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Treatment of congenital clubfoot with the Ponseti method

Doğuştan çarpık ayağın Ponseti yöntemi ile tedavisi

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Amaç: Yazarın erken dönem deneyimlerini yansıtan bu çalışmada, Ponseti yönteminin doğuştan çarpık ayak deformitesini düzeltmedeki etkinliği ve hasta bir yaşına gelene kadar agresif cerrahi gerekip gerekmediği araştırıldı.

Çalışma planı: Çalışmada doğuştan çarpık ayaklı 31 hastanın (25 erkek, 6 kız; ort. yaş 3 ay; dağılım 4 gün-8 ay) 44 ayağı değerlendirildi. Sadece grade II, III ve IV deformiteler çalışmaya alındı. On dokuz hastanın 27 ayağı daha önce hiç tedavi görmemişti; 12 hastanın 17 ayağında başka yerlerde konservatif tedavi denenmişti. Hastaların tümüne Ponseti yöntemine uygun olarak elle düzeltme ve alçı uygulandı; gerektiğinde perkütan Aşil tenotomisi yapıldı. Düzelmenin sürmesi ve korunması için ayak abduksiyon cihazı uygulandı. Ortalama takip süresi 18 ay (dağılım 6.5-40 ay) idi.

Sonuçlar: Yirmi dokuz hastanın 42 ayağı (%95) Ponseti yöntemiyle başarıyla tedavi edildi. Daha önce tedavi görmemiş hastalarla, önceden tedavi denenip, 'dirençli' olarak nitelenen deformiteye sahip hastalar arasında ayak abduksiyon cihazına uyum açısından anlamlı bir fark saptandı. Dirençli olarak nitelenen hasta grubunda cihaza uyum daha iyi bulundu.

Çıkarımlar: Ponseti yöntemi, yönteme titizlikle uyulması koşulu ile, başlangıç derecesi ne olursa olsun idiyopatik doğuştan çarpık ayak deformitesini düzeltmede oldukça etkili bulundu. Sonuçlar, nüksün önlenmesinde kaçınılmaz olan ayak abduksiyon cihazına uyumu artırmak için aileyi eğitmenin ve ayakkabıyı yapan ortotistin deneyiminin önemini de gösterdi.

Anahtar sözcükler: Ayak bileği eklemi/fizyopatoloji; kalkaneus; çarpık ayak/patoloji/tedavi/cerrahi; bebek, yenidoğan; ortotik cihazlar; manipülasyon, ortopedik/yöntem; hareket açıklığı, artiküler/fizyoloji; ayakkabı.

Objectives: This study aimed to present the author's early experience with the Ponseti technique in correcting clubfoot and to evaluate the need for aggressive surgery in the first year of life.

Methods: The study included 44 feet of 31 patients (25 boys, 6 girls; mean age 3 months; range 4 days to 8 months) with idiopathic clubfoot deformities of grade II, III, or IV. Twenty-seven feet (19 patients) had not received any treatment before. Twelve patients (17 feet) had had unsuccessful prior conservative treatment elsewhere. All patients had manipulation casting in accordance with the Ponseti technique, and percutaneous Achilles tenotomy was performed in the presence of persistent equinus. Maintenance of correction was obtained with the use of a foot abduction brace. The mean follow-up period was 18 months (range 6.5 to 40 months).

Results: Forty-two feet (95%, 29 patients) were treated successfully using the Ponseti method. In terms of compliance with the foot abduction brace, a significant difference was noted between patients without previous treatment and those with deformities considered resistant to prior conservative treatment. The latter manifested more compliance with brace application.

Conclusion: Ponseti method proved efficient in correcting idiopathic congenital clubfoot deformities irrespective of initial deformity grades, provided that the details of the technique are strictly adhered to. The results also suggest the role of brace application in order to avoid relapses along with the importance of increasing patients' compliance through family education and experienced orthotists.

Key words: Ankle joint/physiopathology; calcaneus; clubfoot/pathology/therapy/surgery; infant, newborn; orthotic devices; manipulation, orthopedic/methods; range of motion, articular/physiology; shoes.

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Importance of conservative treatment in treatment of congenital clubfoot (Congenital Clubfoot) has been known since the Hippocrates era (approximately 400 B.C).[1] Continuous passive movement treatment method of French authors has also been added to manipulation, bandage, cast and device applications.[2] Besides the diversity of the methods there are significant differences between reported success rates.[3,4] Especially in the studies, where the manipulations unsuitable for foot kinematics and pathological anatomy of the deformity were applied, sucess rates were 10 to 20%.[3,5] Because these success rates were consistent with the success rates in daily practice of many orthopedists, it had been supposed that only mild deformities responded to conservative treatment methods and the surgical methods surpassed other methods. Suggested extensive surgical release methods allowed the surgeons to correct the impaired relation between the foot bones at once and visibly on radiographic images.[3,6,9] It had been believed that this perfect anatomical and radiographic correction would also provide good functional outcomes in the long term, and this assumption made the surgical methods widespread. However, in time, 20-30% relapse rates were reported from early studies [10-12] and radical surgical methods resulted in overcorrection problems as well.[8,13] There is not a clear opinion in the literature on how to treat overcorrection. In the long-term follow-up studies, weakness in muscle groups around the ankle, joint stiffness, and consequently biomechanical problems in lower extremities of the children with Congenital Clubfoot who underwent extensive surgical releases were found. [14-16]

Laaveg and Ponseti, [17] obtained a 89% success rate by using the conservative treatment method and minimal invasive surgery (Achilles tenotomy) if required. Because the Ponseti method pays attention to the kinematics and pathological anatomy of clubfoot and it has the best functional outcomes with the longest follow-up,[18] this method has drawn attention throughout the world.

The author has been using Ponseti method prospectively since 1999 because of failures of conventional conservative treatment methods and the problems resulting from surgical methods in the medium term. In this study, early outcomes were evaluated. In assessment of efficacy of Ponseti method, its effectiveness in prevention from major surgery was used as a criterion. Furthermore, this study aimed to share the early period experiences and emphasize the considerations in learning period for new users.

Patients and the method

44 feet of 31 patients with Congenital Clubfoot (25 boys, 6 girls; mean age 3 months; range 4 days to 8 months), who are over 1 year old at follow-up and have been treated with Ponseti method since 1999, were included in the study.

Cases with deformities associated with arthrogryposis, myelomeningocele and other etiologies were excluded from the study. Mean age of the patients was 22 months (12 to 43 months) at final examination. Thirteen patients had bilateral deformities and 18 patients had unilateral deformities. Twenty-seven feet of nineteen patients had not received any treatment previously. Surgical operation had been recommended for 17 feet of twelve patients because they had received treatment with cast elsewhere, and their feet was considered as "resistant" to conservative treatment. The treatment commenced within the first three weeks of newborn period for untreated group, and within the first 5 months of life (range 2 to 8 months) for the patients in "resistant" group. Mean follow-up was 18 months (6.5 to 40 months).

At first examination,evaluation besides systemic examinations the patients were classified in accordance with the classification system of Dimeglio et al [19] for Congenital Clubfoot. Ten feet of untreated feet (37%) were grade II, and 14 feet (52%) were grade III, and three feet (11%) had grade IV deformity. Grade I feet (mild deformities) were excluded from the study. The parents of the patients with unilateral deformity were informed about possible foot length differences and atrophy in leg muscles. To correct the clubfoot, the cavus is corrected first by supinating the forefoot and dorsiflexing the first metatarsal. It was then observed that forefoot and hindfoot were aligned due to the correction of cavus. Pronation of the foot was avoided carefully. [20] To correct the varus and adduction, the foot in supination is abducted while counterpressure is applied with the thumb against the head of the talus. During

the following plaster casts it was observed that the head of the talus was reduced and covered by navicularis gradually; and abduction of the foot decreased supination. However, the foot was never pronated. When the foot is abducted completely it has been observed that the foot became plantigrade and the calcaneus became everted simultaneously and consequently varus of the calcaneus was corrected.

During manipulations, touching the calcaneocuboidal joint or the heel was avoided so that the calcaneus can correct freely.[20]

Following a 2 or 3 minute gentle manipulation plaster cast was applied. Nearly in all cases semi-rigid synthetic plaster cast (Soft Cast, 3M) was applied above the knee. The parents were informed to check circulation and instructed to remove the plaster cast in case of any doubt. Plaster casts were replaced within five or seven days, immediately after removal of the previous cast. Average seven plaster casts were used (3 to 11 casts).

Following correction of foot adduction and varus of the heel, to correct the equinus the ankle was dorsiflexed. In patients with persistent equinus Achilles tenotomy was performed under general anesthesia. Postoperatively, a plaster cast was applied for three weeks. After removal of the final plaster cast, to avoid relapses special shoes was mounted in such a way that they fix the foot in abduction of 70 degrees and in dorsiflexion of 15-20 degrees against a Denis-Browne brace. The specially produced shoes with open toe cap, flat sole, interior strap, and plastizote part above the calcaneus preventing from unintentional removal, were used. The brace was used full-day for three months and then it was used during sleep for 2 or 3 years. During daytime normal high-top shoes were used.

Results

At the end of average 18 months follow-up period, 42 Congenital Clubfoot deformities (95%) in 29 patients were corrected successfully by using Ponseti method (Figures 1 to 3). In 22 (50%) of 44 deformities, a percutaneous Achilles tenotomy was performed. Only in four feet, open posterior release surgery was performed.

In these four feet, no better range of motion could be obtained after surgery and during follow-up period. Dorsiflexion in both feet of a patient remained limited within 10 degrees.

Though an improvement in the deformities of all feet was observed initially, 12 patients (39%) were not able to use the foot abduction orthosis, and the deformities in 17 feet (39%) relapsed. Eight mild cases of these relapses were recovered by using the orthosis again. In seven deformities recovery was obtained by using plaster cast again. Extensive release surgery was performed for both feet of two patients (5%). Though skin lesions resulting from the first plaster cast improved without complications, these lesions resulted in a pause in the treatment. Although correction of deformities was obtained by plaster cast and Achilles tenotomy later, both patients could not use the foot abduction orthosis and the relapses occurred. Because re-cast treatment was refused by the parents, extensive release surgery was performed at 10th and 12th months of age.

Figure 1. A newborn with bilateral congenital clubfoot defined as grade 3 according to Dimeglio classification.

Table 1. Compliance rates of previously treated (resistant) patients and untreated patients to the foot abduction orthosis.

	Compliance to the foot abduction orthosis					
	Compliant	%	Non-compliant	%	Total	%
Number of untreated patients	9	47.4	10	52.6	19	100
Number of treated (resistant) patients	10	83.3	2	16.7	12	100
Total	19	61.3	12	38.7	31	100

In terms of compliance to the foot abduction orthosis, a statistically significant difference between untreated patients and "resistant" patients was found (Table 1) (Fisher exact chi square analysis (one way; p=0.05).

In seven feet of five patients dynamic forefoot adduction was observed. In these patients any problems relating to the form, flexibility or shoe usage was not observed.

In other patients both calcaneal and subtalar movement were unrestricted whereas in seven feet of four patients dorsiflexion was found below 20 degrees.

Discussion

In this study reporting early results of the Ponseti treatment, 95% of the deformities were corrected without need for extensive surgery. This recovery rate is consistent with the results, reported by Herzenberg et al [21], whose study included similar population and follow-up. Furthermore, in our study, the patients who were deemed as non-responder and had surgical indication elsewhere were also treated by Ponseti method.

Though it was not a new treatment method, Ponseti method had not been adopted by many and surgical treatment methods had been used as standard treatment until recent years. Initially, extensive surgical methods aimed physical improvement[3,6,8], but owing to long term follow-up studies the importance of functional outcomes and maintenance of movement were recognized.[22,23] Muscular weakness and biomechanical changes[14,16], observed in patients who were considered as corrected initially, increased the popularity of conservative treatment methods again.

Figure 2. In the same case, improvement in the deformity at month 16 and flexibility of feet and ankles.

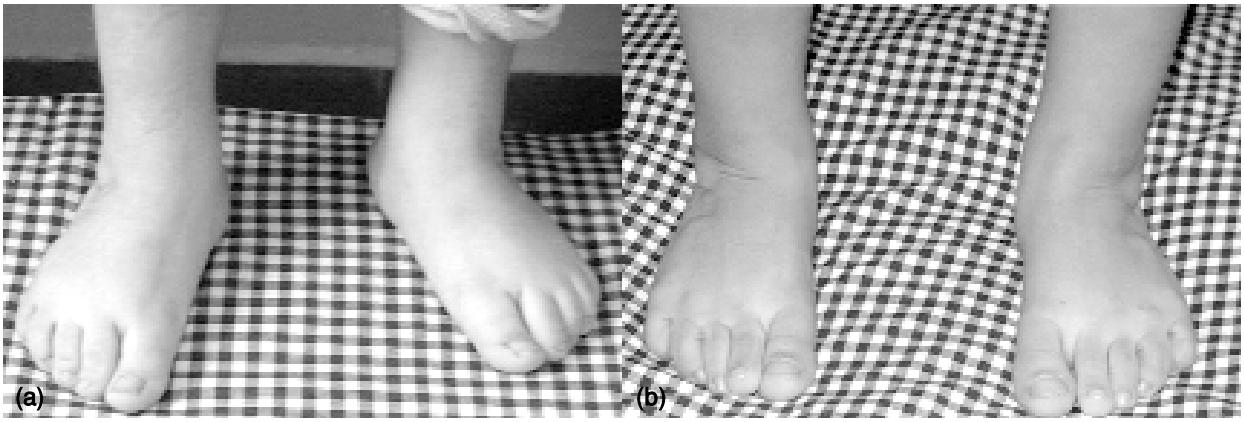

Figure 3. **(a)** Appearance of a patient, who had bilateral grade 3 deformity at initial examination, at age 2. **(b)** Appearance of another patient at age 3.5, who had bilateral grade 4 deformity at initial examination.

Cooper and Dietz,[18] found functionally and clinically perfect and good outcomes in 78% of deformities in patients, who were treated by Ponseti, in their average 30 years, follow-up study. This success rate was 85% in control group, consisting of the patients without congenital foot deformity. The authors reported that having a sedentary occupation and avoiding excessive weight gain may contribute to obtaining positive functional outcomes.

Because even severe deformities were treated by Ponseti method in our study, we believe that initial grade of the deformity has no prognostic importance and the expression "the Congenital Clubfoot resistant to conservative treatment" does not seem to be appropriate.

In their magnetic resonance imaging study, Pirani et al.[24] detected improvement in both the relation of tarsal bones and the forms of osteochondral outlines of the bones in patients, treated by Ponseti method. These findings supports the Ponseti's hypothesis, which asserts that with a proper treatment method that considers the functional anatomy of foot and uses biological potential in the tissues of a newborn, an appropriate improvement can be obtained in most of the deformities.[24]

Our open surgery experiences may make us think that Achilles tenotomy may not be adequate for correction of the equinus or may weaken Achilles tendon. However, in the age group in presented study, an improvement was obtained by Achilles tenotomy as well as a complete regeneration was observed in Achilles tendon of two patients who underwent extensive surgical operation. In no toddler a decrease in power of Achilles tendon was observed. Dorsiflexion was restricted in both feet of the patient who underwent open posterior release surgery, demonstrates that range of motion that obtained by surgery may deteriorate due to scar formation and contracture. Therefore, Achilles tenotomy performed early is a simple, effective and safe surgical method.[18]

Significantly high rate of compliance problem in using the foot abduction brace in untreated patients was attributed to two factors by the author: Firstly, the parents do not take the risk of relapse seriously due to rapid correction of the deformities. Therefore risk of relapse, in case of disuse of the device in subsequent phases, should be emphasized frequently. The second factor includes the age and foot size differences between untreated patients group and previously unsuccessfully treated patients group. To produce a comfortable shoe, suitable for a small foot, is more difficult than producing a larger shoe and requires experienced orthotists. Better compliance in patients who was treated by considering such factors but not included into the study due to their age below 1 year, supports the author's opinion.

Many spontaneous improvements associated with growing up in most of the patients with dynamic (flexible) forefoot adduction were reported.[25,26] However in cases where the flexible deformity does not improve spontaneously and results in relapse, transfer of anterior tibialis tendon is recommended.[25,27] Ponseti,[27] who performed this surgical technique in 35% of his patients in early period, report-

ed that only 10% of later patients needed this surgical operation due to increased rate of orthosis compliance. Considering the cases are reflection of the early period's experiences and suboptimal orthosis compliance, it may be suggested that some patients may need transfer of anterior of tibialis tendon in the future.

Different conservative treatment methods have been suggested in the literature. One of the popular methods in Europe is the method of Dimeglio et al. [2] consisting of daily physiotherapy and continuous passive motion machine. With this method, only 28% of the cases required surgical treatment.[2] However, difficulties in long term physiotherapy, and its high cost makes adoption of this method problematic in many countries, including our country.

In many countries, especially in the USA, Kite's method has been used widely for a long time.[4] Kite, who tried to correct the components of the deformity separately and patiently, obtained improvement within 36 weeks. Ponseti attributes such a delay in improvement to the effort for correction of forefoot by counter pressure from calcaneocuboidal joint, which was Kite's error according to Ponseti. Because kinematics of the foot does not allow eversion of calcaneus before abduction (outward rotation) of it, correction of varus became time consuming for Kite.[18]

There are also different reports on conservative treatment of Congenital Clubfoot in our country. Altav,[28] emphasized the importance of gentle and patient manipulation. In the study of Atilla[29] it was seen that the foot was forced to pronation in early plaster casts. In both studies success rates were not shown. In a careful study, by Tümer et al.[30] where Kite's and Ponseti's manipulation methods were used concomitantly, it was reported that 33% of the cases were treated by only using plaster cast. This success rate reached at 41% with addition of the patients who underwent posterior release surgery. Bursalı[31] reported that they obtained correction in all of the untreated cases and in 75% of the cases, treated previously elsewhere, by using Ponseti's method strictly.

Cost of aggressive surgical methods is approximately 5 times higher than the cost of tenotomy. Considering the complications of extensive surgery and necessity of subsequent operations, the difference between the costs will become more evident.

Consequently, Ponseti's method is an effective and reproducible method for correction of idiopathic Congenital Clubfoot deformities. Furthermore, it may be used in our country widely due to its low cost. For successful outcomes, this technique should be applied carefully and the patients should use the foot abduction orthosis with full compliance. For patient compliance, besides parent training, producing proper and comfortable shoes is required.

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