

Ponseti Method – Some Measured Steps to the Success in Idiopathic Congenital Clubfoot Management

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Abstract: All orthopedists who have faced with the problems of clubfoot, in the past and nowadays, share the same opinion that achieving a success is a difficult task, regardless the management is conducted conservatively or surgically. The fact determined to be essential is that the early start leads to better results. Modern studies have established the role of the so-called “embryonic myosin” which later is substituted with normal myosin while the child is growing. This protein has proven extremely susceptible to manipulation and very sensitive to surgical influence. Thus, gradually and gentle casting in a specific sequence manages to achieve the correction of ligaments, joint capsules and tendons; the rearranged tarsal and metatarsal bones are remodeled. At the same time, upon surgical accesses by different methods this protein is quickly converted to rough scar tissue, which deteriorates the functions of the operated foot even short term after surgery. The objective of this paper is to provide results of the treatment of idiopathic clubfoot by Ponseti Method which convincingly demonstrate that if conducted correctly, the method ensures success. **Patients:** This study included 165 children (228 feet) with clubfoot within the period from 2001 to 2016. The criteria for inclusion were idiopathic type of deformity for which no previous surgical methods of treatment have been conducted till this point. All of them were treated using the protocol described by Ponseti. **Results:** Strictly adhering to Ponseti protocol, 29 feet (13%) were treated only by casting, and the other 199 (87%) were treated by casting and subsequent Achilles tenotomy. The average number of castings - 8 ; Recurrences of equinus and adduction - 34 (15%) feet; a second relapse in 21 (9%) feet, ; unsuccessful results - 7 feet **Discussion:** The results obtained (97% successful correction within the follow-up period) correlate with those of other authors in the short-term. The reasons for recurrences occurred were analyzed as the preponderant role was the improper maintenance of the abduction device in the post-casting period. **Conclusions:** The high final result of 97% corrected feet makes the Ponseti method much more successful and preferred both by doctors who undertake to treat congenital clubfoot and by parents of children with such disease.

Keywords: clubfoot, curved foot, Ponseti Method, conservative management of clubfoot

1. Introduction

It is well known that clubfeet are prone to rapidly progressing deterioration after birth. Studies show that the cause for this is the fast exchange and synthesis of collagen in tendons and ligaments during the first weeks of life. This trend significantly reduces after the age of 5, i.e. then the collagen accretion in ligaments is already highly delayed (3, 8, 9, 11, 13, 15, 19, 23, 29, 30). Toydemir et al. (2006) (31), seeking changes in myosin fibers, concluded that defects in their arrangement are the common cause of congenital contracture syndromes in general. These authors suggested that congenital clubfoot is an isolated congenital contracture due to a defect of the embryonic myosin of flexor muscles of the foot and mostly in m. tibialis posterior. Ionasescu V. (1975) (18) and Ippolito (1980) (21, 22) detected increased density of fibrous tissue in the muscles, fasciae, ligaments and tendon sheaths mostly in the posterior and medial aspects of the clubfoot. Their analysis of an electronic microscopic preparation showed the presence of three cell types in fascia from the medial side of the curved foot: typical fibroblasts, cells resembling myofibroblasts and mast cells. Irani et al. (1972) (16) and Issac et al. (1977), (17) also observed myofibroblasts-like cells in the calcaneonavicular ligament of the curved foot and speculated that the clubfoot deformity results from the fibromatosis in the medial tarsal ligaments. Ponseti's opinion is the same, published in 1980 (26, 27). To sum it up, amid theories about the occurrence of the idiopathic clubfoot, data obtained on the properties of the

“embryonic myosin” prevail. On one hand, it is extremely susceptible to manipulation and, on the other hand, very sensitive to surgical management. This explains the observed trend of mainly conservative treatment, following certain rules. Ponseti Method is based on these data and after the proper conduct of individual phases leads to very high end results.

The objective of this study is to present mid-term results of the treatment of the idiopathic clubfoot by Ponseti technique.

The **tasks** are oriented to outline the significant principles that are fundamental for the method, but also to important details, the knowledge of which guarantees success. These are

- Knowing the rules of casting and the minimally invasive percutaneous techniques,
- Knowing the mistakes to be avoided.

Patients

The study included 165 children (a total of 228 feet) with congenital idiopathic clubfoot (Fig.1), treated and followed by Ponseti method from 2001 to 2016. Of them 63 (38%) had bilateral deformity

The material did not include:

- Children who have been operated earlier prior to inclusion.

- A total of 16 children – who have stopped treatment for unknown reasons,
- Nine children – with “atypical foot” and those with arthrogyriposis whose treatment is subjected to other rules

Characteristics of the group:

- 1) Age of inclusion – 1-2 weeks up to 3 years and 3 months (average age – 2 months and 7 days). 123 (75%) children were included at ≤ 6 months.
- 2) In 75 children (45%) - treatment started in the first 7-15 days
- 3) The average age of follow-up was 5,8 years.
- 4) Sex: M / F- 121 / 44 ;
- 5) First delivery 101 children (61%);
- 6) Family history in 29 children (18%);
- 7) Four(8%) –with pre-existing problems of the mother during pregnancy.
- 8) Nineteen (12%) –earlier treated unsuccessfully in other centers:
 - 3 children – conducted physiotherapy assigned by the general practitioner,
 - 2 children – treated by the “French method” (kinesitherapy),
 - 14 –series of cast immobilizations using other methods (average number of 8 casts until being included in this study)

Classification used: Columbian clubfoot score (CCS, Pirani score) (foot without deformity– 0 scores, most severe deformity – 6 scores):

Average data of the group:

- Prior to casting– average TPS(total score) - 5,0
- At the end of cast treatment and prior to Achilles tenotomy– an average TPS - 2,5.
- At the end of the orthotic management– an average TPS - 0, 5.
- Identifying recurrence in the chronic stage and subsequent restarting of treatment– TPS $\geq 1,5$

2. Ponseti method-Characteristics

Comparing other methods of plaster cast application to correct clubfoot with this of Ponseti method highlights the requirement to observe a mandatory sequence The deformity should be corrected slowly and the ligaments should never be stretched beyond their natural amount to give. The casting follows the correction of the following gradual objectives:

- 1) Supination (cavus) of the foot
- 2) Varus of the heel and the adductus of the feet
- 3) Equinus of the heel. (Figure 1)

The first cast application addresses:

- The five metatarsal bones to be positioned in a plane representing a supination of the anterior foot department,
- Moderate pressure on the first metatarsal bone (from plantar to dorsal aspect) in extension and its aligning with the second and the other plantar bones,
- Aligning the metatarsal bone with the hindfoot,
- The sole of the foot should be so molded as to maintain the height of a normal arch,

The second cast aims at starting plantar and lateral displacement of the entire forefoot and with this – the beginning of repositioning of the navicular bone – in front of the talus and the cuboid against the calcaneus. The surgeon applies a slight pressure with his thumb over the lateral part of the head of the talus for counter pressure; the index finger is positioned behind the lateral malleolus (Fig. 2 – A, B). Since then the so-called “magic move” of the Ponseti technique is applied – rotating the entire calcaneus beneath the talus, which continues with the application of the next few casts. The first corrections occurred are those of the cavus and the adduction of the foot.



Figure 1: Equinus, varus and adductus of the foot

The second cast maintains the foot in plantar flexion and continuing supination so that to be adapted to the initial inversion of the tarsus.

No counter pressure should be exerted over the calcaneocuboid joint. In none of the moments of correction the foot should not be pronated. The calcaneus continues to be free of pressure by the cast so that together with all the metatarsal bones the calcaneus to be rotated and abducted under the talus.

Third cast. Until then it was necessary to maintain the foot in supination. Now it can be brought to neutral position (pronosupination - 0°). Thus, the inversion of the tarsal and metatarsal bones maintained until the moment is corrected. The more noticeable rotation of the foot under the ostali begins.

At this stage clubfeet of medium severity, the cavus, adduction and the varus of the foot are corrected (Fig. 3). The orthopedist must not allow pronation of the forefoot. Overpressure over the talus should also be not allowed as well as over the navicular bone in attempt it to be moved quickly forward in line with the foot

The fourth and the next casts followed increase in the foot abduction to overcorrection (up to 55° – 60° - the so-called Charlie Chaplin’s feet position)

In the attempt of dorsal flexion in the ankle joint a limitation is felt usually up to 0° ; also a skin posterior crease on the back surface of the heel is observed (Fig. 4). In the rear aspect a prominent and tight Achilles tendon is palpated that

restricts dorsiflexion. The shape of the foot should be plantigrade, and the scoring according to CCS – TPS $\leq 2,5$, mostly at the expense of the posterior compartment(28).

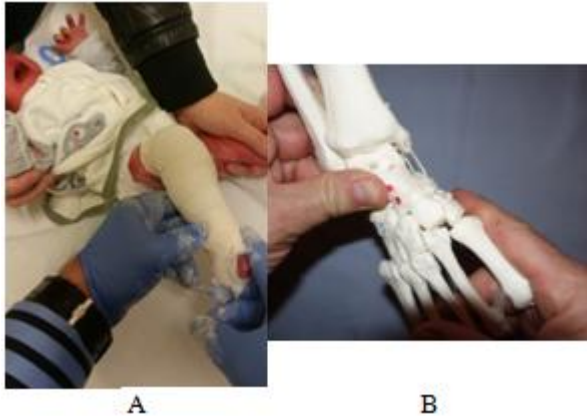


Figure 2: Maintaining the supination of the anterior plantar compartment with a slight initial pressure with the thumb over the lateral surface of the talus (A – live, B – model)



Figure 3: (B) Corrected inversion of tarsal and metatarsal bones. Skin excoriations are a common finding regardless of the caution paid in the casting technique.

It is logically, preoperatively to seek the degree of correction by taking radiographic images. But the author of Ponseti method himself (26), believed that at this stage X-ray imaging is not determinative for further treatment, due to the still unclear or missing image of the tarsal bones and their axes.

The subcutaneous tenotomy of the Achilles tendon can be performed in an operating environment through the appropriate venous line and a short-term inhalation anesthesia.



Figure 4: Restricted dorsal flexion and retrocalcanealcrease

The procedure itself consists of a single scalpel stab incision made parallel and medial to the course of the tendon with the scalpel tip – blade No 11 (Fig. 5), following the appropriate skin sterilizing procedure. A sudden jerk can be felt when the cut is complete and the equinus is corrected up to 10 to 15 ° of dorsal flexion. The pressure maintained over the dorsiflexion of the ankle is suddenly relieved and reaches dorsally to up to 15 °. The wound is only five mm and no other processing is required except covering with a sterile gauze and cotton padding over which winding of plaster casting begins. The latter is molded with a moderate pressure over the posterior surface of the heel (Figure 6). It stays for 20 days and maintains the foot in approximately 60 degrees of abduction and in the maximum possible abduction of the ankle.



Figure 5: Stabbing of skin – medially and parallel to the Achilles tendon

Long-term treatment with foot abduction orthosis

The device is placed immediately after the removal of the last 20-day cast. Many of the cases with unsatisfactory end result after the Ponseti treatment or the occurrence of early relapses are a result of the improper use or failure to use full time the orthosis (4, 16, 21, 25, 26)



Figure 6: Moderate pressure over the heel in distal direction with index finger to strengthen the heel's equinus

The main function of the splint in the Ponseti Methods is to maintain the hyperabduction of the foot for a various period of time (minimum until the age of 2yearsmaximum until the age of 4years.).

The foot abduction orthosis (Figure7)is worn 23 hours per day during the first 8-10 months, i.e. until the child starts walking. Then while sleeping within the above said time frame.



Figure 7 (A): Splint of Denis Broune for long-term maintenance of the abduction (device)



Figure 7 (B): Device on the feet

The official statistics following the Ponseti method reports a tendency of relapsing averagely in 20% of the feet. This usually happens between the ages of 2-4y.o. It is manifested with restriction of the ankle dorsal flexion and increasing of the varus of the heel and the anterior foot compartment. At this point "Late Ponseti" must be started – first 2 long-leg plaster casts should be applied according to the above mentioned rules to correct the occurred curvatures and orthotic treatment should be started for one more year. If no correction is achieved or mandatory in the beginning of a new relapse, after 2 ½ years surgical management is performed – transfer ofm. tibialis ant. tendon to the lateral cuneiform bone. This surgical technique is detailed in other studies of the authors.

3. Results

Strictly adhering to Ponseti protocol, 29 feet (13%) were treated only by casting, and the other 199 (87%) were treated by casting and subsequent Achilles tenotomy.

The average number of castings was 8, as a correction with ≤ 7 castings was achieved in 148 (65%) children.

In the period up to the 24th month there were documented 34 (15%) feet recurrences of equinus and adduction which were corrected with the so-called "Late Ponseti".

A second relapse was observed in 21 (9%) feet during the period up to the 24-36th months, which were managed with transposition of the tendon of tibialis anterior.

In 7 feet treatment is considered to be unsuccessful – the required early surgical management (1 surgery of medial to posterior soft-tissue release and 6 with posterior release and

Achilles tenotomy), determined unsatisfactory early and late-term results.

Here bellow are presented two cases, after fulfilling Ponseti treatment:

Case 1



Figure 8 (A):Plantigrade foot of a child at the age of 2y.o. after orthotic management



Figure 8 (B):The sam child At the age of 7

Case 2



Figure 9 (A):Plantigrade feet (at the age of 2y.o.) with dorsal flexion more than 10°



Figure 9 (B): Relapse of equinus and varus of the heel



Figure 9 (C):Plantigrade foot at the age of 8y.o., following Late Ponseti, Achilles tenotomy and 1 year of wearing foot orthosis at night. The relapse developed at the age of 4.

4. Discussion

In 1990 Adams et al. (1) compared different types of management of congenital clubfoot. They found that feet treated conservatively by plaster castings with or without lengthening of the Achilles tendon result in less deformities and disability. They also found that posteromedial release improves the talocalcaneal index, but reduces both the range of motion of the ankle and the plantar flexion strength compared with the groups treated conservatively.

A recent long-term follow-up studies of Dobbs et al (2006) (6, 7) reporting on 46 patients with 73 idiopathic club feet, treated surgically approximately 30 years ago showed a severe restriction of the function. Patients experienced pain, osteoarthritis of tarsal bones, weakness, stiffness and difficulty walking. Also, the authors analyzed these results using the index of physical health (PCS), measuring the feeling of the patients for health or illness. It turned out that the reported aggregated result in surgically treated patients for congenital clubfoot present data of physical and life discomfort commensurable with patients suffering of renal failure, congestive heart failure or cervical back pain and radiculopathy.

A team of other doctors, Herzenberg et al (14) described a group of 27 children (34 feet), initially treated by series of short leg (below knee) casts for 3 months (2-3 months) and then referred to extensive posteromedial soft-tissue release. These children were not treated by this method and are taken for management under the Ponseti Protocol. As a result only 1 child (3%) of these children required extensive soft-tissue surgery, while others were treated conservatively.

This study presents a group of 165 children with a total of 228 idiopathic club feet treated by Ponseti Method. The results achieved are very similar to those of the leading authors - Ponseti (1996), Dobbs (2006), Morcuende, Dietz (2004) Herzenberg (2002) and many others. It is difficult a generalized comparison with the above said authors to be made due to the much larger comprehensiveness of their research – both in the number of the patients treated and the long-term follow-up (2, 4, 5, 10, 12, 22, 24, 28) .

5. Conclusion

The results of this study support the worldwide success in the treatment of clubfoot by Ponseti Method and make them more understandable, easier and applicable for the small size of our country. Orthopedists who know the clinic and pathology of clubfoot and use the Ponseti Method will be rewarded with the pleasure of success in the treatment of a problem in child health which until recently has been considered insolvable.

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