Treatment of Pediatric Flexible Flatfoot with Subtalar Arthroereisis: Functional and Radiographic Results

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Fecha de recepción: febrero de 2021.
Fecha de aceptación: junio de 2021.

ABSTRACT

Introduction: Flexible flatfoot (FFF) is one of the most frequent conditions that pediatric orthopedists face on a daily basis, with an incidence ranging from 15 to 45%. Subtalar arthroereisis has been described as a valid treatment option, which allows, through a simple and easy technique, to restore the internal plantar arch with few complications. The aim of this work is to retrospectively analyze a series of patients treated with this technique and to evaluate the clinical-functional and radiological results of this technique. **Materials and Methods**: We evaluated 41 patients between 9 and 15 years old, with a diagnosis of idiopathic flexible flatfoot treated by two surgeons of our institution, between January 2013 and December 2019, who underwent subtalar arthroereisis. A clinical functional and radiological evaluation was performed before and after the surgery. For the functional assessment, The Oxford Ankle Foot Questionnarie for Children in parent version (OxAFQ-C) was used. Radiologically the following angles were evaluated: Talonavicular coverage, talocalcaneal angle on the frontal radiograph, talocalcaneal angle on the profile radiograph, and Moreau Costa Bartani angle. **Results**: Radiographic improvement in foot alignment after surgery was observed in all the patients studied. The functional outcome evaluated by means of the Oxford score for children revealed that all the patients analyzed showed a wide improvement in their school participation, physical activities, emotional state and problems caused by the use of their footwear. **Discussion**: While there is no doubt about the initial orthopedic treatment when this pathology is asymptomatic, surgical treatment continues to be a matter of discussion; especially in terms of when to indicate it, patient symptoms, appropriate age, choice of surgical technique and the performance of complementary procedures. **Conclusions**: This study showed that subtalar arthroereisis is a valid treatment option for children with symptomatic flexible flat feet with very good results and few postoperative complications.

KEYWORDS

Flexible flatfoot, Subtalar arthroeresis, Maxwell bronchure arthroeresis

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Tratamiento del pie plano flexible pediátrico con atrorrisis subtalar: resultados funcionales y radiográficos

RESUMEN

Introducción: El pie plano flexible (PPF) es una de las afecciones más frecuentes que el ortopedista pediátrico afronta diariamente, con una incidencia que va desde un 15 a 45%. La artrorrisis subtalar se ha descrito como una opción de tratamiento válida, que permite a través de una técnica simple y sencilla, restaurar el arco plantar interno con pocas complicaciones. El objetivo de este trabajo es analizar una serie de pacientes de forma retrospectiva, tratados con esta técnica y evaluar los resultados clínico-funcionales y radiológicos de esta técnica. **Materiales y métodos**: Se evaluaron 41 pacientes entre 9 y 15 años, con diagnóstico de pie plano flexible idiopático tratados por dos cirujanos de nuestra institución, entre enero del 2013 y diciembre del 2019, a los cuales se les realizó una artrorrisis subtalar. Se realizó una evaluación clínica funcional y radiológica en el preoperatorio y en el postoperatorio. Para la evaluación funcional se utilizó el score de Oxford de pie de tobillo para niños en versión para padres (OxAFQ-C). Radiológicamente se evaluaron los siguientes ángulos: Cobertura talonavicular, ángulo talocalcaneo en la radiografía de frente, ángulo talocalcaneo en la radiografía de perfil y ángulo de Moreau Costa Bartani. **Resultados**: En todos los pacientes estudiados se observó una mejoría radiográfica en la alineación del pie luego de la operación. El resultado funcional evaluado a través del score de Oxford para niños arrojó que todos los pacientes analizados mostraron una amplia mejoría en su participación escolar, en las actividades físicas realizadas, en el estado emocional y en los problemas ocasionados por el uso de su calzado. **Discusión**: Si bien no hay dudas sobre el tratamiento ortopédico inicial cuando esta patología es asintomática, el tratamiento quirúrgico continúa siendo motivo de discusión; especialmente en términos de cuándo indicarla, síntomas del paciente, edad apropiada, elección de la técnica quirúrgica y la realización de procedimientos complementarios. **Conclusiones**: Este estudio mostró que la artrorrisis subtalar es una opción de tratamiento válida para los niños con pies planos flexibles sintomáticos con muy buenos resultados y pocas complicaciones postoperatorias.

PALABRAS CLAVE

Pie plano flexible, Artrorrisis subtalar, Maxwell bronchure arthroeresis

INTRODUCTION

Flexible flatfoot (FFF) is one of the most frequent conditions that pediatric orthopedists see on a daily basis, with an incidence ranging from 15 to A 45%. Consultation about this pathology is usually due to parental concern about the appearance and excessive deformity of the child's footwear, but rarely about pain or functional disability (1). The characteristic signs of this pathology are: decreased or absent internal longitudinal arch, excessive eversion during weight bearing and forefoot abduction.

The vast majority of children with flatfoot deformity will correct spontaneously and/or become asymptomatic (2). Surgical treatment is only indicated if the pain is persistent despite unsuccessful conservative treatment. Subtalar arthroereisis has been described as a valid treatment option, which allows, through a simple and easy technique, to restore the internal plan arch with few complications. The concept was first instituted in 1946 when Chambers attempted to restrict subtalar joint eversion by elevating the posterior facet of the calcaneus with bone graft (3).

Currently, the modified technique consists of placing a cylindrical implant in the subtalar joint, with the objective of elevating the head of the talus and limiting excessive eversion of the foot, restoring the internal longitudinal arch. This technique has gained popularity because it is minimally invasive and allows early loaded gait and a rapid return to play and sport (4).

The aim of this work is to retrospectively analyze a series of patients treated with this technique and to evaluate the clinical-functional and radiological results of this procedure.

MATERIAL AND METHODS

The present study was carried out in a high complexity General Hospital of the private sector, located in the Autonomous City of Buenos Aires. We performed a retrospective protocol. Forty-one patients with a diagnosis of idiopathic flexible flatfoot treated by two surgeons at our institution, between January 2013 and December 2019, who underwent subtalar arthroereisis, were evaluated.

Data collection and evaluation was performed by physicians from the same service, who were independent of the surgeons who treated the patients in this study. The functional evaluation was performed before surgery, at the time surgery was indicated, and at least 6 months postoperatively.

Inclusion criteria were: 1) idiopathic symptomatic FFF (pain in the mid-foot, hind-foot and/or tarsal sinus during standing and/or walking, resulting in limitations during daily activities);

Patients with open phthisis and under 16 years of age; Surgically intervened where subtalar arthroereisis was performed; 4) No associated neuromuscular, neurological and/or bony pathology; 5) Adequate preoperative and postoperative imaging; and 6) More than 6 months of follow-up.

Patients with rigid flatfoot or surgical treatment of the foot previously performed for subtalar arthroereisis, without adequate prior radiological imaging and/or less than 6 months follow-up were excluded.

DESCRIPTION OF THE SURGICAL TECHNIQUE

Patients are operated under general anesthesia. The patient is placed in the supine position. Percutaneous Achilles tenotomy is performed according to Hoke's technique, then an oblique incision is made over the tarsal sinus of approximately 2 cm (Image 1). Subsequently, blunt dissection is performed on subcutaneous and deep fascia. A subtalar guide pin is placed through the tarsal sinus from lateral to medial and its correct location is checked under fluoroscopy (Image 2). The dilators are then placed in successive and increasing increments until the appropriate size is determined. The diameter of the implant is defined according to the largest dilator that has been able to progress; and evidencing that it limits the hypermobility of the subtalar joint, but without restricting the normal mobility of the same. The stability of the implant within the joint, range of motion of the hindfoot and correction of the deformity (formation of the internal longitudinal arch) are then evaluated with a transitional test implant. The definitive implant is placed and the guide pin is removed and checked again with radioscopy. (Image 3).

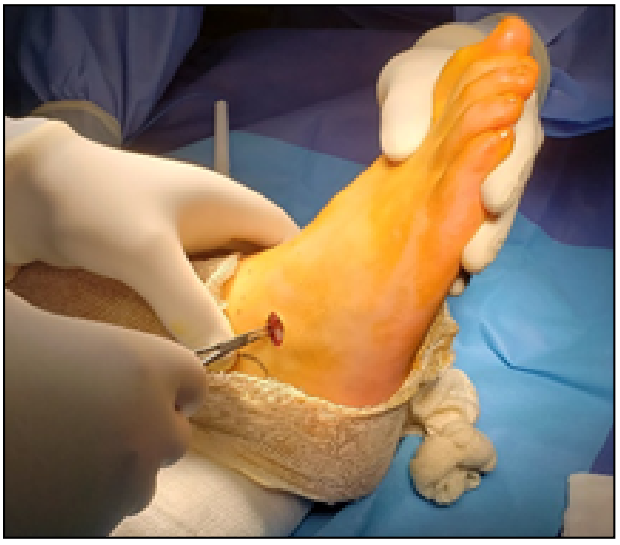


IMAGE 1

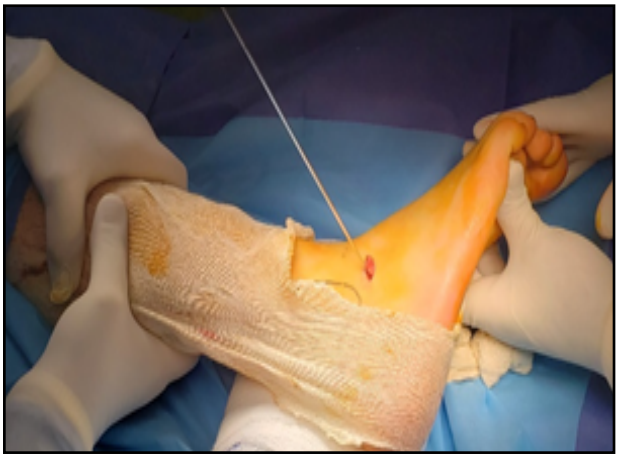


IMAGE 2

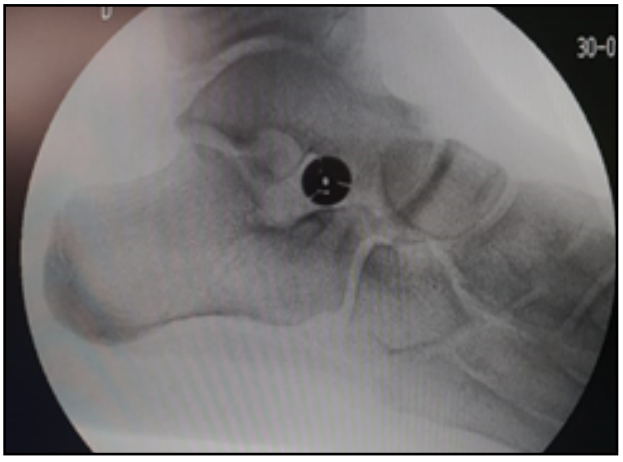


IMAGE 3

The surgeons used a titanium, self-locking, cylindrical, threaded, cannulated and grooved (MBA) implant, which allows for soft tissue growth and helps anchor the implant. The MBA implant (Maxwell Bronchure Arthroresis) is available in 5 sizes (6 mm, 8 mm, 9 mm, 10 mm and 12 mm diameter). 6 mm. Finally, a short plaster boot is made, which will be removed after 15 days. During this period of time, the weight load is completely limited, after which a plastic boot is placed so that walking can begin progressively.
For the functional assessment, the Oxford ankle foot Oxford score for children in parent version (OxA-FQ-C) was used which was performed before and after surgery. This questionnaire consists of a total of 15 questions divided into 4 topics:

1. Physical: 6 questions (24 points total)
2. School and play: 4 questions (16 points total)
3. Emotional: 4 questions (16 points total)
4. Footwear: 1 question (4 points total)

X-rays of both feet were requested in front and profile, standing. To evaluate the degree of correction of the operated foot, the following angles were measured before and after surgery (Figure 1 and 2):

1. Talonavicular Coverage Angle
2. Thalocalcaneal angle on frontal radiographs
3. Thalocalcaneal angle on profile radiographs
4. Moreau Costa Bartani angle

For the statistical analysis we used Student's t-test, with which we analyzed the clinical (Oxford score for children) and radiological differences, comparing the results before and after surgery. A p value <0.05 was considered statistically significant.

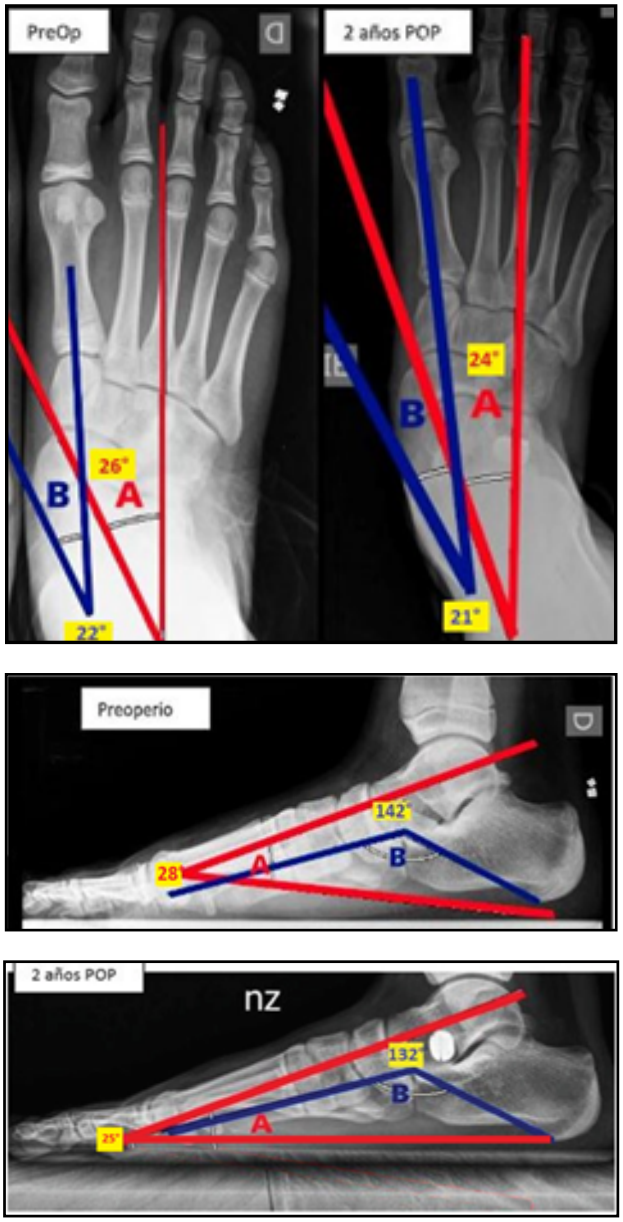


FIGURE 2. BEFORE AND AFTER SURGERY MEASURES, A: TALO-CALCANEAL ANGLE IN PROFILE RADIOGRAPHY. B: MOREAU-COSTA-BARTANI ANGLE.

RESULTS

Between 2013 and 2019, 41 children underwent subtalar arthroereisis at our center. Of the initial sample, 35 patients met the inclusion criteria, 2 of whom underwent the procedure bilaterally, leaving a sample of

37 feet. The study population consisted of 62.9% males (22 patients) and 37.1% females (13 patients), with an average age of 13 years (range: 9 to 15 years). The mean follow-up period from surgery to final patient evaluation was 20 ± 10 months.

The sample statistics indicated significant differences in the OxAFQ-C scale scores in the 4 domains evaluated (Table 1).

TABLE 1 MEAN SCORES FOR EACH TOPIC OF THE OXFORD QUESTIONNAIRE FOR CHILDREN BETWEEN BEFORE AND AFTER SURGERY PERIODS

	Before surgery	After surgery	P Value
Physical	13,18	20,23	0.01*
School and play	10,27	14,27	0.01*
Emotional	9,82	12,91	0.02*
Footwear	2,09	3,68	0.04*

* Statistically significant difference (P <0.05)

The patients showed a vast improvement in their school participation, physical activities, emotional state and problems caused by the deformation of their footwear.

Regarding radiographic evaluation, the statistical analysis showed significant results in the 4 measurements performed between before and after surgery periods (Table2).

TABLE 2 RADIOGRAPHIC ANGLES MEASURED BEFORE AND AFTER SURGERY

	Before surgery	After surgery	P Value
Thalonavicular coverage angle	31.2º	16.6º	0,003*
Thalocalcaneal angle front	25.8º	18.4º	0.001*
Thalocalcaneal angle profile	42.8º	33.4º	0.002*
Moreau Costa Bartani angle	141.2º	130.2º	0.001*

* Statisticallly significant difference (P <0.05)

In the radiographic analysis we observed the correct anatomical alignment of the foot achieved after surgery.



IMAGE 4. PODOSCOPY BEFORE SURGERY.



IMAGE 5. PODOSCOPY AFTER SURGERY.

Significant clinical changes were also evident on podoscope evaluation. (Image 4 and 5).
The following complications occurred during treatment: 2 cases (5.7%) of implant extrusion, which required a revision procedure to reposition them, 2 patients (2.7%) had to have the implant removed due to pain at the site of placement and only 1 patient (2.8%) had a superficial infection that required oral antibiotic treatment.

DISCUSSION

Flexible flatfoot is a common disorder characterized by plantar flexion and medial rotation of the talus, calcaneal eversion, collapse of the medial longitudinal arch and forefoot abduction (5) Spain.
In 1975 Evans first introduced the concept of external column lengthening to correct this deformity, Mosca later modified the technique and popularized it (7,8)symptomatic valgus deformities of the hindfoot in twenty children who had flatfoot (twenty-five feet. However, a large number of complications have been reported with this technique such as under-correction, overcorrection, loss of correction due to inadequate graft size, graft migration or mal-positioning, as well as the impossibility of an early return to the child's usual activities (9).
In 2015 Chong et al. performed a comparative study between subtalar arthroereisis and external column lengthening and observed that there was no significant difference in radiographic measurements and clinical improvement between the two techniques (10). In our experience, subtalar arthroereisis is the method we use to treat symptomatic flexible flat feet, as we consider it a simple technique, with short surgical times, rapid rehabilitation and few complications. In cases where the initial treatment expectations are not met with this procedure, more invasive and irreversible techniques are still a good alternative.
As previously mentioned, one of the most discussed points regarding this treatment is the age of the patient at the time of treatment. It is recommended to be performed between 8 and 12 years of age, this is because before the age of 8, many of the patients correct spontaneously. In addition, the success of operating on these patients after the age of 12 years is poor, since the objective of arthroereisis is to reposition the talus correctly in the calcaneus, which allows bone and joint remodeling during growth, and to perform it after this age, the post-surgical remodeling would bring poor results(11). Although all our patients were older than 8 years, 2 patients were operated on after the age of 12 years, explaining to their relatives the hazard of failure.
Another question the surgeon asks when evaluating surgical treatment is:
How limiting must the pain be for this treatment to be indicated, we take as a criterion for indicating this procedure pain that limits the patient's ability to perform daily activities after having undergone orthopedic treatment for more than 6 months. To quantify this, we used the Oxford score for children, which was developed to assess quality of life in this type of population (12). This tool assesses disease burden and also records clinical changes after treatment. In our study, parents perceived a significant improvement in the 4 domains evaluated, which is in agreement with previously published literature (10,13). A point of discussion among surgeons is whether or not to perform Achilles tendon lengthening, which is a common surgical procedure in the treatment of flat feet. Although some do not consider it necessary (14), most of the publications on subtalar arthroereisis agree on the use of Achilles tendon lengthening, since the gastrocnemius tract is part of the anatomy of flatfoot (15,16) and according to the experience of the authors, it is present in most cases, therefore in our institution we routinely perform it in all patients.

Regarding the complications reported in the literature on this treatment, persistent pain, overcorrection, insufficient correction and extrusion of the implant are mentioned (17). In our series we had 2 cases (5.7%) of implant extrusion, which required a revision procedure to reposition them, 2 patients (2.7%) had to have the implant- Test strips to pain at the site of placement and only 1 patient (2.8%) had a superficial infection that required oral antibiotic treatment. However, all of these patients had a good long-term outcome. This coincides with what has been published to date on this technique, in which a low rate of complications is reported (17). The limitations of our study are: the low number of patients, lack of long-term follow-up of patients to evaluate the possibility of subtalar arthroereisis and the retrospective model of the study.

CONCLUSION

In conclusion, this study showed that subtalar arthroereisis is a valid treatment option for children with symptomatic flexible flat feet with very good results and few postoperative complications.
However, it would be appropriate to perform a prospective evaluation comparing this technique with external column lengthening in order to increase the level of scientific evidence and thus corroborate the results obtained in the long term.

REFERENCES

1. Mosca VS. Flexible flatfoot in children and adolescents. Journal of Children's Orthopaedics. 2010.
2. Sheikh Taha AM, Feldman DS. Painful Flexible Flatfoot. Foot and Ankle Clinics. 2015.
3. CHAMBERS EF. An operation for the correction of flexible flat feet of adolescents. West J Surg Obstet Gynecol. 1946.
4. Martinelli N, Bianchi A, Martinkevich P, Sartorelli E, Romeo G, Bonifacini C, et al. Return to sport activities after subtalar arthroereisis for correction of pediatric flexible flatfoot. J Pediatr Orthop Part B. 2018.
5. García-Rodríguez A, Martín-Jiménez F, Carnero-Varo M, Gómez-Gracia E, Gómez-Aracena J, Fernández-Crehuet J. Flexible flat feet in children: a real problem? Pediatrics. 1999.
6. Giannini S. Kenneth A. Johnson Memorial Lecture. Operative treatment of the flatfoot: why and how. Foot ankle Int / Am Orthop Foot Ankle Soc [and] Swiss Foot Ankle Soc. 1998.
7. Mosca VS. Calcaneal lengthening for valgus deformity of the hindfoot: Results in children who had severe, symptomatic flatfoot and skewfoot. J Bone Jt Surg - Ser A. 1995.
8. Evans D. Calcaneo valgus deformity. J Bone Jt Surg - Ser B. 1975.
9. Moraleda L, Salcedo M, Bastrom TP, Wenger DR, Albiñana J, Mubarak SJ. Comparison of the calcaneo-cuboid-cuneiform osteotomies and the calcaneal lengthening osteotomy in the surgical treatment of symptomatic flexible flatfoot. J Pediatr Orthop. 2012.
10. Chong DY, Macwilliams BA, Hennessey TA, Teske N, Stevens PM. Prospective comparison of subtalar arthroereisis with lateral column lengthening for painful flatfeet. J Pediatr Orthop Part B. 2015.24(4):345–53.
11. Fernández de Retana P, Álvarez F, Viladot R. Subtalar Arthroereisis in Pediatric Flatfoot Reconstruction. Foot Ankle Clin. 2010.15(2):323–35.
12. Morris C, Doll HA, Wainwright A, Theologis T, Fitzpatrick R. The Oxford ankle foot questionnaire for children: Scaling, reliability and validity. J Bone Jt Surg - Ser B. 2008.
13. Faldini C, Mazzotti A, Panciera A, Persiani V, Pardo F, Perna F, et al. Patient-perceived outcomes after subtalar arthroereisis with bioabsorbable implants for flexible flatfoot in growing age: a 4-year follow-up study. Eur J Orthop Surg Traumatol. 2018.
14. Roth S, Sestan B, Tudor A, Ostojic Z, Sasso A, Durbesic A. Minimally invasive calcaneo-stop method for idiopathic, flexible pes planovalgus in children. Foot Ankle Int. 2007.
15. Cicchinelli LD, Huerta JP, Carmona FJG, Morato DF. Analysis of Gastrocnemius Recession and Medial Column Procedures as Adjuncts in Arthroereisis for the Correction of Pediatric Pes Planovalgus: A Radiographic Retrospective Study. J Foot Ankle Surg. 2008.
16. Nelson SC, Haycock DM, Little ER. Flexible flatfoot treatment with arthroereisis: Radiographic improvement and child health survey analysis. J Foot Ankle Surg. 2004.
17. Needleman RL. Current topic review: Subtalar arthroereisis for the correction of flexible flatfoot. Foot Ankle Int. 2005;26(4):336–46.