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Original Article

Arthroereisis with interference screw in flexible flatfoot, a comparison with the conventional surgical technique

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Abstract

Objective: To evaluate functional results of subtalar arthroereisis with non-conventional implants, as well as their clinical, radiographic, and functional results, comparing them with those of the conventional technique.

Methods: Documentary research consisting of the analysis and review of medical records of six patients, with application of the Orthopaedic Foot and Ankle Score (AOFAS) and Short-Form Health Survey 36 (SF-36) questionnaires and evaluation of pre-and postoperative radiographic results.

Results: Patients achieved satisfactory clinical and functional results, indicated by an improvement in the pitch, kite, Giannestras, and Meary angles analyzed and by comparing the pre-and postoperative periods. There was also an improvement in the AOFAS and SF-36 questionnaire scores postoperatively, suggesting an evolution in the quality of life of patients studied.

Conclusion: Subtalar arthroereisis is a non-invasive surgical procedure that contributes to the clinical improvement of patients. The use of interference screw showed good results, with the advantage of it being a low-cost implant when compared to the conventional ones, which makes the procedure more accessible.

Level of Evidence III; Therapeutic Studies; Case control study.

Keywords: Flatfoot; Subtalar arthroereisis; Interference screw.

Introduction

Flexible flatfoot is a multiplanar deformity prevalent in children and adults, clinically differing according to the age of onset. In children, the main complaint reported by parents is the appearance of the feet[1-2], possibly associated with ligamentous laxity and functional disability. In adults, medial pain is characterized as the main symptom, associated with tendonitis and posterior tibial insufficiency[3]. When conservative treatment is not effective, surgical treatment is debatable, and the best age for its performance is between 8 and 14 years[4].

The main surgical techniques are arthroereisis, calcaneal lateral stretching osteotomy, and triple arthrodesis. Subtalar arthroereisis stands out because it is a minimally invasive procedure in which encouraging results have been demonstrated, with low surgical risk and reversible complications, if any (implants can be removed). Another advantage presented by the technique is the possibility of bilateral approach at the same surgical time, rapid recovery, and load release[5]. In this procedure, an implant positioned in the subtalar joint, within the tarsus, is used in order to limit the excessive pronation of such joint, promoting its inversion, with restoration of the longitudinal plantar arch, as per Highlander and Myerson[3-4].

Currently, there are several types of implants, each with its particular biomechanical properties, such as: cancellous screw with polyethylene-coated head (Pisani screw), synthetic polyethylene implant, Blount staple, 4.5 mm 24–26 mm

Study performed at the Hospital das Clínicas – HC, Ebserh-UFG; Goiânia, GO, Brazil.

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short-thread cancellous screw, depending on the age[6], STAY-peg devices, and bioabsorbable interference screws. New materials are being developed and tested in an attempt to find the ideal implant for arthroereisis. It is known that the cost of materials is still a limiting factor for their use in the treatment of flexible flatfeet, and this study seeks an effective and low-cost alternative.

Methods

This study was approved by the Institutional Review Board under the number CAAE 00777118.5.0000.0033.

This is a retrospective study based on the analysis of six patients treated by the foot and ankle group at Hospital de Urgências de Goiânia – HUGO. Patients underwent subtalar arthroereisis from January 2013 to August 2018, with an average follow-up time of 58 months between surgical treatment and the last clinical evaluation in an outpatient consultation (patient 1: 96 months, patient 2: 60 months, patient 3: 24 months, patient 4: 24 months, patient 5: 96 months, and patient 6: 48 months). Findings were compared to those of three other patients with an average follow-up time of 32 months between surgical treatment and the last clinical evaluation in an outpatient consultation (patient 1: 36 months, patient 2: 24 months, and patient 3: 36 months). Patients with symptomatic flexible flatfoot who had failed conservative treatment and did not require other corrections and concomitant osteotomies were included. Patients undergoing calcaneal osteotomy associated with subtalar arthroereisis, under 10 years of age, and with marfanoid phenotype were excluded. Based on data obtained from medical records, pre-and postoperatively, all participants were submitted to clinical evaluation through the application of the Orthopaedic Foot and Ankle Score (AOFAS) scale for ankle and hindfoot and Short-Form Health Survey 36 (SF-36) quality of life questionnaire, thus allowing the standardization of results.

Data inherent to age, gender, affected side, deformity, symptoms, flexibility, and range of motion of the affected foot were evaluated, as well as the radiographs of functional angles (pitch, kite, Meary, and Giannestras), pre-and pos-toperatively. Data collected will be kept confidential and stored for a period of five years. Then, it will be incinerated according to the guidelines of the Brazilian National Health Council (CNS) resolution n. 196/96.

Patients' profile characterization was performed by means of absolute frequency, relative frequency, mean, and standard deviation. Data normality was verified using the Shapiro-Wilk test. The distribution of patients' profile in the control and intervention groups was tested using Pearson's chi-square test and Student's *t*-test. The comparison of angles before and after intervention was tested using paired *t*-test. The evaluation of deltas between groups was performed using the Mann-Whitney test. Spearman's correlation analysis was applied in order to evaluate the relationship between the delta of the angles in each group. Data were analyzed using the Statistical Package for Social Science (IBM Corporation, Armonk, USA), version 26.0. A level of significance of 5% ($p < 0.05$) was adopted.

The AOFAS scale is an instrument of easy application and comprehension for specific evaluation of the hindfoot and ankle region. It does not require imaging or other tests of greater complexity. The questionnaire consists of nine items distributed in three categories – pain, functional aspects, and alignment, with respective scores of 40, 50, and 10 points, totaling a maximum score of 100 points. For its interpretation, the following averages are used: less than 40 points, poor; 40–60 points, satisfactory; 60–80 points, good; 80–100 points, excellent results.

The SF-36 is a generic instrument for assessing quality of life. It is a multidimensional questionnaire consisting of 36 items encompassed in 8 domains, namely: functional capacity, pain, general health status, physical aspects, social aspects, vitality, emotional aspects, and mental health. The score is obtained in ranges from 0 to 100, with 0 being the worst general state of health and 100, the best general state of health.

Surgical technique was performed with the patient in the supine position under spinal anesthesia, taking all asepsis and antisepsis measures. Exsanguination by tourniquet of the limb to be operated was performed. A 2 cm incision was made in the topography of the tarsal sinus, with dissection of the subcutaneous tissues with a hemostatic forceps to create a path for guide wire passage in the tarsal canal. The guide wire was inserted about 15° perpendicular to the sagittal plane that goes from anterolateral to posteromedial with the aid of fluoroscopy, and the interference screw was introduced into the tarsal sinus according to Figure 1. To confirm the final placement, fluoroscopy was used. The size of the implant was

Figure 1. Patient positioning and interference screw insertion with a guide wire.

tested intraoperatively by measuring the subtalar resistance. As for the prosthesis, on average, it is 8 mm, but it depends on the test (normally, materials contain 6 mm, 8 mm, and 10 mm test options). When using the interference screw, the size is chosen by measuring the fixation site, taking care to avoid looseness in the subtalar screw. If satisfactory, the guidewire is removed.

Surgical wound was sutured with a simple stitch using Nylon 4.0. In the postoperative period, patients had suropodalic cast immobilization for four weeks in a neutral position of the ankle; after cast removal, they started a physiotherapeutic treatment to gain range of motion and proprioception. Patients stand up or walk with the use of orthosis for two weeks, with use of full load permitted from the eighth week on.

Operated feet were classified as satisfactory or unsatisfactory based exclusively on clinical criteria and personal satisfaction with the aid of the scales applied (AOFAS scale for ankle and hindfoot and SF-36 quality of life questionnaire).

All participants were clinically followed up and radiographed at at least two moments in outpatient visits (annual radiographic follow-up).

Results

In the period from 2013 to 2018, six patients were treated with subtalar arthroereisis, totaling 10 feet operated using interference screw. These patients were compared with three patients treated with conventional implants who totaled six feet operated. All patients were followed up on outpatient visits and evaluated radiographically and clinically using the AOFAS scale and the SF-36 questionnaire before and after surgical procedure. At follow-up, all patients underwent radiograph of the operated foot in order to verify the angular correction obtained, as well as possible signs of complications or surgical failure. In preoperative radiographs, the deformity was observed as per Figure 2 and Figure 3. Figure 4 shows an intraoperative fluoroscopy image.

Figure 2. Preoperative radiographs. A. Anteroposterior; B. Profile, C. Axial view of the calcaneus.

Figure 3. Deformity photographs.

The total prevalence of flatfoot in the present study was higher in male patients (nine feet operated) than in female patients (seven feet operated). Mean age obtained was 11.67 ± 0.52 years in the control group and 12.30 ± 1.64 years in the intervention group. Regarding laterality, nine right feet (56.3%) and seven left feet (43.8%) were approached. In the intervention group, there were six right feet (60%) and four left feet (40%); of these, seven in female patients (70%) and three in male patients (30%). Four patients were bilaterally affected (Table 1).

Patients walked without crutches or other support. There was angular improvement in all angles observed. Preoperative anteroposterior talus-first metatarsal angle in the control group was 25.33º ± 5.32º; postoperative, 4.00º ± 2.28º. In the intervention group, findings were 25.50º ± 4.60º preoperatively and 3.40º ± 2.17º postoperatively. Preoperative Meary angle in the control group was 13.67º ± 0.82º; postoperative, 5.00º ± 1.10º. In the intervention group, angles of 16.40º ± 4.30º were found preoperatively, and of 4.60º ± 2.67º postoperatively. Preoperative calcaneal pitch in the control group was 4.67º ± 1.03º; postoperative, 12.00º ± 2.53º. In the intervention group, findings were 4.70º ± 1.64º preoperatively and 10.60º ± 1.90º postoperatively. No skin complications were observed after surgery (Figure 5, Table 2).

Most patients were satisfied with postoperative results, which is evidenced by an increase in the mean score on the AOFAS scale, where, in the preoperative period, an average of 69.3 points was obtained, while in the postoperative period the average was 87.3 points out of the total score of 100 points (Figure 6)[7].

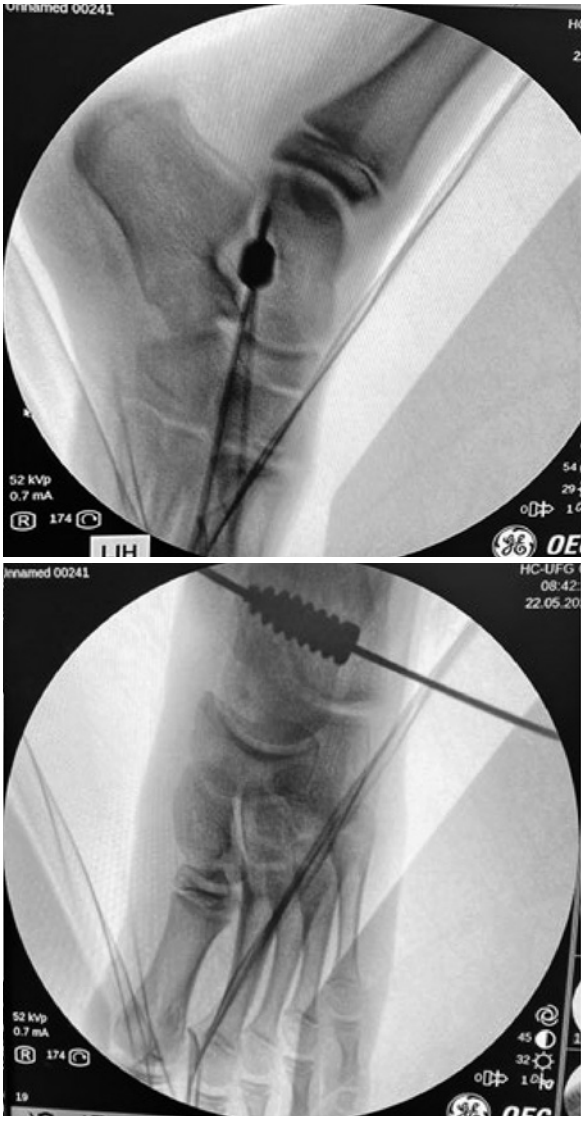

Figure 4. Intraoperative fluoroscopy.

Table 1. Profile characterization of patients in the control and intervention groups

	Groups		Total	p
	Control 6 (37.5)	Intervention 10 (62.5)		
Mean ± SD				
Age (years)	11.67 ± 0.52	12.30 ± 1.64	12.06 ± 1.34	0.38**
	n (%)			
Sex				
Female	0 (0.0)	7 (70.0)	7 (43.8)	0.07*
Male	6 (100.0)	3 (30.0)	9 (56.3)	
Foot				
Right	3 (50.0)	6 (60.0)	9 (56.3)	0.69*
Left	3 (50.0)	4 (40.0)	7 (43.8)	

*Chi-square test; **Student's *t*-test; n = absolute frequency; % = relative frequency; SD = standard deviation.

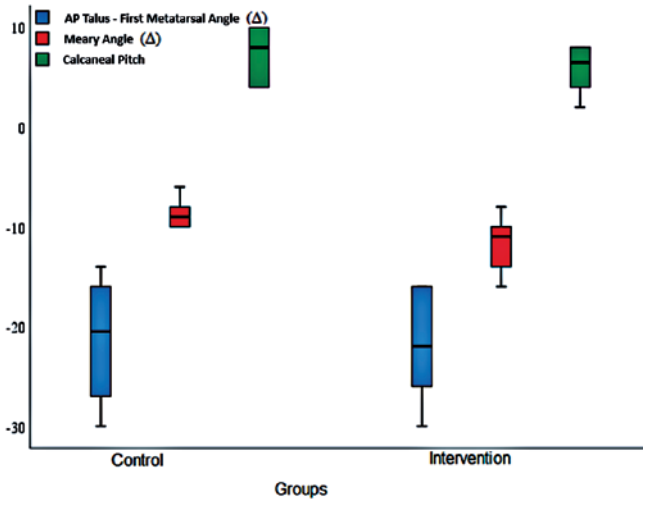

Figure 5. Boxplot graph comparing the delta values of angles between the control and intervention groups.

An improvement in the quality of life of patients was observed, as indicated by the improved SF-36 scale scores obtained. Questions regarding pain and limitation due to physical aspects were the ones that stood out positively as the greatest benefits, considering all general means in the pre-and postoperative periods. Respective scores were preoperatively, 64.5 and 66.6 points, and, postoperatively, 93 and 95 points (Figure 7).

Table 2. Angle comparison pre-and postoperatively in the control and intervention groups

Mean ± SD	Control		p*	Intervention		p*
	Preop	Postop		Preop	Postop	
AP talus-first metatarsal angle	25.33 ± 5.32	4.00 ± 2.28	0.001	25.50 ± 4.60	3.40 ± 2.17	<0.001
Meary angle	13.67 ± 0.82	5.00 ± 1.10	<0.001	16.40 ± 4.30	4.60 ± 2.67	<0.001
Calcaneal pitch angle	4.67 ± 1.03	12.00 ± 2.53	0.001	4.70 ± 1.64	10.60 ± 1.90	<0.001

*Paired *t*-test; AP = anteroposterior; Preop = preoperatively; Postop = postoperatively; SD = standard deviation.

Score	Variation
Pain	0 to 40
Function	0 to 45
Limitation of activities	0 to 10
Type of footwear	0 to 5
Maximum walking distance	0 to 10
Walking surfaces	0 to 10
Gait abnormality	0 to 10
Foot alignment	0 to 15
Total	**100%**

Figure 6. Overall mean score on the AOFAS questionnaire applied to patients evaluated preoperatively and postoperatively.
Source: Rodrigues RC, Masiero D, Mizusaki JM, Imoto AM; et al. 2008 [7]

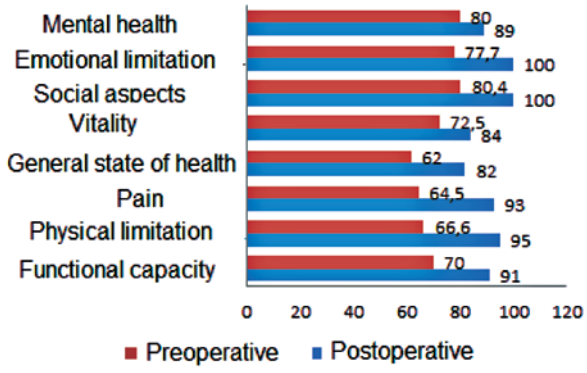

Figure 7. Overall mean score on the SF-36 questionnaire applied to patients evaluated preoperatively and postoperatively.

Figures 8 and 9 show a radiographic comparison of the pre- and postoperative posteroanterior projections of a patient.

Discussion

For Bernasconi[8], flexible flatfoot is a complex and multiplanar deformity, where pain is a constant and determining factor for surgical treatment indication. Currently, there are not enough data to explain why a flexible flatfoot remains asymptomatic or becomes painful, with the exception of cases in which the deformity is advanced and gait dysfunction is present.

Figure 8. Preoperative anteroposterior radiographs.

Figure 9. Postoperative anteroposterior radiographs.

It is a multifactorial pathology with presence of increased stresses on the ligaments that support the arch and the posterior tibial tendon. In most cases, it is associated with other risk factors, such as obesity, hypertension, diabetes, and high impact sports[9].

The true incidence of this condition is unknown, mainly because there is no consensus on the strict clinical or radiographic criteria for its definition[2]. However, it was observed in this study that the prevalence in females was higher, agreeing with literature [9].

There are several treatment options for flexible flatfoot. Although there is still no consensus on the best treatment protocol, subtalar arthroereisis deserves to be highlighted because it is a little invasive procedure that provides faster patient return to daily life activities, with less pain when compared to other surgical techniques[10-11].

According to Giannini[12], there is a variety of arthroereisis implants currently available, which can be divided into bioabsorbable, non-absorbable, or combined implants. Higher complication rates have been observed in absorbable implants. The properties of implants consist of axis change, impact locking, and self-locking. Some implants can cross several categories and differ in various sizes; all of them are capable of multiplanar correction of the deformity.

Despite such variety, the cost of implants is still very high, which becomes an obstacle to the development of the technique and access to such treatment.

The present study aimed to analyze the use of an alternative implant – the interference screw –, which demonstrated excellent postoperative results, with a significant decrease in material costs. The average price of the interference screw corresponds to 8% of the value of the standard implant used in the conventional technique. The interference screw has an average cost of US$40 according to the Brazilian Unified Health System (SUS) table, while the conventional prosthesis has an average cost of US$500.

As observed by Deland[5], treatment of subtalar arthroereisis with conventional implants was able to produce a remarkable improvement in the axes of diseased feet, as well as to increase AOFAS questionnaire scores when compared preoperatively and postoperatively. This result is similar to that found in the present study, where the pre-and postoperative quality of life measured by the SF-36 questionnaire was also assessed.

Despite the favorable results found, complication rates of subtalar arthroereisis vary from 30% to 40%, and main complications include persistent pain in the tarsal sinus, osteonecrosis, subtalar arthroereisis, overcorrection, loosening or breaking of the implant, subluxation, incorrect fixation, and fractures[10].

To perform the procedure, it is necessary to observe the technique, as well as to choose the appropriate implant size in order to reduce the possibility of complications inherent to the treatment, taking into account the need to adapt the size of the implant to its insertion point in the patient's joint, preventing it from being protruding or loose at the insertion point.

The angular results seen in radiographs and clinically observed on the AOFAS questionnaire for patients in whom interference screws were used are similar to those obtained by the conventional technique, with a mean follow-up time of 58 months for those treated with the interference screw and 32 months for those treated with the conventional technique. However, statistical analysis resulted in a high *p*-value for the AP talus-first metatarsal angle (Δ) and for the calcaneal pitch angle (Δ), as seen in Table 3. We credit this result to the small number of patients enrolled in the study.

Conclusion

In this study, we conclude that subtalar arthroereisis using interference screw is a treatment choice for patients with flexible flatfoot.

It should also be considered that the interference screw has a lower financial cost, facilitating access to the procedure and increasing medical indications.

We emphasize the importance of good anteroposterior and lateral radiographs with load to evaluate the plantar arch, subtalar space, and implant positioning, identifying possible complications.

Results of this investigation corroborate those of current scientific studies, and we believe that additional studies on the treatment of these lesions deserve to be highlighted.

Table 3. Angle delta comparison between the control and intervention groups

Mean ± SD	Groups		p*
	Control	Intervention	
AP talus-first metatarsal angle (Δ)	-21.33 ± 6.80	-22.10 ± 5.63	0.713
Meary angle (Δ)	-8.67 ± 1.63	-11.80 ± 2.57	0.031
Calcaneal pitch angle (Δ)	7.33 ± 2.73	5.90 ± 2.33	0.312

*Mann-Whitney; AP = anteroposterior; SD = standard deviation.

Authors' contributions: Each author contributed individually and significantly to the development of this article: JSM *(https://orcid.org/0000-0003-4742-1905). Conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process, performed the surgeries, data collection, bibliographic review, survey of the medical records, clinical examination and approved the final version; LVP *(https://orcid.org/0000-0002-4695-637X), and LOS *(https://orcid.org/0009-0001-4979-7826) Performed the surgeries, formatting of the article, interpreted the results of the study, participated in the review process, approved the final version, statistical analysis; LPSDC *(https://orcid.org/0000-0003-1477-4341), and GDFR *(https://orcid.org/0000-0003-4979-7826), and JYHF *(https://orcid.org/0000-0002-9154-2782), and IOCDM *(https://orcid.org/0000-0001-6281-1480) performed the surgeries, conceived and planned the activities that led to the study, bibliographic review. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

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