Human & Veterinary Medicine
International Journal of the Bioflux Society HVM

OPEN ACCESS
Research Article

Radiological assessment of residual deformities of surgically treated idiopathic congenital clubfeet during early infancy

[1]Andrei Corbu, [2]Dana E. Vasilescu, [2]Maxim Andrei, [1]Ștefan Cristea

[1] Department of Orthopaedics and Traumatology, "Carol Davila ", University of Medicine and Pharmacy, Bucharest, Romania;
[2] Department of Orthopaedics-Traumatology and Paediatric Orthopaedics, "Iuliu Hatieganu" University of Medicine and Pharmacy Cluj-Napoca, Romania.

Abstract. Objective: It is well known that congenital clubfeet will never be normal feet, even if they appear normal at clinical evaluation. The purpose of this study was to evaluate the radiological results of surgically treated clubfeet in early infancy. Material and method: We conducted a retrospective radiological study on 34 patients (54 clubfeet) diagnosed with idiopathic talipes equinovarus who were treated by posteromedial and lateral release in our service taking into consideration the following parameters: the talocalcaneal and talus-first metatarsal angles on the anteroposterior and lateral radiological projection; the morphological changes in the talus, navicular, and distal tibia; the presence of osteoarthritis. Syndromic and secondary clubfeet were excluded. Results: We found residual deformities, single or associated, abnormal development of the talus, navicular and distal tibia, presence of early osteoarthritis most often in the talonavicular and calcaneocuboid joints. The most frequent radiological deformity was adduction of the forefoot (46 feet, 86.79%), followed by varus (25 feet, 47.16%) and cavus (14 feet, 26.41%). Conclusion: Even though complete posteromedial release produces good results on the short-term, surgical treatment fails to achieve complete correction of the deformity, may induce vascular injury and secondary abnormal bone development, leading to altered joint congruency and biomechanics which are known risk factors for earlier development of osteoarthritis.

Key Words: clubfoot, posteromedial and lateral release, osteoarthritis, undercorrected clubfoot.

Corresponding Author: A. Corbu, email: corbuandrei@gmail.com

Introduction

Congenital clubfoot is a three-dimensional deformity with an estimated prevalence of 1-2‰ newborns (McConnell et al 2016), placing it among the most common affections responsible for invalidity in adult life. It is characterized by the presence of four pathological deviations (cavus, varus, adductus and equinus) which need to be corrected in order to achieve a plantigrade, functional, pain-free foot with good mobility. The diagnosis of clubfoot is clinical and it is based on the presence of the four pathological modifications mentioned above, therefore further radiological investigations aren't usually necessary in order to confirm the diagnosis.

An important step after establishing the diagnosis is differentiating between true idiopathic congenital clubfeet and syndromic clubfeet, as the latter group of clubfeet may respond worse to the treatment applied (Cosma et al 2007). Clubfeet can be classified based on the morphology – the Pirani classification – or on their reducibility – the Dimeglio classification - and some authors suggest that it is even more helpful to use the two classification systems in conjunction (Cosma & Vasilescu 2015).

The Ponseti conservative method is considered the gold standard of treatment nowadays because it achieves high correction rates on the short-term and reduces the need for surgery (Cosma et al 2014, Cosma et al 2007). It has also been proven to be more efficient than other conservative methods of treatment on the short term (Cosma et al 2007). On the other hand, the long-term results of treated clubfeet are not so many. Our study aims to analyze the radiological results of surgically treated clubfeet.

Material and method

The present retrospective study was performed in the Pediatric Orthopaedics Department, Clinical Rehabilitation Hospital Cluj-Napoca with the approval of the institutional ethics committee board. Adult patients and legal guardians of the patients signed an approved informed consent. We identified the medical records of the patients with congenital idiopathic clubfeet who were treated by surgical release from 2000 to 2009. Patients with associated diseases such as cerebral palsy, arthrogryposis, spina bifida were excluded from the study. All of the patients were initially treated by manipulation and serial casting in order to correct as much as possible the deformity, followed by comprehensive posteromedial and lateral release (PMR) through a Cincinnati approach (Crawford et al 1982). Depending on the severity and reducibility of the clubfoot, the surgical intervention usually implied superficial and deep release of the contracted soft tissues on the medial, posterior and lateral side of the foot and ankle, plantar release, reduction of the deformities under radiological control and fixation of the

Figure 1. A. Decreased TCA-AP angle indicating subtle persistent heel varus, medial displacement of the navicular. B. Decreased TCA-LL angle indicating residual hindfoot varus deformity, wedging and dorsal subluxation of the navicular. C. Positive TMT-AP showing adduction deformity of the forefoot, important medial subluxation of the navicular bone. D. Increased TMT-LL angle, demonstrating residual cavus, flattening of the talar dome.

foot in the corrected position with one or two Kirschner wires. We didn't excise the talocalcaneal interosseous ligament in feet where radiological realignment was correct during surgery. The operated feet were immobilized in a long leg plaster cast for 8 weeks postoperatively and after the cast removal, the feet were braced in Dennis-Browne orthoses for the following 2 years.

The follow-up radiological examination used in our study consisted of one set of standing anteroposterior (AP) and latero-lateral (LL) radiographs with the feet in the maximal corrected position. For the anteroposterior radiograph, the X-ray tube was inclined 30 degrees proximally. The following parameters were measured by the first author in order to assess the alignment of the foot:

-the talocalcaneal angle on the AP view (TCA-AP): normal range 20º-40º, a value less than 20º indicates varus of the hindfoot;

-the talocalcaneal angle on the lateral view (TCA-LL): normal range 35º-50º, an angle less than 35º indicates varus of the hindfoot);

-the talus-first metatarsal angle on the AP view (TMT-AP): normal range -20º-0º, an angle of more than 0º indicates adduction of the first metatarsal;

-the talus-first metatarsal angle on the LL view (TMT-LL): an angle more than 5º indicates a cavus deformity.

We also analyzed the morphological modifications that were present at the level of the talar dome, the navicular bone, the distal tibial epiphysis. The presence of osteoarthritis in the tibiotalar, subtalar, talonavicular, naviculocuneiform and calcaneocuboid joints was noted and graded according to the classification described by Kellgren&Lawrence 1957. (Table 1).

Table 1. Kellgren-Lawrence classification of osteoarthritis

Grade	Radiological findings
0	no abnormal findings
1	doubtful narrowing of the joint space and possible osteophytic lipping
2	definite osteophytes, definite narrowing of the joint space
3	moderate multiple osteophytes, some sclerosis and possible deformity of bone contour
4	large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bone contour

Table 2. Distribution of degenerative changes in the foot and ankle joints

Joint	Grade 4	Grade 3	Grade 2	Grade 1	Grade 0
Tibiotalar	0%	3.77%	1.88%	18.80%	75.55%
Subtalar	0%	0%	3.77%	26.41%	69.82%
Talonavicular	0%	7.54%	13.20%	41.50%	54.70%
Calcaneocuboid	0%	5.55%	7.40%	33.33%	53.72%
Naviculocuneiform	0%	1.85%	5.55%	16.66%	75.94%

Results

Thirty-four patients with a total of 54 surgically treated clubfeet were included in this study. There were 22 boys (64.7%) and 12 girls (35.29%). Clubfoot was bilateral in 20 (58.82%) patients and unilateral in 14 patients. The surgical release was performed at a mean age of 12.87 months ± 4.94 months. The mean age at follow-up was 152 months ± 34 months.

In one patient who presented avascular necrosis of the talus as a complication after extensive PMR, which was further treated by total astragalectomy, the measurement of the angles was not possible.

The TCA-AP angle was abnormal in 19 feet (35.84%) having a mean value of 15.87º±7.61º. On the lateral view, the mean value of the TCA-LL angle was 31.95º±6.51º, being abnormal in 25 clubfeet (47.16%). The pathologically decreased values of the TCA-LL angle were present in all of the 19 feet having abnormal values of the TCA-AP angle.

In 14 feet (26.41%) the TMT-LL was positive, reflecting a residual cavus deformity (mean range 10.22º±10.66º). Forty-six feet (86.79%) presented a positive TMT-AP angle with a mean value of 10.45º±8.8º.

The deformities that were mostly associated: varus and cavus in 11 feet (20.75%); varus, adductus and cavus in 6 feet (11.32%); cavus and adductus in 5 feet (9.43%); varus and cavus in 2 feet (3.77%).

Flattening of the talar dome was present in all of our patients and according to Dunn & Samuelson 1974 classification, it was mild in 16 (30.18%) feet, medium in 30 feet (56.6%), severe in 7 feet (13.2%). The navicular presented an abnormal wedged shape in 32 feet (59.25%) on the AP view and in 26 feet (48.14%) on the lateral view. Medial displacement was observed in 29 of the feet (53.7%) on the AP view and dorsal displacement in 21 feet (38.88%).

Pathological modifications of the distal tibia included notching of the anterior part of the epiphysis in 68.15% of the feet and slanting of the posterior part of the epiphysis in 40.74% of the feet.

Regarding the presence of osteoarthritis in the ankle and foot joints, we didn't notice radiological signs of advanced arthritis (Grade 4) in any of the patients, but signs of minimal osteoarthritis (Grade 1,2) were present, most frequently in the talonavicular, calcaneocuboid and subtalar joint (Table 2).

Discussion

Clubfoot is known for its increased tendency to relapse despite a successful initial correction (Corbu et al 2017). Any of the four deformities, alone or in association, can recur, as our study has demonstrated. In patients treated using the conservative Ponseti method, it has been shown that joint hyperlaxity is a protective factor against relapses (Cosma et al 2018). In surgically treated clubfeet, the protective effect of joint hyperlaxity can be neutralized by the fibrous scar tissue that forms postoperatively in the posteromedial aspect of the foot and ankle. Another important consequence of the scar tissue formation is represented by the rigidity of the relapsed clubfeet, making them very difficult, if not impossible, to correct using conservative treatment. Furthermore, it has been suggested that the resulting scar tissue has a tendency to retract (Ippolito et al 2003, Uglow et al 2000, Tabatabaei et al 2011). The pathological bone development that results secondary to the vascular insult produced during surgery can play an even greater role in the rigidity and reducibility of relapsed clubfeet.

The rate of wedging of the navicular bone and flattening of the talar dome in our series is similar to other studies (Dobbs et al 2006, Docquier et al 2006). Posterior slanting of the distal tibial epiphysis and notching of its anterior part are considered to be the consequence of the tight posteromedial structures which limit the talar head motion during dorsiflexion, resulting in excessive pressure and growth inhibition at the level of anterior distal tibia (Ponseti et al 1981). The radiological presence of one of the four deformities indicates undercorrection of the clubfoot, but this doesn't necessarily imply a poor clinical result or permanent failure of treatment (Simons 1985, Kuo et al 2009).

Adduction of the forefoot in relation to the hindfoot was the most frequent residual deformity in our series and its relapse rate is comparable to other studies (Kuo et al 2009, Tarraf et al 1992). The increased rate of undercorrection of this deformity is considered to be the consequence of incomplete release and failure to properly reposition the navicular over the talar head. As mild medial subluxation of the navicular was present in 53.7% of the clubfeet included in our study, we consider it to be the most important factor responsible for persistent adduction deformity. Because the ossification of the navicular bone starts around the age of 3-4 years, incomplete reduction of the talonavicular joint is explained by the absence of the ossific nucleus on the X-rays at the time of surgery.

We didn't identify any overcorrection signs in the hindfoot, however residual heel varus (indicated by increased values of TCA-AP and TCA-LL angles) was present in one third of the clubfeet and some patients will need additional surgical procedures to improve the clinical aspect and functionality of the foot. Overcorrection is a known complication of clubfoot surgery, accounting for the majority of fair results reported in the literature (Turco et al 1979).

Undercorrection of the heel varus indicates an incomplete release of the subtalar joints, which is more frequently observed in patients treated by posteromedial release than in patients treated by subtalar release (Thompson et al 1982). On the other hand,

in some clubfeet, the dysplasia of the subtalar joint is so severe that even after a complete release it is not possible to achieve full correction of the varus deformity (Ippolito et al 2003). Flattening of the talar dome, most frequently of medium severity, was present in all of our patients. The alterations in the talar dome determine a limitation of the ankle range of motion and alter joint congruency, a possible cause of earlier onset of arthritis. A disastrous complication in surgically treated clubfeet is represented by the avascular necrosis of the talus, which might further require total astragalectomy (Figure 2).

Figure 2. Lateral X-ray projection of the foot and ankle. The patient developed a severe avascular necrosis of the talus after complete PMR, which was treated by astragalectomy. There are pathological modifications in the tibia, which seems to have remodelled due to the abnormal forces: the distal epiphysis reshaped to accomodate between the articular surfaces of the calcaneus; there is an impression on the anterior part of the epiphysis due to the navicular.

Taking into consideration the mean age of the patients (13 years and 9 months), the presence of osteoarthritis is another concerning aspect. Minimal signs of osteoarthritis(Grade 1 and 2) were present most frequently in the talonavicular, calcaneocuboid and naviculocuneiform joints. In the longest follow up (over 28 years) of surgically treated clubfeet so far, Dobbs found the most common site of osteoarthritis in the same joints, but is was rated moderate or severe in 56% of the patients (Dobbs et al 2006). In contrast, Cooper reported only minimal osteoarthritic changes in 35% of the patients treated using the conservative Ponseti method after 30 years of follow-up. (Cooper&Dietz 1995). In our series, severe osteoarthritis was absent, but we identified signs of Grade 3 (moderate osteoarthritis) in the talonavicular and calcaneocuboid joints in the feet of two patients who were 19 and 20 years old, respectively. In these two patients, pain was already present with physical activity.

Conclusion

Although surgical treatment of clubfeet can achieve good and satisfactory results on the short-term, they are not maintained in all patients on the long-term. In case of posteromedial release, undercorrection of clubfeet, was the most frequent abnormal finding, followed by abnormal pathological modifications of the bones. These can lead to development of osteoarthritis at a younger age due to incongruent joint configuration and abnormal distribution of forces. Based on our findings and current data in the literature, the conservative Ponseti method should be the first choice of treatment, while surgery should be reserved for clubfeet that cannot be completely corrected by conservative means or relapses.

References

Cooper DM, Dietz FR. Treatment of idiopathic clubfoot:a thirtyyear follow-up note. J Bone Joint Surg Am 1995;77:1477–1489.

Corbu A, Cosma D, Vasilescu DE, Cristea S. Congenital Talipes equinovarus:current concepts and treatment. Rev Med Chir Soc Med Nat Iasi 2017;121(4):745-51.

Cosma D, Vasilescu DE. A Clinical Evaluation of the Pirani and Dimeglio Idiopathic Clubfoot Classifications. J Foot Ankle Surg 2015;54(4):582-585.

Cosma D, Vasilescu DE. Ponseti treatment for clubfoot in Romania:a 9-year single-centre experience. J Pediatr Orthop B 2014;23(6):512-6.

Cosma D, Vasilescu Dana, Vasilescu D, Văleanu M. Comparative results of the conservative treatment in clubfoot by two different protocols. J Pediatr Orthop B 2007;16:317-321.

Cosma D, Vasilescu Dana, Văleanu M, Vasilescu D. Reducerea numărului de intervenţii chirurgicale pentru tratamentul piciorului strâmb după implementarea metodei Ponseti. Rev Med Chir Soc Med Iaşi 2007;111(1):89-93.

Cosma D, Vasilescu Dana, Cosma Smaranda, Vasilescu D, Văleanu Mădălina. The integrated informational system for congenital clubfoot. Acta Electrotehnica Cluj-Napoca 2007;48(4):33-36.

Cosma DI, Corbu A, Nistor DV, Todor A, Văleanu MA, Morcuende JA, Man SC. Joint hyperlaxity prevents relapses in clubfeet treated by Ponseti method—preliminary results. International Orthopaedics 2018, 1-6.doi:10.1007/s00264-018-3934-7.

Crawford A.H., Marxen J.L., Osterfeld D.L. The Cincinnati incision:a comprehensive approach for surgical procedures of the foot and ankle in childhood. J Bone Joint Surg Am 1982;64(9):1355–1358.

Docquier PL, Leemrijse T, Rombouts JJ. Clinical and radiographic features of operatively treated stiff clubfeet after skeletal maturity:etiology of the deformities and how to prevent them. Foot Ankle Int 2006;27:29–37.

Dobbs MB, Nunley R, Schoenecker PL. Long-term follow-up of patients with clubfoot treated with extensive soft-tissue release. J Bone Joint Surg Am 2006;88:986–996.

Dunn HK, Samuelson KM (1974) Flat-top talus. A long-term report of twenty club feet. J Bone Joint Surg Am 1974;56:57–62.

Ippolito E, Farsetti P, Caterini R, Tudisco C. Long-term comparative results in patients with congenital clubfoot treated with two different protocols. J Bone Joint Surg [Am] 2003;85-A:1286–1294.

Kellgren JH, Lawrence JS. Radiological assessment of osteoarthrosis. Ann Rheum Dis 1957;16:494–502.

Kuo KN, Smith PA. Correcting residual deformity following clubfoot releases. Clin Orthop Relat Res 2009;467(5):1326–1333.

McConnell L, Cosma D, Vasilescu DE, Morcuende J. Descriptive epidemiology of clubfoot in Romania:A clinic-based study. Eur Rev Med Pharmacol Sci 2016;20(2):220-224.

Ponseti IV, El-Khoury GY, Ippolito E, Weinstein SL. A radiographic study of skeletal deformities in treated clubfeet. Clin Orthop Relat Res 1981;160:30-42.

Tabatabaei S, Haddadpour A, Mehdinasab SA. Results of posteromedial release in resistant Talipes Equinovarus (Club Foot). Pak J Med Sci 2011;27(4):851-854.

Simons GW. Complete subtalar release in club feet. Part II:Comparison with less extensive procedures. J Bone Joint Surg Am 1985;67:1056–1065.

Tarraff YN, Carroll NC. Analysis of the components of residual deformity in clubfeet presenting for reoperation. J Pediatr Orthop 1992;12:207–216.

Turco VJ. Resistant congenital club foot one-stage posteromedial release with internal fixation. A follow-up report of a fifteen-year experience. J Bone Joint Surg Am 1979;61:805–814.

Thompson GH, Richardson AB, Weistin GW. Surgical Management and Resistant Congenital Talipes Equinovarus Deformities. J Bone Joint Surg Am 1982;64(5):652–665.

Uglow MG, Clarke NM. Relapse in staged surgery of congenital talipes equinovarus. J Bone Joint Surg Br. 2000;82:739–743.

Authors

•Andrei Corbu, Department of Orthopaedics-Traumatology, University of Medicine and Pharmacy Carol Davila Bucharest, 8 Eroii Sanitari Boulevard, Sector 5, Bucharest, Romania, email: corbuandrei@gmail.com

•Dana Elena Vasilescu, Department of Orthopaedics-Traumatology and Paediatric Orthopaedics, University of Medicine and Pharmacy Iuliu Hatieganu, 8 Victor Babes Street, Cluj-Napoca, Cluj, Romania, email: drvasilescu@yahoo.com

•Andrei Maxim, Department of Orthopaedics-Traumatology and Paediatric Orthopaedics, University of Medicine and Pharmacy Iuliu Hatieganu, 8 Victor Babes Street, Cluj-Napoca, Cluj, Romania, email: andrei.v.maxim@gmail.com

•Ștefan Cristea, Department of Orthopaedics-Traumatology, University of Medicine and Pharmacy Carol Davila Bucharest, 8 Eroii Sanitari Boulevard, Sector 5, Bucharest, Romania, email: drstefancristea@yahoo.com

Citation	Corbu A, Vasilescu DE, Andrei M, Cristea S. Radiological assessment of residual deformities of surgically treated idiopathic congenital clubfeet during early infancy. HVM Bioflux 2019;11(3):95-99.
Editor	Antonia Macarie
Received	7 June 2019
Accepted	10 July 2019
Published Online	19 July 2019
Funding	None reported
Conflicts/ Competing Interests	None reported