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Henri Bensahel · Ken N. Kuo · Wallace Lehman

ORAL PRESENTATION

1

Are talipes equinovarus and congenital fibular dysplasia different manifestations of aberrant vasculogenesis?

David R. Hootnick, Matthew B. Dobbs,
Russell J. Crider

USA

Objective Purpose Recorded anomalies of the anterior tibial artery (ATA) are found in approximately 5–7% in otherwise normal adult limbs, in 89% of preoperative clubfeet (TEV) ($n = 63/71$), and in 100% of limbs with congenital fibular dysplasia (CFD) ($n = 3$). TEV and CFD occur independently with a frequency of approximately 1/1,000 births. The expected association of these two independent deformities should be 0.001/1,000. The incidence of TEV in limbs with CFD appears at a rate of about 150/1,000. This paper is an attempt to reconcile the disparity between the expected and actual frequencies of limbs with CFD and TEV and explicate their mutually associated arterial anomalies.

Methods We reviewed the results of arteriography of our index patient with CFD and TEV and compared the findings of that study (JBJS 1980) with a report of five limbs with CFD and TEV studies via MR arteriography (MRA).

Findings Our index patient exhibited not only absence of the ATA but also preservation of four persistent primitive arteries: the embryonic interosscus (axis), tibial posterior superficialis, peronea posterior superficialis and ramus communicans inferior arteries. The MRA study of five limbs with CFD and TEV reported absence of the ATA in two of the five limbs with no radiographic images.

Conclusions Arteriography is second only to dissection in obtaining a correct interpretation of aberrant, primitive arteries, which require a precise anatomic identification not currently available with MRA in CFD. TEV is part of a spectrum of congenitally dysplastic lower limbs with persistent aberrant vasculogenesis. Any insult to the six-week embryonic limb bud during rapid vasculogenesis and osteogenesis provides a commonality among the development of

TEV, CFD, and the aforementioned arteries. Therefore, these morphologically disparate clinical entities may all be different manifestations of the same processes.

Level of Evidence Retrospective level III study.

2

Polygenic threshold model with gender dimorphism in clubfoot inheritance: the carter effect

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USA

Purpose Idiopathic clubfoot is approximately twice as common in males as in females. The reason for this gender discrepancy is unclear but may represent an inherent difference in the susceptibility to the deformity. If this difference is due to genetic factors, it is predicted that females with clubfoot would need to inherit a greater number of susceptibility genes than males. Females would also be more likely to transmit the disease to their children and have siblings with clubfoot. This phenomenon is known as the Carter effect, and the presence of such an effect supports a multifactorial threshold model of inheritance.

Methods Ninety-seven multiplex families with greater than one individual with idiopathic clubfoot were studied. This included 1,093 individuals: 291 with clubfoot, and 802 unaffected relatives. Transmission rates were calculated from the 37 affected fathers and 26 affected mothers, and incidence among siblings was determined in the nuclear families of affected persons.

Results Within these multiplex families, the incidence of clubfoot was lowest in daughters of affected males (8/24), and highest in sons of affected mothers (11/13). Affected mothers transmitted clubfoot to 59% (19/32) of all children compared to affected fathers who transmitted idiopathic clubfoot to 37% (26/70) of all children ($p = 0.04$). Siblings of affected females also had a significantly higher incidence of clubfoot compared to siblings of an affected male: 46% (54/117) versus 34% (67/197) ($p = 0.03$).

Conclusions This study demonstrates the presence of the Carter effect in idiopathic clubfoot. This can be explained by a polygenic inheritance of clubfoot with a greater genetic load required for females to be affected.

3

A prospective epidemiological study of congenital talipes equinovarus

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Nigeria

Introduction Several studies have documented the epidemiological features of congenital clubfoot. In most of these studies, it is difficult to determine whether the talipes equinovarus was primary or secondary to some other conditions. Besides, the number of patients might be too small to make valid conclusion.

Aim: The aim of this study is to present the distribution of various parameters associated with Congenital Talipes Equinovarus (CTEV).

Methodology In the Clubfoot Clinic of the National Orthopaedic Hospital, Igbobi, Lagos all congenital extremity musculoskeletal malformations are being seen on a weekly basis since 1979. A proforma was designed to record relevant history and the physical findings at presentation.

Results 2,895 cases of congenital extremity malformations were seen between April 1979 and March 2004; 2,415 (83%) of which were CTEV. There were 1,516 males and 899 females giving a M:F ratio of 1.7:1.0. The deformity affected the right side in 730 cases, the left side in 595 cases while it is bilateral in 1,086 (45%) cases. The mean maternal and paternal ages were 28.3 and 37.2 year respectively. Family history, observed in 155 (6.5%) cases, suggests a polygenic mode of inheritance. Associated peripheral deformities were present in 3.5% of cases, the commonest being overriding of the digits and constriction band.

Conclusion This study shows that CTEV is the commonest congenital musculoskeletal malformation in Nigeria. It confirms the often reported male sex and right side preponderance in CTEV.

4

Motor problems in children treated for idiopathic clubfoot. A pilot study

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Sweden

Purpose To study the prevalence of motor problems in children previously treated for idiopathic clubfoot.

Methods Twenty children (mean age 7.5 years, SD 3.2 months) from a consecutively born cohort were assessed with both the Movement Assessment Battery for Children (MABC) and the Clubfoot Assessment Protocol (CAP).

Results There was an increased prevalence of motor problems both regarding the total score for MABC ($p < 0.05$) and for the subtest ABC-Ball skills ($p < 0.05$). No relation was found between the child's orthopedic foot status and motor ability. The CAP item "one-leg stand" was the only single variable that correlated significantly with the MABC ($rs = -0.53$, $p = 0.02$). The extent of surgery was not related to MABC outcome.

Conclusion Children with idiopathic clubfoot appear to have an increased risk for motor impairments, that is not related to their foot status. We suggest that children with clubfoot and obvious problems with balance should be offered a thorough neurodevelopment assessment in addition to their orthopedic follow-up.

5

Review of ischemic necrosis following clubfoot surgery with case of retained primitive arterial rete

David R. Hootnick, Matthew B. Dobbs, Russell J. Crider

USA

Objective/Purpose Ischemic necrosis following clubfoot surgery is a rare but catastrophic complication. Deficiencies of the anterior tibial (ATA) and dorsalis pedis arteries (DPA) appear to predispose some postoperative clubfeet to the risk of such necrosis. Impaired oxygen delivery was termed "The Purple Hallux Sign" in our review of fourteen limbs in thirteen affected patients. Arteriography of a limb with a clubfoot deformity with postoperative necrosis, obtained prior to amputation, revealed a previously unknown arterial variation in another patient (#15). This case had led us to attempt to provide an estimate of the incidence of ischemic necrosis after clubfoot surgery and its relationship to aberrant vasculature.

Method Arteriographic evaluation of the affected thrice-operated limb of patient #15 was reviewed. Our previous cases had undergone surgery over a 30-year period out of an estimated cohort of 2,000 operative clubfoot cases per year in the USA.

Results Arteriography of the affected limb in patient #15 revealed preservation of the primitive arterial rete.

Conclusions: Deficiency of the DPA in clubfeet that required surgery (54%), compared with those that did not (20%), suggests to us that an ATA/DPA deficiency may be more prevalent among clubfeet with more severe deformity. Further, this case finding suggests that limbs with more severe arterial dysplasia may be stiffer and more likely to fail conservative measures. The 'atypical' TEV may manifest a higher incidence and severity of both arterial and bony dysplasia. Postoperative ischemic necrosis in clubfoot appears to occur infrequently (less than 1/1,000). The risk of litigation after an event of ischemic necrosis is high. The risk of ischemic necrosis should not deter necessary surgical intervention after failure of more conservative measures.

Level of Evidence Retrospective level III study.

6

Do talipes equinovarus (TEV) and congenital vertical talus (CVT) have a common etiology?

Russell J. Crider, David R. Hootnick, Matthew M. Dobbs, Leonard Seimon

USA

A comparison of the radiographic deformities seen in idiopathic clubfoot (TEV), congenital vertical talus (CVT) and the rocker bottom deformity (RBD) after over-vigorous non-operative treatment of TEV reveals several common radiological features.

Osmonde-Clarke (1956) first suggested that CVT might be a variation of TEV in which forced forefoot dorsiflexion occurs in the face of severe equinus of the calcaneus.

Wicart (2007) reviewed 36 feet in children with clubfeet who developed rocker bottom deformities after vigorous closed treatment. These feet were found to have an average Calcaneo-tibial angle of 95 degrees prior to treatment, improving to only 87 degrees with non-operative treatment. The apex of the rocker bottom deformity was

universally in the midtarsal joints (i.e. the talo-navicular and the calcaneo-cuboid joints—the same site as in CVT).

Ritsila (1969) produced both TEV and CVT in newborn rabbits, by producing a severe equinus deformity by tethering the Achilles tendon posteriorly to the tibia, or by placing the feet in casts in severe equinus. He produced TEV in these feet by transecting the peroneal and the extensor digitorum tendons. CVT was created with the same calcaneal equinus contracture plus the resection of the transverse crural ligament and/or the resection of the extensor digitorum longus and anterior tibial tendons. Thus, the equinus deformity of the calcaneus was identical in both TEV and CVT. The only factors that lead to the creation of CVT instead of TEV were the forces applied to the foot distal to the mid-tarsal joints.

The consistency of the presence of calcaneal equinus in these three deformities can be seen in the calcaneal-tibial angles in the following series.

TEV (Authors)—15 feet—ave. C-T angle—110 degrees

RBD (Wicart)—23 feet—ave. C-T angle—118 degrees

CVT (Authors)—16 feet—ave. C-T angle—92.8degrees

Bohm (1929) noted that the talus was parallel to the tibia in the normally developing fetus at about 8 weeks of gestation. Thus the foot in the normal fetus begins its development in a severe equinus position.

In view of the well known arterial dysplasias seen in TEV (absence of the Anterior Tibial Artery) (Hootnick) and as well as in CVT (usually absence of the Posterior Tibial Artery) (Sodre), arterial aberrations occurring in utero at 6 to 8 weeks of gestation are likely related to the prenatal tethering of the calcaneus in equinus and the possible induction of other muscle imbalances in the forefoot and ankle.

In conclusion CVT in humans is most likely caused by an extreme equinus contracture of the calcaneus in utero (as is TEV), but with other forces acting to dorsiflex the forefoot causing a disruption at the midfoot. These forces could be muscular in origin, or possibly due to other mechanical intrauterine forces. The similarities of CVT and the rocker bottom deformity seen in overly vigorous correction of TEV seem to be due to similar forces and likely have similar mechanical causes.

7

Ultrasound assessment of clubfoot in infants

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Canada

Purpose Clubfoot is a relatively common musculoskeletal disorder. It is characterised by equinus and varus of the hindfoot, adduction of the forefoot, supinatus plus or less cavus. The purpose of this study was to establish the usefulness of US in clinical practice. To determine the value of the different US items analysed and to compare the talo-calcaneal angle measured by US and plain films.

Material and Methods Using a linear high frequency transducer, the US was performed along medial, dorsal, posterior and lateral borders of the foot. The talo-navicular relationship was established and quantified from medial and dorsal approaches. Measurement of the distance between the navicular and the medial malleolus was evaluated. The talo-calcaneal divergence was assessed in order to correlate with angle obtained on plain films. The tibio-talo-calcaneal axis in dorsiflexion of the foot was evaluated by a posterior approach. The relationship between the cuboid and the calcaneus was established and quantified with examination of the lateral border of the foot.

Results 110 patients with idiopathic clubfoot were assessed by US (73% male; mean age at first exam 11.5 weeks; 66% bilateral involvement). Patients with neuro-muscular disorders or other syndromes were excluded. Morphological changes of the talo-navicular joint, the distance between the medial malleolus and the navicular, and the talo-calcaneal relationship are good indicators of the clinical severity. There is good agreement between US and plain films measurement of the talo-calcaneal angle.

Conclusion US is an effective technique to assess and quantify the deformity in clubfoot.

8

Podogram and foot bimalleolar angle in the evaluation of club foot

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India

The objectivity of Podogram in clubfoot is lacking. We calculated foot bimalleolar (FBM) angle on podogram in normal infants and correlated with CTEV. Foot tracings with level of both the malleoli of 182 feet (91 normal infants) were recorded. The anteromedial angle between the long axis of foot and the bimalleolar plane is the FBM angle. The FBM angle in normal infant was 82.50. Eighty-four CTEV (51 patients) were clinically classified as grade I ($n = 5$; FBM angle; 73.20). Grade II ($n = 21$ feet; FBM angle, 66.60), and grade III ($n = 58$; FBM angle, 54.70). 31 feet (22 patients) prospectively followed after conservative ($n = 17$; grade I, three feet; grade II, three; grade III, $n = 11$) and surgical release all grade III, 14 feet). All feet with grade I and grade II and 44% (11 feet) with grade III deformity were amenable to gentle graduated manipulations and cast application, whereas 56% (14 feet) with grade III deformity underwent soft tissue release. After nonsurgical treatment, the mean FBM angle was 82.30. Of surgically treated feet those with excellent (11 feet) and good correction (3 feet) had a mean FBM angle of 79.90 and 74.30, respectively. The clinical severity of foot deformity and treatment outcome correlated well with the FBM angle. Foot tracing with the FBM angle is a simple, objective, and reproducible clinical criterion to classify the severity of foot deformity and evaluate the outcome. It is correlation with Pirani score in underway.

9

Correlation of radiographs to pedobarographs in nonoperatively treated idiopathic clubfoot

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USA

Purpose To determine if radiographic measures correlate with pedobarograph pressure in the assessment of non-operatively treated clubfoot.

Methods 156 idiopathic clubfeet treated by the French physical therapy program ($n = 72$) or Ponseti casting ($n = 84$) without surgery were included. Standing lateral foot radiographs were obtained at 18 months of age. Gait analysis, including pedobarograph pressure mapping, was performed at 2 years of age.

The tibio-calcaneal angle was measured (normal = 70–90 degrees). Higher values represented equinus. The talo-calcaneal angle was also

measured (normal = 40 degrees). Lower values represent hindfoot varus.

Each patient underwent gait analysis, and kinematics were obtained using the Vicon system. Sagittal plane ankle kinematics were analyzed and equinus and calcaneus patterns identified. Pedobarographs were obtained with the Emed system. The foot was divided into nine masks, and peak pressures and contact time were analyzed. Pearson correlation coefficients were calculated to compare pedobarographic and radiographic measurements.

Results The relationship between an increased lateral talo-calcaneal angle, signifying hindfoot valgus, and increased mean force in the medial midfoot revealed a correlation coefficient of $r = 0.07$ ($p = 0.34$), i.e. there was poor correlation. A very good correlation was found between decreased talo-calcaneal angles, or radiographic varus, and increased pressure in the lateral midfoot ($r = -0.33$, $p = <0.0001$).

In 9 patients who had kinematic ankle equinus, an analysis of the relationship between hindfoot and midfoot pressure and tibio-calcaneal angle was performed. While there was no correlation with decreased medial or lateral heel pressure ($r = -0.24$, $p = 0.53$), there was a trend towards increased lateral midfoot pressure ($r = 0.60$, $p = 0.09$). In 11 patients with calcaneus, defined as <3 degrees of plantarflexion at terminal stance, there was no statistical relationship between a decreased tibio-calcaneal angle and increased contact time in the medial or lateral hindfoot.

Conclusion In young children, standing radiographs do not correlate with foot function as measured by pedobarograph, except for residual varus.

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Clinical and physiological examinations of congenital clubfoot (principles and results)

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Russia

Introduction There are only few articles devoted to the problem of neuromuscular (Thomson G.L. et al. 1982, Levis Mark et al. 1999, Vavilov M.A. 2007) and vascular systems examination (Vavilov M.A. 2007) of newborns and infants with clubfoot.

Materials and methods 56 patients with congenital clubfoot passed through the complex examination at the age of 7 days–1 year, what included: neurological, ultrasonic, electromyographic and Doppler's examinations.

Results Neurological symptoms were present in 70% of the patients with congenital clubfoot, such as—movements disturbance syndrome with the clinical signs of dystonia and high muscle tonus or muscle hypotonia; hydrocephalus etc.

Electromyographic examination revealed low amplitude electrogenesis values of Iliotibial band's muscles in 85% of the patients /30–50% lower than age values.

Doppler's examination revealed significant disturbances of blood circulation values on the level of the surface and deep femoral arteries and popliteal artery, in the deformed limb, including cases with bilateral clubfoot. The most significant disturbances were revealed in the distal vessels of low extremities. The lower speed values of artery blood stream more than 30% and hypoplasia of the vessels in 20% of the patients were diagnosed.

Ultrasonic examination of the foot revealed—the anomaly insertion of tibialis anterior muscle tendon—in 65% of examined patients and lateralisation of the distal articular surface of the first cuneiform bone—in 65%.

Conclusion Treatment of congenital clubfoot must be complex—with the use of vessel therapy; muscle tissue activity stimulation; neurological treatment. In cases where the anomaly of bone development and joint apparatus are presented—prolonged conservative treatment is not recommended; the better time for surgical treatment at the age of 4–5 months is better to obtain good results.

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Natural history relapses after correction in idiopathic clubfoot

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USA

Background This study evaluates the natural history of idiopathic clubfoot relapses after successful correction with the Ponseti method and the effects of foot maximum abduction on relapse prevention.

Methods Consecutive case-series from 1948 through December 2000. A total of 320 patients (502 clubfeet) were evaluated. All patients were treated by serial manipulation and casting as described by Ponseti. Two groups were analyzed based on the degree of abduction in the last cast and brace. Group I: clubfeet treated between 1948 and 1984 whom did not receive maximum abduction ($n = 291$); and Group II: clubfeet treated between 1991 and 2000 with maximum abduction ($n = 211$). Main outcomes included surgical releases, relapses, and anterior tibialis transfers.

Results There were no differences between groups with respect to gender, family history of clubfoot, and bilaterality. Thirty-three percent (95/288) of group I had previous conservative treatment at outside institutions versus 77% (163/211) of group II ($p < 0.05$). Casting and tenotomy corrected 286/291 (98%) of group I and 209/211 (99%) of group II. Relapses occurred in 170 patients (58%) in group I compared to 59 (28%) in group II ($p < 0.0001$). Overall, 91% of relapses occurred before six years of age. Relapses were related to non-compliance with the brace (65% in group I and 61% in group II) in both groups ($p = 0.001$). Surgical releases decreased from 11% in group I to 4% in group II ($p = 0.004$), and anterior tibialis transfer from 51 to 15% ($p < 0.0001$).

Conclusions Most idiopathic clubfeet will not relapse after six years of age, but the tendency to relapse may persist until 11 years of age. Maximum abduction of the last cast and brace has significantly reduced relapses and the need for extensive corrective surgery and anterior tibialis transfers.

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Results of using Ponseti method for clubfoot correction in Elzahra'a University Hospital in Cairo since 2001

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Egypt

Introduction The classic management of babies with club foot or feet in our university hospital in Cairo till 2001 was conservative manipulation by a trial to reverse the deformity and serial applying of adhesive plaster till the age of 6 to 9 months. Personally, I used to hold the calcaneum during correcting the forefoot which was a big mistake that I realized later on after I learn Ponseti method. At this age of 6 to 9 months, a decision to do a surgery is usually taken either to correct the residual deformity or the relapsed one

after failure of the conservative treatment. The conservative treatment was not successful in most of cases but was applied as a palliative or an alternative medicine till the time of the surgery come. We started to do Ponseti method in our university hospital in Cairo from 2001 after I learn it in one of Ponseti courses in USA in 1999. By 2003, all professors and doctors in our department appreciated the excellent results of the method. I started to teach the method to many doctors everywhere in Egypt. By 2005, the method started to be the golden standard for the treatment of clubfoot problem in Egypt. This pushed the Pediatric Orthopedic society in Egypt to organize the first international course on the method in Egypt by February 2007 followed by another one in February 2008 and I will organize the third one in my university in Cairo in 2009.

Purpose We wish to evaluate the results of using Ponseti method in our hospital, specially after the publication of its excellent long term results published by Cooper and Dietz (1996).

Methods We used Ponseti method in all infants presented by club foot or feet under the age of 16 months. The total number of feet available for this study was 84 feet. These are the feet that I managed by myself as other doctors including some assistant lecturers and residents did also many other cases by themselves. Six babies were older than 10 months. Four of them had a failed conservative (non Ponseti) in another hospital and the last had a failed Ponseti method in another hospital. All of them were bilateral cases. We evaluate all patients during treatment using Pirani scoring system.

Results Success rate is 97.6% which meet with others excellent results ranging between 92 and 100%. Only two baby needed for a surgery of postero medial release later on. The pre- procedure Pirani score average was 5.2. Final evaluation using Pirani score average was only 0.43. Average number of cast was: 5.3 times, 72 feet from total 84 had percutaneous tendo-achelis tenotomy (85.7%). From these 72, second tenotomy was done in 12 feet (14.2%) from the total and third tenotomy was done in 6 (7.1%) from the total. All 18 feet we did re-tenotomy, the families of these babies mentioned some kind of negligence or reliance in continue wearing the Dennis Brown splint after full correction was achieved. The timing of second tenotomy average was 6.6 months and for the third tenotomy average age was 10.3 months. Four out of the 6 feet we did the third time tenotomy needed later on for tibialis anterior tendon transfer.

The first 17 tenotomies I applied them, were under general anesthesia This was due to the fear of doing a surgical procedure in the outpatient clinic and the possible resistant of this act by the other colleagues as well as the babies' families. Later on and after our hospital became the reference hospital for the method and till now, we prefer to use Emla cream for local anesthesia and cut the tendo achelis percutaneously in the out patient clinic. For this, we use a very small longitudinal medial skin approach about 4 to 5 mm. long to cut the tendon transversely from inside out. We did not manage complications at all using this percutaneous method while in some literature mentioned complication of injury to neurovascular bundle! Cast is applied usually from 18 to 24 days after that.

Average follow up period for our study was 22.4 months ranged between 8 and 42 months. The Ponseti method successfully corrected the CTEV deformity in 82 feet out of 84 with a 97.6% success rate.

Discussion and conclusion Ponseti method is strongly recommended to correct club foot deformity and the Dennis Brown splint and Orthosis is essential to prevent relapse. Re-tenotomy may be needed when the hind foot Pirani score start to be more than 1 again. Pirani scoring system is helpful in evaluation and follow up, however after a long time using this easy to apply score, we feel personally that

we need another more accurate Pirani score to be applied. During evaluation using Pirani score, we feel that we need a number between 0 and 1/5 as well as between 1/5 and 1. We feel the need for 1/4 and 3/4! In addition to the already many established advantages for Ponseti method in correcting clubfoot problem and from my personal experience with clubfoot problem in general either in Babies or relapsed and neglected cases, I can say confidently that Ponseti method also prevent internal tibial torsion that is commonly associated with clubfoot problem. Internal tibial torsion problem usually need a derotational osteotomy of the tibia during surgically correction of the relapsed or neglected cases. I noticed that no one baby we applied Ponseti technique for them is suffering from internal tibial torsion problem after we screened all patients recently for this problem.

Ponseti method became the gold standard to treat the club foot deformity in our university hospital in Cairo. We have now a special clinic for management of clubfeet cases every Wednesday. We work until 6 pm. To manipulate and doing the cast for many babies. Many university hospitals in different cities in Egypt started already to apply the method successfully as in Alexandria, Mansoura and Cairo. Also, I have done by myself many workshops in Bahrain, Kuwait and Syria, Uganda to popularize the method more and more in our area.

14

Early results with Ponseti method of manipulation and casting in patients with clubfoot and effects of variables (age at starting, severity at presentation, compliance with brace) on the result

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India

Background The Ponseti technique is reported to have a high success rate in the treatment of idiopathic clubfoot. The aim of this study was to evaluate Ponseti method of manipulation and casting in patients with clubfoot and to know the effects of variables (age at which casting was started, severity at presentation, compliance with brace) on the result by using two established clubfoot scoring systems.

Material and methods We report here 25 patients (36 feet) of idiopathic congenital clubfoot who were treated with Ponseti technique and followed up for a minimum of 6 months. Patients were evaluated by Dimeglio-Bensahel and Catterall-Pirani scoring at every cast change and at subsequent visits.

Results All patients had good results (DB score ≤ 6 , CP score ≤ 1.5) at end of casting and at 3 months follow-up. Achilles tenotomy was done in 72% of cases. Recurrence of deformity was noted in two patients at 6 months follow-up, one of which eventually required soft tissue release surgery at 1 year of age. Statistically significant correlation was found between severity at presentation and need for Achilles tenotomy ($p = 0.019$), and non-compliance with brace and relapses ($p = 0.029$). Though not found to be statistically significant, a trend towards higher number of casts with increasing severity of deformity at presentation was noted. No correlation was found between age at which treatment started and number of casts required and also between initial severity and recurrence.

Conclusion Our results show that Ponseti casting technique provides excellent early results. Achilles tenotomy is required in a significant number of cases and can be predicted by severity at presentation.

Recurrence of deformity is associated with non-compliance with the bracing protocol.

Keywords Clubfoot, Ponseti technique

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Ponseti method for the treatment of clubfoot: Riyadh experience

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Purpose The aim of this study was to evaluate the efficacy of Ponseti method for the treatment of clubfoot in Saudi patients.

Methods We report the results of using Ponseti method in 125 children with a mean age of 7.3 weeks (range 1–48 weeks) from September 2002 to September 2007 retrospectively at the one of the main hospital at Riyadh, Saudi Arabia. A total of 194 clubfeet (134 patients) were treated by the author, using Ponseti method. The patients were followed for 22 months in average (range 6 months to 5 years and 2 months). Pirani score was used to evaluate the patients' pre and post casting.

Results There were 134 patients with 194 clubfeet treated with Ponseti method. There were 85 male (63.4%) and 49 female (36.6%). Bilateral clubfeet were seen in 60 patients (44.8%), left side in 44 patients (32.8%), and right side in 30 patients (22.4%). The average casts used were 5.6 cast (range 3–8 casts). One hundred and eighty five feet (95.4%) had percutaneous tenotomy, while 20 feet (10.8%) required second tenotomy because of non compliance to the brace. Five feet (2.6%) had failed Ponseti method which required surgical intervention (3 feet with Arthrogyposis, and 1 foot had talo-clacaneal coalition). One hundred and eighty nine feet (97.4%) had full correction. Twenty-five feet (13.2%) had recurrence because of non compliance to the brace. No major complications were occurred.

Conclusions In children with clubfeet, Ponseti method showed very encouraging results with our patients, with success rate of 97.4%. Braces compliance is a big challenge especially at night time. Long term FU is recommended to evaluate the relapse.

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Early results of modified Ponseti clubfoot treatment

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Introduction Ponseti clubfoot treatment has been shown to be effective in the management of clubfoot. We review the outcome with a modified technique since its introduction in 1999 to 2007.

Methods 29 cases were treated. The corrective maneuver and corrective sequence followed Ponseti except that the casting was replaced with synthetic cast.

Result The average age at follow-up is 4.2 years (0.34–8.7). Age at first cast average 23 days (2–150). Nine female and 20 male patients. Eleven right, 6 left and 12 bilateral cases. The rigidity according to Dimeglio classification was 14.1 (10–16) for right foot and 13.88 (10–16). The number of casts changes averaged 4.62 (0–10). Thirteen patients had PETA performed and the number was increasing in the later part of the study. There were 23 idiopathic and 6 syndromic cases. Ten patients eventually required conventional open surgery. These were earlier and syndromic cases. The age at first cast was also higher for this group at 48 days (2–150). The number of casts change

averaged 5.2 (3–10). PETA were performed in 3 cases. The rigidity for this group was also higher at 15.5 for right and 15.1 for left foot. All patients completed treatment with 3 cases of superficial plaster cutter burn during removal of casts. All patients were satisfied with the outcome of treatment.

Discussion The Ponseti clubfoot treatment has a learning curve. Later results showed open procedure were almost avoided. It can be successful in some syndromic cases.

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New home stretching program to prevent recurrence of clubfoot deformity after treatment with Ponseti technique

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Thailand

Purpose Ponseti technique is reported to have a high success rate in the treatment of idiopathic clubfoot. Recurrence after correction is not uncommon. Foot abduction orthosis is an important factor in maintaining the achieved correction but convincing a patient to wear the orthosis for 3–4 years is difficult. Thai parents usually massage their babies' leg and feet due to their beliefs that this massage will help correcting the babies' physiologic bow legs. The purpose of this study was to evaluate the effectiveness if a new home stretching program to parents of our patients with a view to reducing the recurrent rate and avoiding the orthosis.

Method Forty-nine idiopathic clubfeet treated by Ponseti technique and followed for at least 3 years were included in this study. All of the patients achieved initial correction by casting alone or casting and tendo achilles tenotomy. Home stretching scheme adapted from Ponseti manipulation technique was introduced to parents after the last cast was removed.

Result Forty-seven of the 49 feet complied with the home stretching scheme. Seventy-four percent of the recurrent cases occurred within 4 months after the last cast. No recurrence found after 8 months from the last cast. The oldest age at which recurrence occurred was 1 year and 2 months old. No recurrence found after these patients started walking. Of the 19 recurrent feet, three feet was successfully treated by recasting only, twelve feet by recasting and percutaneous tendo achilles tenotomy, two feet by recasting and percutaneous tendo achilles lengthening. Two feet needed more extensive surgeries, one foot had open tendo achilles lengthening and posterior release, and one foot had posterior-medial release.

Conclusion This new home stretching program after initial correction of idiopathic clubfoot achieved high rate of compliance and avoided further extensive surgeries in most cases.

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Results of treatment of clubfoot relapses after age 4 using the Ponseti method

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USA

Background Early relapses of idiopathic clubfoot are easily treated by repeated manipulation and casting. However, late relapses are a

challenge. We report rationale and results of treatment of 22 patients initially well corrected using the Ponseti method, who were treated for relapse after their fifth birthday.

Methods Retrospective review of patients treated from 1948 to 2000 by senior author (IVP). Thirty-three patients (52 feet) were identified; 22 patients (34 feet) met inclusion criteria. A matched comparison group was randomly selected from the same treatment era to detect differences in initial corrective treatment. Initial treatment, brace compliance, age at relapse, relapse treatment, and latest follow-up was recorded. Paired *t* test analysis was performed.

Results Number of casts needed to achieve initial correction was not statistically different ($p = 0.27$) between the late relapse group and the controls. Treatment of late relapse followed one of four courses: (1) anterior tibialis transfer to either third cuneiform or cuboid (ATT), with or without TAL (9 patients/15 feet); (2) ATT $\pm$ TAL with a series of preoperative casts (4 patients/6 feet); (3) casting and continued bracing (4 patients/5 feet), (4) trial of repeat bracing (6 patients/8 feet). Fifty-nine percent of patients had further surgery (13/22) after the above treatment. Average age at follow-up was 24.5 years (range 7.5–43.6), for an average follow-up from late relapse of 18.1 years (range 2.1–35.2 years). Shoe wear, pain, and function were generally not a problem. Nineteen patients wore normal shoes. Ten patients were pain free. Despite this, only 5 patients acknowledged their feet limited their activities.

Conclusions Clubfoot recurs late in a small percentage of cases and responds very well to manipulation and casting followed by ATT transfer. Functional feet can be expected using this technique, despite mild residual deformity.

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Management of neglected clubfoot by Ponseti method—are we joking?

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India

Introduction Role of Ponseti's technique in the management of club foot in newborns is well known. Correcting a neglected clubfoot by the method is not reported in the world literature.

Materials and Methods We prospectively evaluated the results of Ponseti's method of treatment in 17 children (21 feet) having neglected club feet (no treatment for first 3 years of age). Patients were evaluated by Demeglio system. Sequential correction of cavus, adduction, varus and equinus was done. TA lengthening was done in all.

Results The average age at the time of treatment was 5.3 years. Average follow-up was 4.6 years. Demeglio criteria 13 feet had grade II (score 5–10), 7 grade III (score 10–15) and 2 had grade IV (score 15–20) deformities at beginning of treatment. Average Demeglio score at the start of the treatment was 9.9 and was 7.8 at the end of four years. Sixteen feet (76.2%) had full correction and five feet (23.8%) had recurrence. Out of five, 3 needed posterior release with one required lateral transfer of tibialis anterior tendon for persistent dynamic supination of the forefoot and one required a complete subtalar release. One patient had superficial plaster sore.

Conclusion Although we recommend that Ponseti's method should be the preferred initial treatment modality for neglected clubfeet and remaining residual deformity can be dealt with surgical intervention as and when deemed necessary. Randomized control study with greater number of neglected clubfeet is required to become a universally acceptable standard initial treatment.

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Use of the Ponseti method for recurrent clubfoot following posteromedial release

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USA

Purpose Frequently a child with recurrent or incompletely corrected clubfoot after previous extensive soft tissue release is treated with revision surgery. This leads to further scarring, pain, and limitations in range of motion. We have utilized the Ponseti method of manipulation and casting and when indicated, tibialis anterior tendon transfer, instead of revision surgery for these cases.

Methods A retrospective review of all children treated since 2002 ($n = 11$) at our institution for recurrent or incompletely corrected clubfoot after previous extensive soft tissue release done elsewhere. Clinical and operative records were reviewed to determine procedure performed. Ponseti manipulation and casting were done until the clubfoot deformity was passively corrected. Based on the residual equinus and dynamic deformity, heel cord lengthening or tenotomy and tibialis anterior transfer were then done. Clinical outcomes regarding pain, function, and activity were reviewed.

Results Eleven children (17 feet) with ages ranging from 1.1 to 8.4 years were treated with this protocol. All were correctable with the Ponseti method with 1–8 casts. Casts were applied until the only deformities remaining were either or both hindfoot equinus and dynamic supination. Nine feet required a heel cord procedure for equinus and 15 required tibialis anterior transfer for dynamic supination. Seven children have follow-up greater than 1 year (average 27.1 months) and have had excellent results. Two patients had persistent hindfoot valgus which were required hemiepiphysodesis of the distal medial tibia.

Conclusion The Ponseti method, followed by tibialis anterior transfer and / or heel cord procedure when indicated, can be successfully used to correct recurrent clubfoot deformity in children treated with previous extensive soft tissue release. Early follow-up has shown correction without revision surgery. This treatment protocol prevents complications of stiffness, pain, and difficulty ambulating associated with multiple soft tissue releases for clubfeet.

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Results of idiopathic congenital clubfoot conservative treatment with functional method

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France

Introduction The goal of this article was to analyse the results of the functional conservative technique in the treatment of idiopathic clubfoot.

Material and methods The basis of the study was a consecutive series of 83 feet (59 patients), treated between 1988 and 1990. The functional method included daily physiotherapy and splints with a progressive stopover through childhood. Average age at first caring was 22 days (0 days to 8 months). Mean age at follow-up was 14 years old (7.6–19.2).

Results Thirty-eight feet (45%) underwent a surgery at mean age of 3.5 years old, with a complete or selective soft tissue release in respectively 15 and 30% of cases. At last follow-up, 71 (85.5%), 10 (12%) and 2 (2.5%) feet were rated respectively excellent, good or fair results. The most frequent abnormality was a sub-talar joint

stiffness often associated with a lack of dorsal flexion of the ankle. The results of non-operated were excellent (44) or good (1). The most frequent flaws were a flattened talar dome and a lack of ankle dorsal flexion. On the whole series, the results were lower if the feet had undergone surgery.

Discussion This historical series shows the interest and the limits of functional treatment, which provides excellent or good results without surgery in more than half of the feet. Surgery gives lower results in term of function. The introduction of Achilles tenotomy may decrease the frequency of surgery and improve the results.

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Comparison of serial casting versus stretching technique in children with congenital idiopathic clubfoot. Evaluation of a new assessment system

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Sweden

Purpose The outcome of clubfoot treatment is the result of several factors such as severity, type of treatment, and measurement instruments. We compared two intervention groups with two assessment procedures.

Methods 16 children were treated consecutively with intensive stretching according to the Copenhagen method and 16 children consecutively with casting according to the Ponseti technique, during their first 2 months of age. The need for surgery was then assessed. At 4 months of age, all children used a dynamic Knee Ankle Foot Orthosis. The Clubfoot Assessment Protocol (CAP) and the Dimeglio Classification System (DCS) were used and compared during treatment and at 2 years of age.

Results According to the CAP (but not the DCS) the casting technique was superior in clubfoot correction, apparent as better mobility and better quality of motion at 2 years of age. These children also required less surgery. The orthotics management functioned well in both groups, with high compliance and maintenance or slight improvement of the clinical status except for morphology. DCS score changed over time but not between the groups. Because of its multidimensional and narrower scoring interval construct, the CAP enabled us to elucidate and evaluate different clinical functions.

Conclusion The casting technique according to Ponseti seems to be the better of the two for clubfoot correction, regarding mobility and quality of motion. The Clubfoot Assessment Protocol (but not the Dimeglio Classification System) was able to reveal differences between the Copenhagen and Ponseti treatment methods.

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Nonoperative clubfoot treatment 2008: a comparison between the Ponseti method and the French physiotherapy method

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USA

Purpose The Ponseti and French physiotherapy methods for clubfoot correction have been reported to be successful in reducing the need for surgical releases. The purpose of this prospective study was to compare results of these two methods at one institution in patients having a minimum 24 months followup.

Methods Beginning in 2001, patients under 3 months of age with previously untreated idiopathic clubfeet were enrolled. Parents selected the method of treatment. Ponseti's and Dimeglio's treatment protocols were strictly adhered to. Before treatment, each foot was rated for severity using Dimeglio's numeric scoring system and grouping (moderate, severe, very severe). Outcomes were assessed for (1) initial correction, (2) relapses, and (3) results after 24 month followup at which time they were graded as good (plantigrade foot $\pm$ TAL), fair (limited posterior release or tibialis anterior transfer), or poor (complete PMR).

Results Followup averaged 51.4 months (range 24–79 months). The average pre-treatment Dimeglio severity scores were similar (Ponseti 12.1, French 12.8) [$p = \text{NS}$]. Initial correction to a plantigrade foot was similar (Ponseti 94.4%, French 95.0%). Relapse occurred in 37% Ponseti and 29% French. The outcomes at 24 months minimum FU are shown in the table below.

Overall outcomes	Good	Fair	Poor
Ponseti (267 feet)	193 feet (72%)	32 feet (12%)	42 feet (16%)
PT (119 feet)	80 feet (67%)	20 feet (17%)	19 feet (16%)

Conclusions At 4 years average followup, both methods demonstrate great success in reducing the need for extensive surgical correction. Overall, the outcomes for both groups were similar. When necessary, cross-over treatment between methods may result in further improvement in outcomes.

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Rocker bottom deformity: a complication of idiopathic congenital clubfoot conservative treatment

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France

Introduction Rocker bottom deformity (RBD) is a complication of idiopathic congenital clubfoot conservative treatment. The goals of this study are to describe the pathoanatomy of RBD, to analyse its evolution during conservative treatment, to identify early diagnostic indicators and propose preventive measures and curative treatments.

Methods Among 1120 clubfeet treated conservatively between 1975 and 1996, 36 feet (3.2%) in 23 patients who developed a rocker bottom deformity were analysed.

Results Average follow-up period was 15.4 ± 3.7 years. Thirty feet (83%) reached skeletal maturity. At first examination, all the feet were belonging to most severe categories (groups Dimeglio C and D). Radiological patho-anatomy was characterized by a plantar convexity appearing at 3–6 months of age. Hindfoot equinus was constant. The convexity concerned initially the medial column (talo-metatarsal angle) and secondarily the lateral one (calcaneo-metatarsal 5 angle). The apex of the deformity was the Chopart's joint with a dorsal calcaneo-cuboid subluxation. A conservative treatment was applied in 8% of the feet. Structural RBD (92% of the feet) required an adequate soft tissue release with or without osseous procedures provided satisfactory corrections at average age of 12 ± 6.8 months.

Discussion Ideal treatment of RBD is preventive with adequate manipulations/splinting and Achilles' percutaneous tenotomy as soon as plantar convexity appears or for resisting hindfoot equinus. In case of severe RBD, surgery provides satisfactory corrections. However,

RBD is often combined with three-dimensional deformity leading to extensive and complex procedures. This highlights the advantage of RBD prevention and early radiological diagnosis.

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Extra space cast correction technique in clubfoot: 20 years of experience

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Russia

Introduction For the first time this method was described by Furlong M.W. and Lawn G.W. in USA in 1960.

Materials and methods We use extra space cast correction technique since 1987 for conservative clubfoot correction, and in postoperative management for early ankle motion. The cast application (with reserve space) was performed as follows: a special elastic pad was placed on the dorsolateral aspect of the foot before the procedure and fixed with a cotton bandage. The plaster cast was applied. After the cast was set, the elastic pad was removed, leaving a reserve space on the dorsolateral aspect of the foot. Total number of cast applications according to this technique was more 7,000.

Results The advantages of reserve space technique are: (1) possibility of manipulations into dorsiflexion (i.e. passive dorsiflexion); (2) possibility of active foot dorsiflexion by patient himself; (3) spontaneous foot growth into the side of correction and (4) extra space is a reservoir for swelling after surgery or after active manipulations.

Conclusions Extra space cast application provides good results of primary clubfoot correction in short period of time. This technique is optimal to early ankle motion in postoperative period.

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Adduction in clubfoot

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Purpose Revisiting Forefoot Adduction for a better comprehensive treatment.

Functional Anatomy At birth, in clubfoot, it is known that the forefoot is deviated towards medial plan. Two issues are to be studied regarding such deformity:

- is it truly an Adduction?
- is the anatomic forefoot the site of such deformity?

The midtarsal joint plays a major role in the pathophysiology of clubfoot. Its dislocation allows the talus to become unstable. Due to it, the whole os calcis is deviated towards equinus and varus. Thus, the soft tissues of hindfoot become tightened, together with a contracture of the triceps surae. This is making worse the deformity into equinus and varus deformity.

Due to the strength of the tibialis posterior, the talo-navicular joint turns towards supination: mid and forefoot follow this deviation. Such appear the so-called forefoot adduction.

Thus, we note that, at birth, the whole forefoot deformity has its onset in the Chopart joint.

Later on, as the child starts walking, the natural history of clubfoot induces a true adduction of the forefoot. In the same way, after an uncompleted treatment, an adduction of the forefoot can be developed.

Conclusion We may consider 2 stages in the forefoot deformity of clubfoot: at birth and in baby, the supination of midtarsal joint is its origin. After walking, a true forefoot adduction may happen from various causes.

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Clubfoot clinical outcomes resource and education guide developed by the Shriners Hospitals for Children—clubfoot work group

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The Orthopaedic Outcomes Advisory Group has identified clubfoot, as a clinical area in pediatric orthopaedic surgery, with high volume, high variation in clinical practice and variable cost in treatment. As a result, the Clubfoot Outcomes Task Force has been formed to develop a Clinical Practice Resource Guide. This guide will present the most recent literature (evidence) as a clinician reference. In the absence of literature, expert opinion from SHC has been included in the guide.

The Clubfoot Clinical Resource Guide is part of the “Club Foot Clinical Outcomes Resource and Education Tool Kit—(Clubfoot CORE)”, which includes an algorithm of evidence based treatment options, optional order sets, patient education materials and other resources that can be reproduced or edited for use across the SHC system.

Measurement of outcomes and costs related to clubfoot treatment and the generation of research proposals to enhance the evidence used for decision-making, are the anticipated end products related to the use of the Clubfoot CORE products. This guide can then be used to compare current practice patterns within SHC to better understand variations in treatment and improve outcomes with cost efficiency. This resource should not be construed as a standard of care, but rather should be used as a source of information for clinicians and patients. The use of the Clubfoot CORE will, however enhance:

1. Clinical care;
2. Research;
3. Management reporting; and
4. Performance improvement.

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Classification of clubfeet before treatment and evaluation at outcome

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Purpose Treatment of clubfeet should start early after birth. To allow for a correct evaluation of the treatment it is mandatory to assess the feet before treatment and follow them, optimally until growth is finished with a minimal f/u at walking age. Only this will allow for a continuous improvement of our strategies and achievement of results that are as normal as possible. In order to take into account the functionality of the feet at outcome, different scoring systems are used for the two evaluations.

Method A group of 45 newborns were classified with the Bensahel/Dimeglio-classification (max. 20 points) before treatment in the first days of life. All infants had severe and very severe clubfeet with 11–

20 points, groups III and IV. The feet were treated with dynamic-functional (French) method by one single physiotherapist. After walking freely for at least three months, they were again evaluated on a scale of 0–60 points using the rating system developed by the Clubfoot Study Group.

Result With the initial classification of severe and very severe clubfeet (11–20 points) treated with the dynamic-functional method, the average score at outcome was 2 points out of 60 on the Clubfoot Study Group scale, with a maximum of 6 points. All feet—even those that required an additional eventual operation—had excellent results.

Conclusion Feet must be classified before and after treatment with two different systems. Initially there are newborn feet, at outcome functionally different, weight-bearing feet. Although the analyzed group is small, it is clear, that global pooling of data can conceal very important facts. All scoring systems have drawbacks in that there is no final validation of performance and quality of life. However it is mandatory to evaluate results of different methods in order to find the best solution for each culture and the individual patient.

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Splint and clubfoot

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Purpose To assess the usefulness of the splint in clubfoot according to its property.

Technical Note Whatever is its treatment, a splint is needful for stabilizing the result. It is much more valuable in the steps of the conservative treatment. As the treatment of clubfoot includes immobilisation, the plaster casts control the progression of the reduction of the foot.

As the proposed treatment is the functional method, it proceeds the manipulations. It is an active splint as it is the other components of the treatment. As the child reaches to upright position, the splint is modified to help the foot to achieve its status: it is the ski-splint. It is often missed in the statement of the functional method.

It is as useful as the previous parts of treatment.

Conclusions In the field of the Functional Method, the manipulations are the major factor of the treatment. Its splint is also much useful during babyhood as for the onset of walking stage.

Also, splint helps the alignment of the foot with regard to bimalleolar axis and the whole lower limb.

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Improved brace wear compliance in children with clubfeet treated with the Ponseti method using a dynamic orthosis

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Purpose Bracewear noncompliance in children with clubfeet treated with Ponseti method is the leading risk factor for recurrence. A dynamic foot abduction orthosis developed at our institution is believed to result in improved compliance, fewer skin complications, and fewer recurrences. A case–control trial was conducted to test this hypothesis.

Methods A prospective cohort of children with idiopathic clubfoot using the dynamic brace was compared to an equal size group most recently treated with a standard orthosis. Compliance, skin complications, recurrence, and need for surgical soft tissue release were compared between groups at equivalent length of follow-up.

Results The dynamic and standard brace groups are equivalent in age (1.9 vs. 2.9 months), number of affected feet (97 vs. 92), and severity (average of 4 casts required for correction in each group). Fifty-seven children were followed in each group for an average of two years. All were corrected initially with the Ponseti method. Compliance is higher using the dynamic brace (47/57, 81%) compared to the standard brace (21/57, 47%) ($p < 0.001$). Recurrence rate is lower using the dynamic brace (11/57, 19%) compared to the standard brace (22/57, 39%) ($p < 0.02$). Skin complications are fewer in the dynamic brace (2/57, 3%) compared to the standard brace (11/57, 19%) ($p < 0.008$). Most importantly, five children using the standard brace underwent posteromedial release within two years of treatment, as compared to none in the dynamic brace.

Conclusion The dynamic brace results in improved compliance, fewer recurrences, fewer skin complications, and reduced rates of surgery in idiopathic clubfoot than the traditional brace.

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Extensive soft tissue release in idiopathic congenital clubfoot. Correlation between radiological and functional outcomes

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Purpose To evaluate correlation between radiological and functional outcomes of extensive soft tissue release (ESTR) in patients with idiopathic congenital clubfoot.

Methods We retrospectively reviewed medical records of 48 clubfoot patients (71 feet) who underwent ESTR during their infancy. The follow-up period averaged 11 years (9 to 19.3). Radiological outcomes were evaluated using the indices of tarsal bone deformation, joint degeneration and foot alignment. Deformation of tarsal bones at postoperative 5 years was compared with that of a comparative group treated by Ponseti method (32 feet in 22 patients). Functional results were assessed using the criteria proposed by Laaveg and Ponseti in 27 patients (39 feet) with long-term followup of ESTR.

Results Flattening of talar head (66%, 47 feet) and dome (44%, 31 feet) deformed talus to a triangular shape on lateral radiographs. Other deformation of tarsal bones included flattening of the subtalar facets of calcaneus (23%, 16 feet), wedge-shaped navicular (25%, 18 feet), and blunting of the anterior part of distal tibia (20%, 14 feet). Joint irregularity was observed in talonavicular (42%, 30 feet), calcaneocuboid (14%, 10 feet) and talocalcaneal (11%, 8 feet) joints. Talonavicular subluxation was observed in 16% (11 feet). Radiographic indices revealed marked improvement of foot alignment except some residual forefoot adduction. Functional results were assessed as excellent to good in 36%, fair in 28% and poor in 36% of the operated feet, which correlated with severity of the initial deformity (Dimeglio grading). Final functional outcomes could not be predicted by any of radiological parameters.

Discussion/Conclusion ESTR resulted in considerable deformation of tarsal bones and joint degeneration in association with high rate of unsatisfactory function. This study strongly suggests that ESTR should be a last resort to restore foot alignment and joint orientation

after failed primary treatment that minimizes soft tissue damage and scar formation.

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Modified posteromedial release in infants clubfoot surgery: personal experience in 142 cases

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Introduction Statistics of recurrent congenital clubfoot (according to the scientific literature) is about from 30 to 60% of forefoot adduction remain in 85% of the patients.

Materials and methods 100 patients were performed at the age of 3 months to 3 years with congenital clubfoot, which were not treated at all before or treated not enough. All these children were previously examined clinically, neurologically, by electromyography, dopplerography, X-ray and ultrasound to evaluate the condition of bone-joint and ligament apparatus of the foot.

We treated patients with the method, based on combination of posteromedial release and bone-joint apparatus reconstruction (original method). Medialisation of first cuneiform and first metatarsal, replacement of the point of attachment of the tibialis anterior tendon to the second cuneiform bone were performed, also we made derotation of the talus in the ankle mortise, elimination of medial subluxation of talo-cuneiform joint with pin fixation.

Results Remote results were studied for the period of 3–9 years. Recurrent clubfoot were observed in two patients with initial deformation of the talus; in one child—the secondary valgus deformation developed, which haven't been corrected surgically. Recurrent forefoot abduction was not observed. During control examination—proper of correlation in the foot's joints; the improvements of muscle function and blood circulation in the operated foot were revealed and the absence of degenerative and dystrophic lesions of bone was evident.

Conclusion Surgical treatment of the clubfoot, if serial plaster casts bring no results, must be started from the age of 4 months. We recommend the complete foot reconstruction operation with subluxation reposition of forefoot, midfoot and hindfoot joints, which must have been done after posteromedial release.

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The athletic ability in congenital clubfoot patients at school age

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Purpose Our purpose was to assess the athletic ability of the patients with congenital clubfoot through their records of physical test.

Material and Methods Between 1989 and 2006, we treated 434 clubfoot patients. Forty-six clubfeet of thirty patients (18 boys and 12 girls) without any congenital neuromuscular disorders were subjected for this study. Sixteen patients were bilaterally affected, and fourteen were unilaterally affected. Nine patients were treated conservatively, eight patients underwent percutaneous tenotomy of Achilles tendon, and 13 patients underwent extensive soft-tissue release. The average age at this investigation was 8.8 years old. The mean follow-up term was 8.3 years. We collected their records of physical test held in elementary schools. These tests consisted of following 5 events: 50 meters race, standing

long jump, softball arm throw, agility test, and shuttle run. We referred to the standard record of each event in normal group published by the ministry of education, and calculated the standard score of each records based on them. We made a comparison of those scores between unilateral and bilateral clubfoot, among three methods. The correlation between the scores and the radiological measurements were also examined.

Results The mean standard scores of all patients were 46.8 in 50 meters race, 48.5 in standing long jump, 51.0 in softball arm throw, 52.2 in agility test and 47.5 in shuttle run. Of all 148 records, 143 were over -2SD.

In every event, there was no significant difference in score between unilateral and bilateral clubfoot (Mann–Whitney's *U* test, $p > 0.05$) and among treatment methods (ANOVA, $p > 0.05$).

The lateral talo-calcaneal angle, the lateral first-fifth metatarsals angle, and the antero-posterior calcaneus-fifth metatarsal angle had significant correlations with the scores in some events. Especially, the antero-posterior calcaneus-fifth metatarsal angle was significantly correlated with scores of agility test, shuttle run, and long jump (Spearman's rank, $p < 0.05$).

Conclusion Treated clubfeet didn't result in decline of athletic ability in this study.

Purpose Our purpose was to assess the athletic ability of the patients with congenital clubfoot through their records of physical test.

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Selective soft tissue release for residual deformity after conservative treatment of idiopathic clubfoot

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South Korea

Purpose The Ponseti method has gained widespread popularity in recent years and known to be the standard initial method of conservative care. However relapsed or residual deformity can be a problem after the Ponseti method. The purpose of this study was to evaluate the surgical outcomes of selective soft tissue release for the relapsed or residual deformity cases of idiopathic clubfoot after Ponseti method in the intermediate term.

Materials and Methods Out of 28 patients with 50 clubfeet deformities who had been treated with the Ponseti method, 13 patients with 19 residual clubfeet who had relapsed or residual deformities after Ponseti method underwent selective soft tissue release between 2000 and 2006. The mean age at operation was 2.1 years (1.3–4.0 years). The mean follow-up was 2.4 years (1 ~ 4.0 years). Percutaneous or vulpius type achilles tendon lengthening, myofascial lengthening of tibialis posterior, tibialis anterior and abductor hallucis muscle with medial joint capsulotomy were undertaken selectively depending on the deformities of the foot. The Pirani score was used for clinical assessment. Parental satisfaction with the results was assessed during interviews with the patients with the questions regarding the cosmetic appearance and complaints such as pain and difficulty in walking. The talo-calcaneal angle, talo-1st metatarsal angle and tibio-calcaneal angle on standing AP and dorsiflexion lateral views were used for radiographic parameters.

Results At last follow up, all cases achieved parental satisfaction with the results. The mean Pirani score improved from 2.7 to 1.3 ($p < 0.05$). The tibio-calcaneal angle improved from 91 degree pre-operatively to 69 degree ($p < 0.05$) at final follow up.

Conclusions Selective soft tissue release is thought to be an effective joint sparing method for treatment of the residual or relapsed clubfoot deformity after conservative treatment of idiopathic clubfoot.

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Gait analysis of children treated non-operatively for clubfoot: physical therapy vs Ponseti casting

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Background Currently, clubfeet are treated with Ponseti casting or the French physical therapy program at our hospital. The purpose of this study was to compare the gait of children treated with these two techniques.

Methods A review was made of 182 patients with idiopathic clubfoot (273 feet). Seventy-seven patients were excluded because of lack of adherence to the treatment protocol or because surgery was required. Gait analysis was performed at 2 years of age. Temporal and kinematic data were classified as abnormal if they fell outside one standard deviation from age-matched normal values.

Results 105 patients (56 Cast and 49 PT) with 154 clubfeet (79 Cast and 75 PT), were tested at an average age of 2 years and 3 months. Initial Dimeglio scores ranged between 10 and 17.

No statistical differences for cadence parameters were found. Sixty-seven percent of feet treated with physical therapy had normal ankle sagittal plane kinematics versus 47% treated with Ponseti casting. When kinematic deviations were present, children treated with PT were more likely to walk with knee hyperextension (37%)*, equinus (15%)*, and foot-drop (17%)*; whereas one casted patient walked in equinus and only three demonstrated foot-drop. In contrast, the casted group demonstrated excessive stance phase ankle dorsiflexion (48%)* and calcaneus (10%). More PT feet had an internal foot progression angle (45% PT vs. 24% Ponseti)* [$p < 0.05$].

Conclusion Children treated non-operatively for clubfoot by either method had a higher proportion of normal sagittal-plane ankle motion than a similar group of surgical patients previously published. Less than 15% in each group demonstrated calcaneus or equinus. The increased incidence of equinus in the physical therapy group is due to the intact Achilles tendon, while increased ankle dorsiflexion in the Ponseti group was linked to tenotomy. Intoeing is less likely following Ponseti casting, probably due to long-term external rotation nighttime orthoses.

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Evaluation of dynamic foot pressures and foot and ankle kinematics twenty-one years following operatively treated clubfoot

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USA

Purpose To investigate foot pressures and multi-segment foot and ankle kinematics during gait in young adults with surgically treated clubfeet as infants.

Methods This study included sixteen subjects ("Clubfoot Group", 13 M, 3 F, mean age 21 ± 1.6 years) who underwent comprehensive soft-tissue release for clubfoot deformity by one surgeon between 1982 and 1987 (mean age at surgery 8 months; mean follow-up 21 years). Twenty-one age matched controls ("Control Group", 12 M, 9 F; 21.9 ± 2.9 years) were also evaluated. Foot kinematic analysis was performed using a multisegmental foot and ankle model and dynamic foot pressures were measured. Nine selected segments within the foot were analyzed identifying peak pressures, maximum

force, total contact area and pressure time integral. Each subject completed the midfoot and hindfoot American Orthopedic Foot and Ankle Society (AOFAS) outcome measure.

Results Differences in kinematics of the hindfoot and hallux were noted between the two groups. Findings in the Clubfoot group included reduced hindfoot range of motion in the sagittal plane throughout the stride and in the coronal plane during stance phase. Reduced ROM was also noted in the hallux in the sagittal plane. Plantar pressure analysis found the largest differences between groups in the hindfoot, including maximum force measurements over 2.5 times those of the Control group. The forefoot also demonstrated multiple differences from the Control group; in general, excessive measurements in the hindfoot were associated with decreased measurements in the forefoot.

Conclusion The Clubfoot Group demonstrated significant deviations in forefoot and hindfoot motion during gait, increased peak pressures at the hindfoot and midfoot with decreased pressure at the forefoot, and significantly lower scores on the midfoot and hindfoot AOFAS. These results demonstrate measurable differences from normal subjects at 21 years relative to foot structure and dynamic range of motion of the foot during gait.

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A twenty-one year follow-up of adults after comprehensive soft-tissue release for clubfoot deformity

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USA

Purpose To evaluate long-term outcomes of young adults who underwent comprehensive clubfoot release as an infant compared to age matched controls.

Methods This is a study of 16 subjects ("Clubfoot Group", 13 M, 3 F, mean age 21 ± 1.6 years; 9 bilateral) who underwent comprehensive soft-tissue release for clubfoot deformity by one surgeon between 1982 and 1987 (mean age at surgery 8 months; mean follow-up 21 years). The "Control Group" (12 M, 9 F; 21.9 ± 2.9 years) consisted of 21 age-match controls. Evaluation consisted of: gait analysis, physical examination measuring ankle range-of motion (ROM), heel rise test, and isokinetic strength testing of ankle plantarflexion, dorsiflexion, inversion, and eversion. The Clubfoot Group completed the Disease Specific Instrument (DSI), Short-Form 36 (SF-36), and Foot Function Index (FFI). Turco, International Clubfoot Study Group (ICFGS) and American Orthopaedic Foot and Ankle Society (AOFAS) midfoot and hindfoot scores were calculated. Significance was set at $p < 0.05$.

Results Clubfoot Group heel-rise score was 3.6 ± 1.4 , Turco score 1.96 ± 0.6 , ICFGS score 14.9 ± 6.9 , FFI 0.17, and DSI 26.7%. SF-36 scores were significantly lower for physical function and bodily pain subscales. Compared to the Control Group, the Clubfoot Group demonstrated significant differences in the hindfoot and midfoot AOFAS scores, lower values for strength testing of all parameters except ankle dorsiflexion, and decreased ROM for all ankle motions. The Clubfoot Group demonstrated diminished stride length (87% Control), walking speed (82% Control), and increased stance phase duration (104% Control). Reduced sagittal plane ROM and internal moment demand during stance were also noted.

Conclusion The Clubfoot Group demonstrated more pain with activity, reduced walking speed, and significant ankle weakness except for ankle dorsiflexion compared to the Control Group.

Operatively treated clubfeet have measurable deficiencies from normal controls at 21 years out, but the relationships of these findings to quality of life is still unknown.

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Functional evaluation of long-term results of clubfoot surgery—local experience

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Introduction Majority of the patients with clubfeet are treated with a period of manipulations or serial taping. Surgeries are required if adequate correction cannot be achieved. Ponseti's method is increasingly popular and much of the attention in the recent literature is focused on Ponseti's method. The purpose of the study is to review the functional outcome of the patients treated by surgical release for the clubfoot deformities.

Materials and Methods This is a retrospective review of all surgically treated clubfeet using McKay's or a la cart approach in the Duchess of Kent Children's Hospital between 1988 and 2004. All the clubfeet must be idiopathic in nature and had failed conservative treatment without prior surgical treatment. The functional outcome of all feet was evaluated both radiologically and clinically using the Lehman functional rating system.

Results 39 patients including 53 feet were reviewed. The average age of operation was 19 months and the average follow-up was 75.5 months. Eight-three percent of the feet achieved either excellent or good results. There was no significant difference in the functional outcome when comparing among patients treated before 1 year old, 1–3 years old and older than 3 years old. Two feet developed recurrence and 1 foot developed calcaneal deformity due to overlengthening of the Tendo Achilles.

Discussion and Conclusion Surgical release of clubfoot can achieve reasonable functional results without much complication. Despite increasing popularity of Ponseti's method in the past 15 years, surgical release should not be considered as an inferior treatment option.

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Outcome after repeated soft tissue release in postoperative recurrence of idiopathic congenital talipes equinovarus

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France

Purpose of the study The aim of this study is to evaluate the results of the repeated soft tissue release for recurrent postoperative idiopathic congenital talipes equinovarus.

Patients and methods Sixty patients (79 feet) underwent revision surgery between 1974 and 2001. Mean age at the time of revision was 6 years, 11 of them were operated on after age of 10 years Soft tissue release was performed for all patients, subtalar release in 24, and distal calcaneal excision in 52. The clinical and radiological outcome was assessed using the Ghanem and Seringe scores.

Results Mean follow-up was 12 years (4–32 years). The anatomical correction was highly significant. Dorsoplantar X-rays show the improvement of mean calcaneus-fifth metatarsal angle (17° to 3°).

The average of tibiocalcaneal angle in lateral view improved from 87.5° to 79° and of calcaneal pitch from 7° to 10° . At follow-up, outcome was considered as “excellent” and “good” in 78% of the cases. We had “fair” results in 14 feet because of poor functional results in all, associated with anatomical defects in 8 of them. Four feet had “poor” results due to poor functional and anatomic results. Complications included overcorrection in valgus (8 feet) and recurrence (7 feet). Triple arthrodesis was needed in 3 feet.

Discussion and conclusion Repeat soft tissue release provides an effective means to realign a recurrent club foot deformity. The mid-term results are however affected by functional limitations characterised by decreased range of motion, joint pain and triceps muscle weakness. We do not set an age limit for repeat soft tissue release and there is no need for early triple arthrodesis as a routine in the difficult cases.

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Initial management of congenital clubfoot: from the regimen of an individual surgeon to the campaign of public healthcare in Mainland China

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Introduction Neglected clubfoot is a major problem in Mainland China, one of largest developing countries in this world, producing a high incidence of lower limb disability. This is due not only to financial problems and lack of medical resources in the remote areas, but also to the lack of awareness that clubfoot can be treated soon after birth with good outcomes. Because we are not currently able to prevent the occurrence of congenital clubfoot, early recognition and treatment is critical for prevention of neglected clubfoot. However, it is still controversial whether initial management is surgical or non-surgical. The regimen of initial management varied from surgeon to surgeon and from institution to institution across Mainland China. The Ponseti method, as a minimally-invasive treatment for congenital clubfoot, has been demonstrated to be an easy, efficient, effective and economical, which particularly fits the developing countries needs. We, as pediatric orthopaedic surgeons, are trying to make a difference by launching a campaign for preventing neglected clubfoot with use of the Ponseti method as the initial management across Mainland China.

Materials and Methods: For the last few decades, the most common approach in Mainland China for the treatment of congenital clubfoot has been a surgical release. The Ponseti method has been applied in a few medical centers in Mainland China, such as in Tianjin, Xi'an, Shandong and Shanghai, since the beginning of this decade, with encouraging early results. The orthopaedic surgeons using the Ponseti method in Mainland China have been able to overcome some of the difficulties more prevalent in a developing country. Unfortunately, the Ponseti method has not been widely disseminated over Mainland China because of its large size as well as financial and political obstacles. It was proposed that the task force for a clubfoot project at the national level should be established for disseminating the knowledge and skills necessary to be successful with the Ponseti method. It was presumed that the project for the healthcare solution of common disorders should be targeted to the majority of healthcare professionals, particularly at the level of primary healthcare service, so that it could eventually benefit the majority of patients and the value could be realized for contributing to a healthcare solution that is

simple, efficient and economical. With the sponsorships and endowments from Chinese governmental agencies and NGOs as well as from the international organizations, such as PONSAs, Global HELP organization, Ponseti International Association and charity foundations, China Clubfoot Project has been launched with the campaign entitled “Healthy Walk”.

Results: The task force for clubfoot project at the national level has been established. The copies of Ponseti method of clubfoot management (Chinese edition) have been disseminated to more than two thousand healthcare professionals over the last 3 years. In collaboration with Ponseti International Association, six courses or symposiums were organized in various locations jointly with the teams from Ponseti International Association. These activities, including well-designed practice sessions, demonstrated not only how excellent the results were using Ponseti method, but also why the results were good and how simple, efficient and cost-effective the method was. Till now, almost 200 medical professionals, including primary medical doctors, were trained through the courses and hands-on workshops. The Ponseti method has been accepted for the initial treatment during the neonatal period in many hospitals, and even for the treatment of neglected clubfoot in some medical centers.

Conclusion: The Ponseti method does not only mean minimally invasive intervention, but it also allows an excellent functional outcome in both childhood and adulthood. It is a good method of choice as the initial management of congenital clubfoot for sustained good outcome. It is expected that we, as pediatric orthopaedic surgeons, will make a difference for clubfoot children by decreasing the amount of surgical intervention and/or delayed management, by using Ponseti method and changing from the regimen of an individual surgeon to the campaign of public healthcare in Mainland China.

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Split tibialis anterior transfer in relapsed club foot

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Background Relapse of club foot deformity after conservative or operative treatment is very common. Muscle imbalance is one of the many factors responsible for this. Restoration of muscle balance by suitable tendon transfer is desirable in such cases.

Material and Method: During the period 1974–2001 split tibialis anterior transfer has been carried out in 181 patients of club foot in whom deformity had recurred either after conservative treatment (52 patients) or after operative treatment (129 patients). There were 117 male and 54 female patients. Average age at operation was 3 years 4 months (range 1 year 6 months to 6 years). In addition to this transfer 168 patients required further soft tissue release. Post-operative management was above knee POP cast for 8–12 weeks and talipes shoes for a further period of 1–2 years.

Results The deformity remained corrected and no further treatment was needed in 118 (65%) patients. There was recurrence of deformity in 48 (26.2%) necessitating further operative procedure (JESS in 25, Triple arthrodesis in 11, astraglectomy in 2). Ten patients were operated in other hospitals. In 15 (8%) patients transplant was over-acting producing tendency to calcaneovalgus deformity requiring tenotomy of transplanted tendon.

Conclusion Split tibialis anterior transfer is a useful procedure in selected cases of relapsed club foot. It should be carried out, where peronei remained weak. Other factors responsible for relapse should also be tackled. Follow-up for at least 5 years is essential to detect and correct any overacting transplant in time.

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Tibialis anterior tendon transfer (TATT) after clubfoot surgery

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Purpose Recurrence of deformity following clubfoot surgery is commonly due to residual muscle imbalance. This produces a dynamic supination due to a strong tibialis anterior muscle and weak antagonists. It may also be a contributory factor in structural deformities.

Methods We evaluated our results of tibialis anterior tendon transfer (TATT) after clubfoot surgery. Intraoperatively, the tendon is transferred subcutaneously to the dorsum of the midfoot and inserted through a drill hole. The patients were divided into two groups: Group I, dynamic supination deformity only and Group II, dynamic supination with other structural deformities. The results were graded: good, restoration of muscle balance; fair, partial restoration of muscle balance; and poor, no improvement.

Results One-hundred twenty-two patients (173 feet) underwent TATT between 1986 and 2005. Only patients with a minimum of a 24-month follow-up were included. There were 95 patients (137 feet) meeting this criteria. Group I had 51 patients (76 feet), and Group II 44 patients (61 feet). The mean follow-up was 65 months (range 24–155 months) in both groups. In Group I, there were 65 good (87%), 11 fair (13%), and no poor results. In Group II, there were 54 good (88%), 7 fair (12%), and no poor results. Group II had 2 late complications (6%). Both required late recession due to limited plantar flexion. They subsequently had good results. There were no neurovascular injuries, postoperative infections, or tendon pull-out.

Conclusion Residual muscle imbalance is a common factor in recurrent deformities following clubfoot surgery. These may be dynamic, structural or a combination of both. Early correction of dynamic supination may prevent secondary osseous changes. Muscle imbalance also supports, at least partially, the neuromuscular aspects of congenital clubfoot.

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Long-term results of anterior tibialis transfer in idiopathic clubfeet: a fifty-year follow up study

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USA

Background Relapses of idiopathic clubfoot after walking age can be effectively treated with an anterior tibialis tendon transfer (ATT). However, a long term assessment of its results has not been documented. This study was designed to evaluate the long term results of this procedure.

Material and Methods Thirty-five patients treated for idiopathic clubfoot between 1950 and 1967 participated in the study. Fourteen were treated with ATT for relapses at an average age at surgery of 5 years old. They were compared to the remaining 21 non-ATT patients. Patients were evaluated using the AAOS Foot and Ankle Baseline Questionnaire with the SF-36, Laaveg–Ponseti Clubfoot Questionnaire, Foot Function Index, musculoskeletal examination, radiographic analysis, gait analysis, and surface EMG.

Results Quality of life surveys demonstrated no statistical difference between the groups. None of the patients had further relapses or required other surgeries associated with their clubfeet. Mean ankle

dorsiflexion was 3.4 degrees and motor strengths were similar in both groups. ATT patients were able to complete more toe-ups compared to non-ATT group. Radiographic analysis showed no significant difference between the groups except for a smaller AP talocalcaneal angle and slightly more talar flattening in the ATT group. Peak pressures and total force distribution were not statistically significantly different. Surface EMG demonstrated no difference in the firing pattern of the anterior tibialis muscle when compared to non-ATT and normal individuals.

Conclusions Long term follow-up of ATT demonstrated that the procedure effectively treats relapses and lead to a long-term functional foot.

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The prognostic value of the navicular in failed surgical management of clubfoot deformity

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USA

Purpose Surgical treatment of congenital clubfoot can be complicated by residual deformity. Further surgical intervention may be avoided if at risk factors are identified and treated appropriately during early treatment. Therefore, the purpose of this study was to correlate early post-operative findings with initial surgical treatment failure.

Methods We reviewed the charts and radiographs of 41 patients with clubfoot without associated congenital or neuromuscular disorders who underwent surgical posteromedial subtalar release and percutaneous talonavicular pin fixation as a primary treatment for their deformity. The incidence of post-operative infection and residual deformity (hindfoot varus, metatarsus adductus) were recorded. Standard weight-bearing anterior-posterior and lateral views were evaluated post-operatively to assess the navicular ossific nucleus, talocalcaneal angles, and talo-first metatarsal angles. Failure of treatment was defined as residual clubfoot deformity necessitating further surgical intervention.

Results The patients were divided into two groups—successful and failed initial surgical management (see Table 1).

Table 1 Patient demographics and post-operative clinical and radiographic findings

Study outcomes	Successful	Failed
Number in study	34	7
Mean age (range) at surgery	1.2 (0.5–6.5) years	1.5 (0.8–1.6) years
Mean age (range) at last follow-up	6.1 (2.0–17.5) years	6.2 (2.2–14.3) years
Incidence of post-operative infection	2 (6%)	3 (43%)
Incidence of metatarsus adductus	11 (32%)	5 (71%)
Average talus-first metatarsal angle	9 degrees	17 degrees
Average talocalcaneal angle (lateral)	33 degrees	26 degrees
Incidence of navicular dorsal subluxation	34 (26%)	6 (86%)
Incidence of navicular avascular necrosis	14 (41%)	3 (43%)

Conclusions Failed initial surgical management was associated with clinical and radiographic findings of recurrent deformity (increased incidence of metatarsus adductus an elevated mean talus-first metatarsal angle). Importantly, dorsal subluxation of the navicular was highly predictive of failed initial treatment. Early post-operative infection was also associated with treatment failure, which may be associated with loss of initial correction of the navicular position from early talonavicular pin removal.

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The role of metatarsal osteotomies for clubfoot treatment of the older child

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Differential Distraction has demonstrated to be an effective, minimally invasive procedure for treatment of clubfoot. Long-term follow-up (over 5 years) have demonstrated that patients, 5 years and older, treated with this method have residual/recurrent forefoot adductus. Incorporating M1 osteotomy and lengthening within the DD protocol in this age group of patients has eliminated the residual/recurrent adductus deformity of the foot.

We present a series of six cases treated with DD, M1 osteotomy and lengthening, all patients were over 5 years of age. Two patients had neglected and four had recurrent clubfoot deformity. M:F ratio was 2:1. The treatment with DD extended between 6 and 8 weeks. M1 osteotomy was carried out at the proximal 1/3 of the bone, subperiosteally, 4 weeks after beginning of the DD. Rate of distraction after the osteotomy was 3:1 for 2 weeks. Slowing the distraction rate allowed the regenerate to consolidate as distracted. M1 was lengthened in average ~8 mm and the distal fragment laterally translated. The regenerated bone healed in all cases. DD was continued until correction of all components of the clubfoot was completed. During follow-up, there was no recurrence of deformity in any of the cases. **Complications:** The first two cases had MPJ subluxation that was addressed by stabilizing the MPJ with pinning or an aluminum sling in all other patients.

Conclusion M1 osteotomy combined with DD has shown to be an effective procedure that eliminates residual forefoot adductus after clubfoot treatment in the older child.

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Correction of stiff club foot deformity without osteotomy or soft tissue release using Ilizarov external fixator

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Club foot deformity which recurred after surgery is generally stiff and difficult to treat. Ilizarov external fixator allows gradual stretching of the tight soft tissues and provides a minimally invasive method to deal with the problem.

We treated 13 children with 20 stiff club feet that failed surgical correction with simultaneous gradual correction of all deformity components without osteotomy or soft tissue releases. A

standard frame configuration that varies in the diameter of the half rings was used. Fixation were achieved with 2 smooth wires for the metatarsus, 2 smooth wires for the calcaneum (two cases had additional half pin fixation the calcaneum) and 2 smooth wires/one half pin for the tibia. On frame removal the corrected feet were applied with below knee POP cast for 4 weeks before converted into AFO splint.

The mean duration of frame application was 3.35 months. In all cases equines and adduction deformities were over-corrected beyond neutral position. In 4 feet the hindfoot were not over corrected (only to neutral or slight varus). Over a mean follow up of 1 to 7 years 4 feet required repeat Ilizarov correction. They were treated with the exact method and all achieve satisfactory correction. In one older child we evaluated a preoperative/postoperative MRI and demonstrated partial lateralization of navicular bone over the talar head. There was also articular and bone bruises over lateral aspect of the talar dome corresponding to antero-lateral ankle pain on walking. While syndesmotom release was being considered, the pain resolved and the patient was able to walk with near normal gait.

A standard frame configuration that is constructed before operation significantly reduces the operating time. The procedure is also simpler and few components are required to be sterilized. Incidence of frame adjustment during gradual correction was minimal and there was no additional procedures requiring anaesthesia. Longer follow up will be required to evaluate the functional outcome. Special imaging is also required to evaluate the anatomical outcome of the procedure.

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Complications in clubfoot treated with JESS differential distraction

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Residual deformity in clubfoot after traditional casting and open treatment are challenging problems. The most common of these recurrent deformities are adductus, cavovarus and rocker bottom deformities of the foot, with the most challenging being calcaneus's foot deformity. Multiple surgeries are commonly employed, which render the foot stiff, and eventually require fusion.

We present a series of cases of complications following prior clubfoot treatment (casting and/or surgery) that were managed with the JESS Differential Distraction (DD) method, physical therapy and long-term bracing. Twelve feet (four, with cavovarus deformity; seven, with rocker-bottom foot and two feet with calcaneus's deformity) were treated with this protocol. The average patient age was 8 years, (range 4–14 years), male:female ratio was 2:1. The treatment with DD extended between 4 and 8 weeks. Follow-up after DD treatment was between 3 and 5 years (average 4.2 years). In all cases of rocker bottom foot, after overcorrection was achieved, the distractors were replaced with curved rods during the static phase to maintain the arch. During follow-up period, there was no recurrence of deformity in any of the cases. No serious complications were observed in this series.

Conclusion Residual and Iatrogenic foot deformities are serious complications resulting from clubfoot treatment. Differential Distraction (DD), physical therapy and long-term bracing is a viable, minimally invasive option for treatment of these serious conditions, restoring shape, and improving foot mobility and function.

POSTER PRESENTATION

1

Treatment of clubfoot with Ponseti method: early experience results

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Conservative treatment of clubfoot with Ponseti method has become increasingly popular worldwide in orthopaedic practice. Twenty-five feet of 14 patients treated with Ponseti method were reviewed. There were 12 male, 2 female patients with a mean age of 3 months (4 days–10 months). On 11 patients, the deformity was bilateral. Five feet of three patients have been treated with different methods before (three feet with casts, one foot with posterior and one foot with posteromedial release). The mean cast number was 6 (5–8 casts). On 20 feet, we performed percutaneous achilles tenotomy. After tenotomy, 3 weeks of casting followed by 3 months of full time bracing is performed. Then, patients were followed by 12–14 hours of bracing in a day. The mean follow up was 12 months (5–20 months). 21 feet of 11 patients (84%) were treated successfully by Ponseti method. The cast number was more than the others in the treated group before. There was a resistance to correction especially to equinus and varus on these feet. On three patients, we observed recurrence. They all were uncompliant to the brace treatment. They were treated by repetitive casting and bracing. We needed to perform one posteromedial release and one achilloplasty with posterior capsulotomy to achieve correction on two patients with resistant feet. The Ponseti method is a safe, effective and low-cost treatment for idiopathic club foot. The success rates are dependent on compliance of brace treatment.

2

Results of the plantar fascia tenodesis technique for tibialis anterior tendon transfer

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Introduction Tibialis anterior tendon transfer is an established technique for treating dynamic residual clubfeet, and occasionally, dynamic equinovarus feet in cerebral palsy and other pathology. Several tenodesis techniques have been described. However, there has been no prior study evaluating specifically the efficacy of the tenodesis techniques. We report on our results of the plantar fascia tenodesis technique used for tibialis anterior tendon transfer.

Methods The study group comprised 66 cases (57 patients) of tibialis anterior tendon transfer using the plantar fascia buried suture tenodesis technique. There were 36 males and 21 females with an average age of 5.2 years (range 1.5 to 11 years). Post-operative care included 6 weeks of non-weight bearing in a cast followed by 6 weeks in a weight-bearing short-leg cast.

Results Average follow-up time was 43.2 months (range 24 to 119 months). There were no tenodesis failures and no permanent complications. There was a five percent (three patients) minor complication rate. One patient developed a plantar ulcer and granulation tissue which eventually resolved with oral antibiotics and topical silver nitrate treatment. One case of plantar stitch abscess and pain

necessitated two surgical debridements and antibiotic treatment before resolution. One patient developed a dorsal foot sinus tract infection, fifth metatarsal osteomyelitis, and plantar stitch abscess and pain. After surgical debridement and antibiotic treatment he eventually recovered fully.

Discussion and Conclusion Plantar fascia suture tenodesis technique is an effective method for securing tibialis anterior tendon transfers with no failures or permanent complications noted in our series. Attention to surgical technique can help avoid short-term complications such as stitch abscess, local infections, plantar ulcers, and plantar pain.

3

Exploring the treatment of brain paralytic equinovarus

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China

Objective To explore the best treatment of Brain paralytic equinovarus.

Methods 300 cases (1 to 9 years older) of brain paralytic equinovarus were divided into 3 groups and carried out medical activities. The first group who did not have fixed deformity undergoes rehabilitation therapy under the protection of the brace. The other two groups were

those who had fixed deformity. The second group were treated with soft tissue releasing of ankle and tender transfer—dynamic balance of strength of ankle muscles simultaneously. The third group were treated with soft tissue releasing of ankle under the protection of the brace and observed the development of deformity up to school age (7–9 years older) firstly. If foot deformities were not relieved or promoted, the group were treated with the second operation of soft tissue releasing in ankle area or transfer—dynamic balance of strength of ankle muscles, and treated with the above two operation according to concrete condition. At last, the patients were followed up till relative stable condition (18 years older). Results (According to the standard of curative effect evaluation) the excellent rate of the first group was 34%, the second group was 58%, the third group was 96% ($p < 0.05$).

Conclusions 1. The first treatment for brain paralytic equinovarus without fixed deformity was rehabilitation therapy under the protection of the brace. 2. Brain paralytic equinovarus accompany with fixed deformity should be treated with soft tissue releasing of ankle as soon as possible for preventing equinus skeletal deformity. 3. Because cerebral palsy was stationary lesion and muscle strength and motion was developmental, dynamic balance of strength of ankle muscles should be performed in school age. Early treatment by tender transfer—dynamic balance of strength of ankle muscles was not the optimal therapeutic plan. 4. Two-step procedures were better than one-time operation in actual effect.