that non-compliance with the foot abduction orthosis and a parental education level of high school or less were significant risk factors for recurrence of the deformity. In a similar study, Thacker and coworkers, reported no recurrences among patients compliant with the foot abduction orthosis compared with 57% recurrence among noncompliant patients when studied at short-term follow-up.

Despite its longstanding practice at the University of Iowa and several select centers around the world, the Ponseti technique is only recently gaining widespread acceptance as the treatment of choice for infants with clubfeet. The technique has been clearly described and is easily reproducible. It is now even implemented in several third world countries where it is supported by their national health systems and administered by casting specialists and technicians. By learning the details of this technique and applying all of the elements without modification, one can expect optimal results in the short and long term for children with clubfeet.

References
