

Systematic Review

Arthroscopic subtalar arthrodesis – results and complications: a systematic review

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Abstract

Objective: The objective of this study is to evaluate the results and complications of the subtalar arthrodesis technique conducted via arthroscopy.

Methods: Searches were run on PubMed/Medline and Google Scholar for publications dated from 2007 to 2020. Original articles were included that reported the results of at least one comparative postoperative scale. Methodological quality was assessed using the PRISMA tool. Union rate, complications, and the American Orthopedic Foot and Ankle Society (AOFAS) score were prioritized.

Results: A total of 124 references were identified and, after application of the inclusion and exclusion criteria and the PRISMA tool, 9 articles were eligible. A total of 180 patients were analyzed, with mean postoperative follow-up of 18 months (± 6) and with before and after AOFAS scores varying from 44 to 79 with $p < 0.001$, demonstrating statistical relevance with significant improvement of AOFAS scores during the postoperative period. Deformity correction, improvement of pain, and rates of union were good and there was clinical improvement according to postoperative AOFAS scores, with few complications. However, the heterogeneous nature of studies, with variations in techniques and samples, prevents generalization of the findings.

Conclusion: The results of arthroscopic surgery for subtalar arthrodesis are good and rates of complications are low, but there are still few studies with high evidence levels that demonstrate the efficacy of the technique, although preliminary results are encouraging.

Level of Evidence I; Therapeutic Studies; Systematic Review.

Keywords: Arthrodesis; Subtalar joint; Arthroscopy.

Introduction

Degenerative injuries of the subtalar joint have multiple etiologies, such as primary osteoarthritis, posttraumatic arthritis, inflammatory arthropathy, congenital pathologies, or acquired deformities. When conservative treatment is unsuccessful, arthrodesis can relieve pain and improve functional status. Arthroscopic techniques are becoming increasingly popular, because they involve reduced surgical trauma, fewer complications, and faster recovery⁽¹⁻³⁾.

Painful symptoms, primarily when walking on rough ground, and instability are both common, leading to loss of function and restriction of activities⁽⁴⁾.

Fractures of the calcaneus cause chronic pain, are incapacitating, and have uncertain prognosis. Pain may be caused by subtalar and/or calcaneocuboid arthritis, widening of the lateral wall, causing impact on the fibular tendons, malalignment of the hindfoot, loss of heel height and inclination of the talus (causing ankle pain and reducing impulse strength), in addition to damage to the fat pad of the heel and/or injury to sensory nerves of the hindfoot⁽⁵⁾.

The most common clinical findings of subtalar arthritis are: lateral swelling of the hindfoot, painful amplitude of subtalar movement, and altered tactile sensitivity. Diagnosis is confirmed by weightbearing X-rays of the foot in anteroposterior,

Study performed at the Unievang lica, Centro Universit rio, An polis, GO, Brazil and Hospital Santa Marcelina, S o Paulo, SP, Brazil.

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oblique, and lateral views. Additional projections include Broden's view (showing the posterior facet of the calcaneus for assessment of the extent of arthritis), the Harris axial view (to determine whether widening of the heel is causing subfibular impact, as occurs after calcaneus fractures), and the Saltzman view (to objectively assess alignment of the calcaneus in relation to the tibia). Radiological examination is important to identify hindfoot malalignment that must be treated during surgery and to determine the loss of calcaneus height and changes to the inclination of the talus⁽⁶⁾.

Subtalar arthrodesis is a procedure commonly performed on the foot to reduce pain and correct deformity. It has several indications, such as: surgical treatment of primary arthritis, posttraumatic arthritis, and correction of hindfoot deformity. Causes of deformity include failure of the posterior tibial tendon which can aggravate deformity in valgus and lateral impact, causing pain in the tarsal region. Any trauma to the subtalar joint and posterior facet can lead to posttraumatic subtalar arthritis, and certain fractures of the calcaneus with severe comminution can benefit from this procedure⁽⁷⁻⁹⁾.

Other studies confirm that subtalar arthrodesis is a treatment option for pain caused by arthritis subsequent to fractures of the calcaneus. It was described by W. Van Stockum in 1912 and popularized by W. E. Gallie in 1943 for treatment of fractures in which there is comminution of the calcaneus. The procedure is performed to relieve subtalar joint pain, especially in patients with posttraumatic osteoarthritis after fractures of the calcaneus or talus, or in patients with subtalar primary osteoarthritis for acquired flatfoot, congenital deformities (tarsal coalition), neuromuscular dysfunction, or inflammatory disease^(4,5,10-12).

There are several techniques, approaches, and fixation options for subtalar arthrodesis in isolation, which can be performed as an open procedure or assisted with arthroscopy. The arthroscopic technique is limited to cases without major malalignment of the subtalar joint or major bone loss^(6,13).

The open technique for subtalar arthrodesis is used more often and results are generally favorable. It is a minimally invasive technique that theoretically preserves the blood supply to the calcaneus and the talus, reduces perioperative morbidity and can preserve the foot's proprioceptive sensitivity. However, several complications may occur because the open procedure involves removal of interosseous and periarticular ligaments and requires a lateral incision that can cause neurovascular dysfunction. The open technique involves greater risk of wound infection, of non-union, and of neurovascular injury^(11,14).

According to Vilá-Rico et al.⁽¹⁰⁾, around 30% of patients will have a degree of pseudarthrosis and bone grafts are commonly used to improve the likelihood of union. Therefore, minimally invasive techniques such as arthroscopic subtalar arthrodesis improve on the results of traditional open methods, with the advantages of preserving the blood supply to the tarsus, reducing postoperative morbidity, and preserving proprioception.

Arthroscopic arthrodesis provides surgeons with an alternative to the open technique for treatment of severe arthritis of the ankle⁽¹⁵⁾.

Arthroscopic procedures are less invasive than conventional open techniques and posterior arthroscopy, performed in ventral decubitus, may be more advantageous than the conventional anterior and/or lateral approaches^(4,16).

Arthroscopic subtalar arthrodesis was first described in 1992 by J. P. Tasto and was conceived of as a minimally invasive approach. The technique was used in patients with rheumatoid arthritis, degenerative osteoarthritis, and subtalar instability with paralytic disorders. Absolute contraindications include: presence of major deformities, infection, and failure of anterior union. The best-known relative contraindication is subtalar arthritis after calcaneus fracture, because of narrowing of the joint space and presence of arthrofibrosis, which make the procedure more difficult⁽¹⁷⁾.

Contraindications for this procedure are failed prior arthrodesis, deformities that require correction and/or additional procedures that cannot be performed with the patient in ventral decubitus. After the advent of this procedure, the majority of surgeons began to use lateral portals (anterolateral, posterolateral, and accessory)⁽¹⁴⁾.

Arthroscopic procedures reduce morbidity and arthroscopic subtalar arthrodesis is a surgical procedure for subtalar arthritis that achieves high union rates⁽¹²⁾.

This procedure demands a high level of experience with ankle and subtalar arthroscopy, which can be considered a disadvantage compared with the open procedure. Patients should be carefully selected, since malalignment of the hindfoot exceeding 15 degrees in valgus or 5 degrees in varus are contraindications for this procedure, because correction of the deformity cannot be achieved with this technique⁽¹⁸⁾.

Regardless of the approach – open or arthroscopic – non-union of the site of subtalar arthrodesis is an unwelcome possibility. Risk factors for this outcome are: smoking, osteonecrosis, ipsilateral union of the ankle, and surgery to re-treat. Progressive arthritis of the ankle and foot has been documented after subtalar arthrodesis, but was not clinically relevant⁽⁶⁾.

The objective of this study is to evaluate the results and complications of arthroscopic subtalar arthrodesis treatment.

Methods

A systematic review of the literature was conducted to evaluate the arthroscopic subtalar arthrodesis technique, in accordance with the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses. This study is registered on PROSPERO (the International Prospective Register of Systematic Reviews).

Searches were run on PubMed/Medline and Google Scholar using the keywords: “arthroscopic subtalar arthrodesis” (n=75) and “arthroscopic subtalar fusion” (n=49). Studies published from January 2007 to March 2020 were included.

Studies were selected by analyzing the title and/or abstract of all of the articles identified by the database searches. The full texts of potentially relevant studies were then retrieved

and assessed for eligibility. Additionally, the references of relevant studies were also searched for studies missed in the initial searches.

Studies were included that reported complication and union rates by technique used, with follow-up \geq twelve months, and which administered at least one standardized scale to assess postoperative surgical results (the American Orthopedic Foot and Ankle Society – AOFAS – Ankle Hindfoot Scale).

Studies were excluded if they were published in languages other than English, if they employed unknown or little-used techniques, were case reports, reports of experience with techniques, technical experiments on cadavers, descriptions of surgical anatomy, or articles with very poor evidence levels.

Four reviewers extracted data from the articles according to the following predefined: surname of first author, number of feet, duration of follow-up, before and after AOFAS scores, rate of union and time taken, grafting and complications (Table 1). These data were used in the analysis and discussion in this article.

Results

A total of 124 references were identified, but after application of inclusion and exclusion criteria and the PRISMA tool, 9 articles were eligible for inclusion.

The searches run with the keywords mentioned returned a total of 124 articles. After exclusion of duplicates and irrelevant articles, 23 studies were carefully analyzed by the authors. Finally, 9 articles were found to be eligible and were selected for the meta-analysis. These steps are illustrated in a flowchart (Figure 1) according to the PRISMA guidelines, to aid understanding.

The majority of the articles have level 4 evidence – with a predominance of prospective studies and studies of treatment cases. There was also 1 article with level 3 evidence, in which Rungprai compares outcomes and complications between open and arthroscopic subtalar arthrodesis techniques.

An analysis was conducted of the 9 articles selected, in which a total of 180 feet were assessed, with a mean postoperative follow-up of 18 months (± 6) and with before and after AOFAS scores varying from 44 ± 6 to 79 ± 4 with $p < 0.001$, demonstrating statistically relevant, significant improvement of AOFAS scores during the postoperative period (Table 2 and Figure 2).

The ages of the patients in the studies analyzed ranged from 37.8 to 50.9 years (mean: 45.2), but no correlations between age and other variables could be detected.

With regard to the relationship between postoperative AOFAS score and number of complications, no strong rela-

Table 1. Characteristics of studies and surgical methods

Author and year	N	Grafting?	Surgical method	Follow-up	Scales used	AOFAS before	AOFAS after	Union rate	Complications
Coulomb, R. (2019)	22	No	Posterior approach, 2 screws	≥ 12 months	AOFAS, EVA, SF-12	46 ± 13	76 ± 10	91%	1 case of paresthesia of the tibial nerve and 1 of the sural nerve 2 cases symptomatic hardware, 2 did not achieve union
Albert, A. (2011)	10	Yes	Posterior approach, 2 screws	≥ 12 months	AOFAS	47 (22-65)	78 (60-91)	100%	2, Lateral submaleolar entrapment
Amendola A. (2007)	11	Yes	Posterior approach, 2 screws	≥ 24 months	AOFAS	36 (19-57)	86 (78-94)	91%	1 did not achieve union, 1 symptomatic hardware
El Shazly O. (2009)	10	No	Posterior approach, 1 screw	≥ 24 months	AOFAS	38	74	100%	1, neuroma
Glanzmann M. (2007)	41	Yes	Posterior approach, 1 screw	≥ 24 months	AOFAS	53 (22-69)	84 (41-94)	100%	10, Symptomatic hardware; 3, ankle pain; 1 fibular tendinitis
Lee K. (2010)	16	No	Posterior approach, 2 screws	≥ 12 months	AOFAS, Angus & Cowell	35 ± 7	85 ± 7	94%	1, did not achieve union
Vilá-Rico (2018)	37	No	Posterior approach, 1 or 2 screws	≥ 24 months	AOFAS	49 ± 11	76 ± 8	92%	1, superficial infection; 2, symptomatic hardware; 3, did not achieve union
Martín Oliva (2017)	19	No	Posterior approach, 2 screws	≥ 24 months	AOFAS & EVA	43 ± 9	80 ± 5	94%	1, reversible neuropaxia; 2, implants removed; 1 did not achieve union
Thaunat M. (2011)	14	No	Posterior approach, 1 or 2 screws	≥ 12 months	AOFAS	51 ± 10	77 ± 9	78%	3 did not achieve union; 1 sural paresthesia

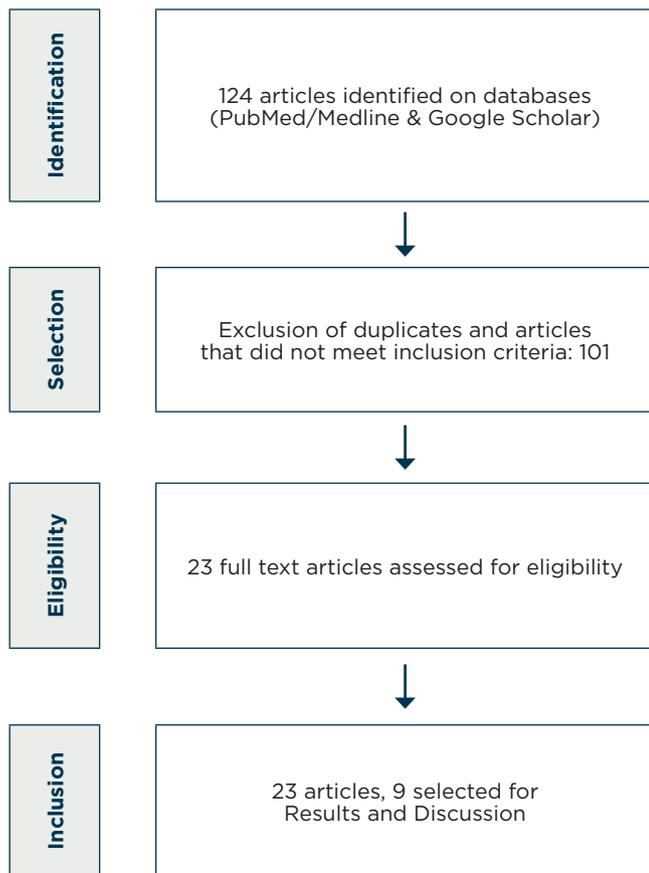


Figure 1. PRISM flowchart (adapted) illustrating process of selection of articles.

tionship was observed according to the Pearson correlation coefficient (used to measure correlations between numerical variables). Complications cited in the studies included: superficial infection, neuropraxia, neuropathic pain, neuroma, and fibular tendinitis.

Discussion

The rate of union after arthroscopic subtalar arthrodesis found in the studies analyzed was 93%±7 (range: 78% to 100%), which is compatible with Lee et al.⁽¹²⁾, who report that arthroscopic subtalar arthrodesis is an acceptable surgical procedure for isolated subtalar arthritis, with union rates of 94% (range: 91% to 100%).

Also in the abovementioned study by Lee et al.⁽¹²⁾, the mean time taken for union was 11 weeks (range: 8 to 16 weeks). The time to union found in the studies reviewed here was 10.3 weeks (range: 7 to 12.5 weeks). In a different study, union rates were reported that ranged from 65% to almost 100%, depending on whether bone grafts were added, on patient selection, and on operating technique⁽¹⁹⁾.

Table 2. Analysis of means and standard deviations for variables

Variable	Mean	Standard deviation
AOFAS after	79.5	4.4
AOFAS before	44.2	6.6
Union rate	93%	6.9
Time to union (weeks)	10.3	1.7
Complications per study	4.4	4

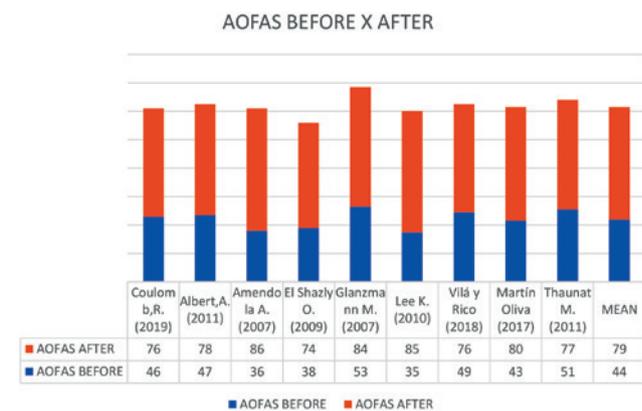


Figure 2. Comparison of AOFAS before vs. AOFAS after.

In turn, a consecutive series of 65 patients treated with arthrodesis reported by Vilá-Rico et al.⁽⁵⁾ had mean follow-up of 57.5 months and union was achieved in 62 patients (95.4%) after a mean of 12.1 weeks, while nine patients (13.8%) exhibited complications (superficial infection of the wound, need for removal of prominent screws because of pain, and failure to achieve union).

According to Vilá y Rico et al.⁽¹⁹⁾, failure to achieve union is one of the most feared complications and surgeons recommend debridement of joint surfaces and addition of bone grafting to avoid it. The majority of authors reported mean AOFAS scores in the postoperative period in the range of 70 to 76 points, although some achieved mean postoperative AOFAS scores exceeding 80 points.

Amendola et al.⁽¹¹⁾ described a series of 11 patients who were treated with arthroscopic posterior subtalar arthrodesis using bone grafting, with just one union failure in a mean period of 10 weeks. Moreover, Albert et al.⁽⁴⁾ reported a series of 10 patients treated with bone grafting who were followed-up prospectively for a minimum of 1 year (range: 12 to 31 months), among whom there was a 100% union rate in a mean time of just 7 weeks. Union had occurred in all cases within 9 weeks, without complications and mean AOFAS score improved from 47 to 78.

Martin Oliva et al.⁽¹⁴⁾ confirm that many researchers have used the arthroscopic technique and reported high rates of union and few complications.

Initially, arthroscopic subtalar arthrodesis was only used in cases of subtalar osteoarthritis in isolation, with no malalignment. However, over time, indications have been expanded to include increasingly severe deformities and a range of different pathologies. The lateral and posterior techniques are reproducible and are associated with very low rates of iatrogenic complications. The procedure has also gained popularity because of evidence of bone union in more than 90% of cases, shorter healing times, a simpler postoperative course, and fewer complications than with open surgery⁽²⁰⁾.

Posterior arthroscopic subtalar arthrodesis achieves significant improvement in pain scores and a good level of patient satisfaction, confirming the good union results⁽¹⁾.

Rungprai et al.⁽²¹⁾ conducted a study with level 3 evidence, involving retrospective review of the medical records of 121 patients (129 feet) who underwent subtalar arthrodesis with the open technique (60 feet in 57 patients) or the arthroscopic technique (69 feet in 64 patients) from 2001 to 2014. They did not observe significant differences between groups in terms of the rate of union or time taken for union when analyzed by different screw sizes and types of bone graft. Return to work, to activities of daily life, and to sporting activities were earlier in the arthroscopic arthrodesis group.

With regard to relationships between grafting and other variables (grafting against union rate, against time to union in weeks, and against postoperative AOFAS scores), there was no statistical basis for determination of any relationship, because each study reported a different observation.

Albert et al.⁽⁴⁾ commented that, since arthroscopy cannot be used for structural bone grafting, it would be better to treat significant deformities of the hindfoot with the open procedure.

There is not yet any consensus on the most effective technique for subtalar arthrodesis⁽²²⁾, although excellent results have been demonstrated with arthroscopy.

In the past, double arthrodesis (subtalar and talonavicular) or triple arthrodesis (subtalar, talonavicular, and calcaneocuboid) were the preferred treatments for subtalar arthritis with major deformity. However, since the function of the talonavicular joint has a great influence on the overall function of the hindfoot, subtalar arthrodesis only has become the option of choice, to preserve hindfoot mobility and reduce the risk of secondary degenerative disease of the neighboring joints^(14,23).

One of the most unwelcome complications of arthrodesis is failure to achieve union and for this reason many surgeons prefer to use the open approach, to guarantee adequate debridement of all affected joint surfaces. However, problems

involving the soft tissues can occur and infections are common after open surgery⁽¹⁰⁾.

In the study by Vilá-Rica et al.⁽¹⁰⁾, arthroscopic subtalar arthrodesis was shown to achieve higher union rates without the need for supplementation by bone grafting and lower rates of complications than open techniques, in addition to being a safe and reliable procedure, providing that the surgical technique is followed rigorously. The AOFAS scores improved significantly in all patients and patient satisfaction was high, even among patients followed for more than 5 years.

Several published series have proved the safety and efficacy of arthroscopic subtalar arthrodesis, but the majority of them included patients with varied indications, both posttraumatic and non-traumatic. The ideal would be to conduct a study comparing open and arthroscopic arthrodesis, but it would be difficult to run such a study prospectively, in view of the low numbers of cases in the majority of published case series⁽⁵⁾.

In general, the studies observed good correction of deformities, with improvement of pain, good union rates, clinical improvement according to postoperative AOFAS scores, and low rates of complications. However, because of the heterogeneous nature of the studies, with variations in the techniques used and the samples studied, findings cannot be generalized.

Vilá y Rico et al.⁽¹⁹⁾ explain that arthroscopic techniques cause less damage to soft tissues, preserving local vascularization and proprioception, which promotes union and faster recovery, in addition to reducing pain and shortening hospital stays. They also confirm that although the safety and efficacy of the technique have been confirmed in several different studies, the majority of series are limited to small numbers of patients with variables indications for subtalar arthrodesis, preventing comparisons between them.

The results of this review confirm the hypothesis that the arthroscopic technique is a reliable option for achieving consistent union, with low rates of complications and high level of patient satisfaction.

Conclusion

As observed, subtalar arthrodesis can be performed using open or arthroscopic techniques. It was possible to conclude that arthroscopic surgery for subtalar arthrodesis achieves good results with low rates of complications, but that there are few studies with high evidence levels that confirm the efficacy of the technique, although preliminary results are encouraging.

The arthroscopic technique is safe and effective and achieves significant clinical improvement in patients with indications for subtalar arthrodesis.

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