

Original Article

Isolated subtalar arthrodesis causes loss of ankle mobility

Camilo Miranda de Pinho Tavares¹, Roberto Zambelli de Almeida Pinto¹, Fernando Araújo Silva Lopes¹,
Rodrigo Simões Castilho¹, Thiago Alexandre Alves Silva², Daniel Soares Baumfeld³

1. Hospital Mater Dei, Belo Horizonte, MG, Brazil.

2. Hospital Madre Teresa, Belo Horizonte, MG, Brazil.

3. Hospital Felício Rocho, Belo Horizonte, MG, Brazil.

Abstract

Objective: To evaluate and quantify, through physical examination, loss of ankle mobility in patients undergoing subtalar fusion, in comparison to the contralateral side.

Methods: A total of 12 patients who underwent unilateral isolated subtalar arthrodesis for different conditions were selected. The assessment was performed with the aid of a goniometer, measurements of the bilateral range of motion of the tibiotalar joint, in closed chain weight-bearing and open chain non-weight-bearing. The same foot and ankle surgeon performed all measurements.

Results: The operated side achieved significantly lower range of motion values in the closed chain weight-bearing test compared to the contralateral side, with a mean difference of 5.4° ($p=0.029$) for dorsiflexion and 7.6° ($p=0.006$) for plantar flexion. No statistically significant difference was found in the open chain test.

Conclusion: Isolated subtalar joint arthrodesis leads to reduced range of motion in the ipsilateral ankle.

Level of Evidence III; Therapeutic Study; Comparative Retrospective Study.

Keywords: Arthrodesis; Subtalar joint; Joint diseases.

Introduction

Subtalar joint arthrodesis (SJA) is a procedure used by foot and ankle surgeons to treat degenerative disorders of this joint⁽¹⁾, aiming at possible corrections of deformities and at relieving chronic pain. This surgical approach is usually the treatment of choice for primary and secondary arthrosis, and in some cases is also used to treat posterior tibial tendon insufficiency and tarsal coalitions (Figure 1). It is a viable surgical option when no other hindfoot joint is involved. Studies show that isolated subtalar fusion can affect neighboring joints, but not to a debilitating degree. At present there is no objective and accurate method to assess the effect of different hindfoot arthrodeses on the movement of unfused adjacent supra and inframalleolar joints⁽²⁾.

Clinically, patients undergoing isolated SJA benefit from improved quality of life and pain relief⁽³⁾, and these benefits are, in most cases, superior to the procedural limitations. This arthrodesis restricts eversion and inversion movements by 84% and 88%, respectively⁽⁴⁾, reduces to some degree the movement of the talonavicular and calcaneocuboid joints, and produced an average decrease of 46% in the excursion of the posterior tibial tendon during active hindfoot inversion⁽⁵⁾. Patients commonly have difficulty accommodating their feet on uneven ground, and may progress with some degree of arthrosis in adjacent joints.

Physical examinations of patients with limitations in the sagittal plane of the ankle joint are not an uncommon occurrence in the immediate or late postoperative period.

Study performed at the Hospital Mater Dei, Belo Horizonte, MG, Brazil.

Correspondence: Camilo Miranda de Pinho Tavares. 310/601 dos Otoni St., Belo Horizonte, MG, Brasil, Zip Code: 30150-270. **E-mail:** camiloptavares@gmail.com
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Few studies have objectively quantified the value of this loss. Most of them are trials with cadaveric models of healthy feet, and do not take into account the subject's clinical evaluation.

The aim of this study is to assess and quantify, through physical examination, loss of ankle range of motion (ROM) in a patient undergoing isolated SJA compared to the healthy contralateral side.

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 22254619.5.0000.5128.

This is a retrospective study to assess ankle ROM in patients undergoing isolated subtalar arthrodesis between 2017 and 2018 in a tertiary referral hospital. Patients with sequelae of calcaneal fractures, primary arthrosis, talocalcaneal bar, sequelae of pes cavus and sequelae of pes planovalgus in posterior tibial tendon insufficiency, in which the only procedure on the operated foot was subtalar arthrodesis, were enrolled in this study. Exclusion criteria were: bilateral involvement or any other surgical procedure on the contralateral side, presence of other arthrodeses on the foot or ankle, adjuvant soft tissue procedures and follow-up of less than 12 months.

To assess ankle movement, we performed the ROM measurement in the sagittal plane of the tibiotalar joint in closed

and open chain with weight-bearing, comparing the operated side with the contralateral side, which served as a control. To measure the range of motion of weight-bearing closed chain dorsiflexion (MDF), the patient was positioned standing with one foot on the floor and the foot to be examined on a bench about 30cm high, keeping the knee and hip flexed (Figure 2). The patient then leaned forward with most of their body weight on the examined foot. To measure weight-bearing plantar flexion (MFF), the patient was asked to lift the heel of the examined foot so that they would be standing with the limb on the bench supported by the toes alone, with the knee still flexed and with most of their weight body resting on the examined foot⁽⁶⁾ (Figure 3). Measurement of range of motion in open chain of dorsiflexion (MDA) and plantar flexion (MFA) was performed with the patient in the supine position on a stretcher, and the ROM performed passively (Figure 4). The angle between the longitudinal axis of the tibia and the lateral margin of the foot was used as a parameter and measured using a goniometer. All patients were evaluated and had their ranges of motion measured by the same Foot and Ankle surgeon. The measurements were performed on the limb that had undergone surgical intervention and on the contralateral limb, which was considered the parameter of normal mobility for each subject.



Figure 1. Lateral ankle radiograph showing subtalar joint arthrodesis.



Figure 2. Evaluation of weight-bearing closed chain ankle dorsiflexion. Hip and knee flexed with body weight on the evaluated limb. The red line shows the angle used to measure the range of motion.



Figure 3. Evaluation of ankle plantar flexion in weight-bearing closed chain test. Hip and knee in flexion with body weight on the evaluated limb, with the patient on the tips of his toes. The red line shows the angle used to measure the range of motion.

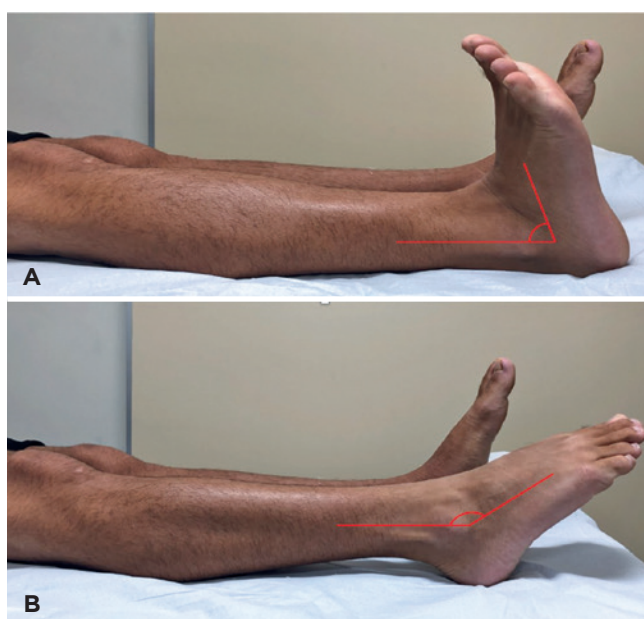


Figure 4. Evaluation of ankle dorsiflexion (A) and plantar flexion (B) in non-weight-bearing open chain test.

All patients answered a brief questionnaire covering the resumption of daily activities, the resumption of sports activities, and the visual analog scale (VAS) of pain.

To statistically verify if there is difference between the left and right sides of the MDF, MFF, MDA and MFA variables, the Mann-Whitney test was performed⁽⁷⁾. To assess the factors related to the differences between one side and the other, we conducted Spearman's correlation test between the quantitative variables, the Mann-Whitney test⁽⁷⁾ for the categorical variables, and the linear regression model for the Pathology variable. The software used in the analyses was R Studio. The p-value of <0.05 was considered significant.

Results

A total of 12 patients were selected, aged between 24 and 73 years. Within this sample, four were female (33%) and six male (67%). Considering the affected side, the sample consists of an equal number of patients operated on the right or left side. The condition responsible for most of the isolated talocalcaneal arthrodesis procedures, with 42% of cases, was calcaneal fracture, which includes primary fusions or sequelae after previous osteosynthesis. The other causes were talocalcaneal coalition (25%), primary arthrosis (17%), pes planovalgus (8%), and pes cavus (8%) (Table 1).

Eight patients resumed the sport they engaged in before the fusion as normal. Only two patients had not yet resumed sports activities at the time of this analysis, and the remaining patients did not engage in any sports activities before the arthrodesis. All patients assessed resumed their daily activities, such as work, recreational activities and social life. The VAS answered by the patients averaged two on the scale of zero to ten.

Table 2 presents the comparison of categorical variables between the operated and nonoperated sides. Significant differences between the sides can be seen in the weight-bearing

Table 1. Descriptive analysis of categorical variables

	Variables	N	%
Sex	Female	8	67%
	Male	4	33%
Operated side	Right	6	50%
	Left	6	50%
Conditions	Calcaneal fracture	5	42%
	Talocalcaneal coalition	3	25%
	Primary arthrosis	2	17%
	Pes planus	1	8%
	Pes cavus	1	8%
Resumption of daily activities	Yes	12	100%
	No	0	0%
Resumption of sport	Yes	8	67%
	No	4	33%
Mechanical axis	Normal	12	100%

Table 2. Comparison of ankle mobility between the operated and nonoperated sides

Variable	Side	Mean	S.D	p-value
MFF	Operated	30.6°	1.8	p=0.006
	Not Operated	38.2°	1.0	
MDF	Operated	12.8°	1.8	p=0.029
	Not Operated	18.2°	1.1	
MFA	Operated	32.7°	2.4	p=0.081
	Not Operated	38.0°	1.4	
MDA	Operated	12.3°	1.7	p=0.208
	Not Operated	15.3°	1.1	

MDF and MFF range of motion tests. The mean difference in dorsiflexion was 5.4° (ranging from 0°-10°) as compared to the normal side (p=0.029), and the mean loss of plantar flexion was 7.6° (ranging from 2°-20°), also compared with the contralateral limb (p=0.006).

The difference in non-weight-bearing open chain ROM averaged 3° (ranging from 2° to 11°) for MDA (p=0.208) and 5.3° (ranging from 2° to 18°) for MFA (p=0.081), with no statistical significance.

Discussion

The result of this study showed a difference in ROM measurements between closed and open chain. The non-weight-bearing open chain test showed less loss of movement than the weight-bearing closed chain test. The result also revealed that in our sample, the loss of ankle ROM was probably due to fusion of the subtalar joint, not having any statistical significance when we compared loss of ankle movement with the variants sex, operated side, nature of the condition that led to arthrodesis, presence of residual pain and alteration of the mechanical axis.

It is widely accepted in the orthopedic community that the purpose of SJA is to relieve pain and improve function⁽⁸⁾. Some arthrodeses prevent certain functions, as they limit the patient's ability to perform movements considered crucial for activity⁽⁹⁾. After a clinically and radiologically fused subtalar joint, there is a high rate of patient satisfaction and more than 90% of patients are able to perform their daily activities⁽¹⁰⁾. In the case of this study, in which patients underwent isolated SJA, the movement of this locked joint can lead to alterations such as difficulty in walking on uneven terrain. Patients should be aware that fusion is a salvage procedure, which will cause persistent changes in gait, with the potential for deterioration due to the development of arthrosis in neighboring joints⁽¹⁰⁻¹²⁾.

The best way to assess and quantify loss of ankle movement in patients who have undergone isolated subtalar arthrodesis is to measure and compare the amount of movement in the bilateral sagittal plane, giving consideration to the fact

that the healthy contralateral limb is considered normal for each patient. Savva and Saxby reported that dorsiflexion and plantar flexion capacity was almost 20% lower compared to the healthy side when they assessed postoperative range of motion in the sagittal plane in patients with subtalar arthrodesis for calcaneal fracture sequelae⁽¹³⁾. Another study compared ankle range of motion after isolated SJA with the contralateral side, and the result was average movement in the sagittal plane of 9.8° of dorsiflexion (contralateral limb, 14.2°) and 47.2° of plantar flexion (contralateral limb, 52.4°). This represented a reduction of 30% (4.4°) and 9.2% (5.2°) in dorsiflexion and plantar flexion, respectively, when compared to the contralateral limb⁽¹⁴⁾. In the study in question, they performed the measurements under load, and distinguished between closed and open chains, which no study found in the literature had done. We found a 5.4° reduction in dorsiflexion and 7.6° in plantar flexion, both under load in closed chain. In open chain, the reduction was 3° and 5.3° for dorsiflexion and plantar flexion, respectively.

Several studies have used cadaver foot and ankle models to investigate ROM before and after arthrodesis^(2,4,15,16). Despite the relevance of these studies in defining the parameters to be evaluated when defining the type of arthrodesis to be performed and the joints to be involved in the case of a condition that requires some hindfoot fusion, these studies were carried out without considering the effect of the load applied on the lower limb, or the muscle strength vectors that interfere in ankle movement. Accurate clinical evaluation of foot and ankle ROM after a particular arthrodesis procedure is difficult, because several factors can interfere with the measurement, such as knee, hip or lower back conditions, which limit the ability to bear weight on the ankle to be assessed, thus interfering in the final result despite the fact that some forms of measurement are shown to be reliable in the literature^(6,17-19).

The result of this study showed that even though subtalar arthrodesis leads to loss of ankle mobility, the non-weight-bearing open chain test specifically had a higher ROM in the study compared to the weight-bearing closed chain test. This greater mobility was due to the fact that the midfoot joints were not locked during the open chain test. Accordingly, we can attest that these joints contribute to hindfoot mobility in the sagittal plane after an isolated subtalar fusion. We must also remember that the patient undertaking the open chain test was supine with their knee extended, without counteracting gastrocnemius force, and that a possible shortening of this muscle could alter the plantar flexion movement.

The type of pathology that triggered the subtalar arthrosis does not seem to be related to the magnitude of loss of ankle ROM. One study demonstrated that there was no difference in ROM in the sagittal plane between patients with subtalar arthrosis secondary to calcaneal fracture and those with other etiological factors⁽¹⁾. Our study showed no difference when we compared loss of ankle movement with the nature of the pathology that led to the arthrodesis. There are no studies comparing range of motion after subtalar arthrodesis in relation to other etiological factors.


This study has some limitations. It consists of a small sample, with only 12 feet. We measured only one simple movement in the sagittal plane alone. The joint complex of the ankle and foot are composed of a system of joints that act synergistically and normally no movement is performed alone.

Further studies comparing the impact of loss of ankle movement after isolated subtalar arthrodesis on the patient's activities of daily living, and biomechanical studies showing

the value of the contribution of each hindfoot joint to ankle mobility will be needed in the future.

Conclusion

Isolated subtalar arthrodesis leads to significant loss of ankle movement in the sagittal plane, particularly in plantar flexion. Midfoot joints contribute to continued ankle mobility after a subtalar fusion, offsetting the loss of movement to some extent.

Authors' contributions: Each author contributed individually and significantly to the development of this article: CMPT *(<https://orcid.org/0000-0002-2503-8721>) conceived and planned the activities that led to the study, interpreted the results of the study, wrote the article and approved the final version; RZAP *(<https://orcid.org/0000-0001-9692-5283>) conceived and planned the activities that led to the study, performed the surgeries, participated in the review process and approved the final version; FASL *(<https://orcid.org/0000-0001-5214-2420>) conceived and planned the activities that led to the study, participated in the review process, approved the final version; RSC *(<https://orcid.org/0000-0001-5388-475X>) conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process, approved the final version; TAAS *(<https://orcid.org/0000-0003-2333-2334>) participated in the review process, approved the final version; DSB *(<https://orcid.org/0000-0001-5404-2132>) participated in the review process, approved the final version. *ORCID (Open Researcher and Contributor ID). 

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