

SURGICAL TREATMENT OF INTRAARTICULAR CALCANEUS FRACTURES OF SANDERS' TYPES II AND III. SYSTEMATIC REVIEW

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ABSTRACT

Objective: This paper aims to identify the most effective surgical technique for intraarticular calcaneal fractures of Sanders' types II and III. **Methods:** Systematic review of comparative randomized clinical trials on surgical treatment of the intraarticular fractures of the calcaneus (Sanders types II and III) that used the questionnaire of the American Orthopaedic Foot and Ankle Society. The studies were identified and retrieved in the following databases - LILACS, MEDLINE/PubMed, Cochrane Library, SciELO, EMBASE, Science Direct, Scopus, Journals@Ovid, ISI Web of Knowledge, Evidence Based Medicine, besides consulting the references of studies accessed. The keywords used Boolean logic (AND and OR): "calcaneus fracture, calcaneous, calcaneal; surgical treatment, management;

open reduction, minimally invasive, percutaneous reduction; internal fixation, external fixation. **Results:** We identified only three randomized comparative trials. Each study compared a different technique (external fixation, percutaneous fixation with Kirchner wires and cannulated screws fixation) to the open reduction with internal fixation using plate and screws (considered the standard technique). **Conclusion:** Comparing the series, percutaneous fixation using Kirchner wires presented the best results, however, evidence is insufficient to assert superiority of this treatment in comparison with other surgical techniques.

Keywords: Calcaneus. Intraarticular fractures. Surgical procedures, operative. Review literature as topic.

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INTRODUCTION

The calcaneus is the most frequently fractured tarsal bone, accounting for about 60% of cases. Such fractures mainly affect active young adults, and the principal trauma mechanism is falls from heights.¹

Historically, these fractures lead to poor outcomes and are associated with unsatisfactory clinical and functional results due to their complexity and the difficulty in keeping the joint congruent and perfectly reduced, without causing major damage to the hindfoot structures during the surgical procedure. Such fractures can cause considerable disability due to complications associated with pain and chronic joint stiffness. They are related to arthrosis of the subtalar and calcaneocuboid joints, and may result in severe hindfoot deformities, impeding the use of conventional footwear because of the widening of calcaneus.²

The diagnosis is performed by imaging examinations (radiographs and tomographies) in which professionals observe the fracture location, the quantity and the displacement of intra or

extraarticular fragments. As intraarticular fragments constitute trauma with a greater risk of degenerative sequelae, they require a more thorough evaluation, cases in which professionals use computed tomography, an examination in which they achieve a clearer view of the fragments and intra-articular deviations. The fragmentations are subsequently classified, as proposed by Sanders, into four types (I, II, III and IV) according to the number of fragments, and subdivided into A, B, and C according to the location of these fragments.³ The use of computed tomography in the diagnosis of type II and III fractures allows a more adequate surgical planning, which may lead to a better prognosis. With the exception of fractures classified as Sanders I, in which closed treatment can be used, the others have preferentially surgical treatment. Early arthrodesis is formally indicated in type IV fractures.³ Surgical treatment using osteosynthesis is indicated for the remaining fracture types, II and III. However, there are a large number of orthopedic surgical techniques,⁵ including: open surgery with fixation using plates and screws,⁵ fixation with screw and clamps,⁶ minimally invasive surgery

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with fixation using Kirschner wires,⁷ percutaneous fixation with cannulated screws⁸ and external fixation with circular fixator.⁹ There is still a shortage of literature evidencing which surgical technique involving intraarticular calcaneal fractures (Sanders types II and III) is the most effective. Some studies only describe or try out the surgical techniques. Others compare treatment types (conservative or surgical)¹⁰⁻¹⁵ or otherwise systematically review the best treatment, but do not evidence the surgical technique that presents the best results for these fractures. The aim of this study was to identify in literature the most effective surgical technique in adult patients for the treatment of Sanders II and III intraarticular calcaneal fractures.

MATERIAL AND METHODS

We analyzed comparative randomized clinical studies of surgical treatments of Sanders II and III intraarticular calcaneal fractures in adults. To identify the studies, we consulted, without restriction of languages or dates, the databases LILACS, MEDLINE/Pubmed, Cochrane Library (Cochrane Systematic Reviews and Cochrane Bone, Joint and Muscle Trauma Group), Scielo, Embase, ScienceDirect, Scopus, Journals@Ovid, ISI Web of Knowledge and Evidence Based Medicine, besides the references of articles retrieved from the databases for the identification of further studies.

The search strategies used the keywords: "fracture calcaneus, calcaneous, calcaneal; surgical treatment, management; open reduction; minimally invasive; percutaneous reduction; internal fixation; external fixation; Sanders". Initially, in order to identify the surgical techniques for the treatment of intraarticular calcaneal fractures in adults (Sanders II and III), we used the keywords combined by Boolean logic (AND and OR): "fracture calcaneus OR calcaneous OR calcaneal AND surgical treatment OR management". Afterwards we included the keywords combined by Boolean logic relating to the treatment techniques: "fracture calcaneus OR calcaneous OR calcaneal AND surgical treatment OR management AND open reduction OR minimally invasive OR percutaneous reduction OR internal fixation OR external fixation". Soon after, two independent reviewers selected the studies in three stages, following meta-analysis concepts^{17,18}:

1^a. stage: apparent studies, according to title or abstract, which presented surgical interventions for the treatment of intra-articular calcaneal fractures. Later on we obtained complete texts of all the studies, including those that presented uncertain methodology.

2^a. stage: studies that fulfilled the inclusion criteria (comparative randomized clinical trials). We performed a careful evaluation of the description of the blind randomization process, allowing us to classify the study in four categories:

Category A: when the blind process of randomization was appropriately reported (randomization centralized by an office; sequential administration of pre-coded or numbered packages; computerized system at a distance etc. or other methods that appear to offer adequate allocation, combined with the fact that the person who handled the secrecy of the allocation is not involved in the survey);

Category B: when the blind randomization was not described, but the text mentions that the study is random (list or tables used; envelopes without qualifying their type; allocation apparently adequate, but without any other information);

Category C: when the blind randomization was inadequate (alternation; numbers of medical records; dates of birth; weekdays; any blind allocation in which this is not totally unpredictable); Category D: means that the study was not random.

In concluding this classification, we created a collection of documents with the articles classified as A, B, C or D. Articles classified as A or B were included in the study, and those classified as C or D were excluded as they did not constitute randomized clinical trials. After identifying the comparative randomized clinical studies, we verified other inclusion criteria: a) skeletally mature patients, both sexes; b) atemporal intra-articular calcaneal fractures, classified exclusively on a basis of computed tomography as Sanders II and III; c) minimum follow-up of six months; d) clinical and functional outcome evaluated by the questionnaire of the American Orthopaedic Foot and Ankle Society (AOFAS).

3^a. stage: studies that did not fulfill the inclusion criteria, involving the identification of studies with skeletally immature patients, patients with congenital deformities, pathological exposed fractures or local dermatological pathologies, re-fractures or previous hindfoot surgery; follow-up time under six months, besides cases submitted to conservative treatment.

The reviewers' evaluations were not masked in relation to the authors or the results of the studies. The reason for the exclusion was documented for each study and the discrepancies regarding inclusion and/or exclusion of studies were resolved by consensus.

In relation to the collection of data, these were extracted independently by the two reviewers and cross-referenced to verify concordance. The discordant results were resolved by consensus. A standardized form was used to gather the following information:

- Methods: question from the survey, Sanders classification (I to IV), treatment sequence generation process; description of the blind allocation process, randomization, time to surgery, duration of the post-intervention follow-up period, statistical calculation used;
- Participants: according to inclusion and exclusion criteria, number of fractures and age bracket;
- Intervention: surgical technique adopted;
- Clinical and functional outcome: according to the AOFAS questionnaire (scale from 0 to 100 that assesses pain, function and alignment of fractures in patients); besides information about complications presented; notes: sources of promotion, ethical approval, conflict of interests.

RESULTS

Of the 143 studies identified, only seven presented surgical interventions in adults, classified as Sanders types II and III, besides clinical and functional evaluation by the AOFAS questionnaire. However, four studies were excluded as they were not comparative randomized trials, and were classified in category D relating to the type of study.^{3,26-28} (Table 1)

The three comparative randomized studies included, classified as B (without describing the randomization process) compared two different techniques. Open surgery with fixation using plate and screw was the common surgical technique in all the studies, and thus considered standard.

168 fractures were evaluated. The three studies separated the cases into two groups, with one group submitted to the standard surgical technique and the other to the respective technique to be compared.²⁰⁻²² (Table 2)

The results provided by the three studies allowed us to obtain the following means: 86.23 points in the fixation with plate and screw, 88.2 points with external fixation, 90.6 points with percutaneous fixation using Kirschner wire and 87.2 points with fixation using cannulated screw. The percutaneous fixation technique with Kirschner wire obtained a mean of 90.6 points according to the AOFAS questionnaire, proving superior both to the standard technique and to the compared techniques, also presenting a lower number of complications.

DISCUSSION

The results of this review showed that there are few studies with a high level of evidence involving surgical techniques for calcaneal fractures. Many papers report various surgical techniques, yet few comparatively evaluate the techniques.

A relevant point is the divergence of standardizations in terms of the clinical and functional evaluation used in the studies. A total of seven different types of clinical and functional evaluation questionnaire were found: Creighton-Nebraska Health Foundation, Merle d'Aubigne, Hannover Scoring, Zwipp Score, Maryland Foot Score, Crosby and Fitzgibbons, Rowe and Pozo Score, besides subjective analyses imposed by the authors themselves.

This study used the AOFAS questionnaire that analyzes data on pain, limitation of activities and need for support, walking distance, gait abnormalities, sagittal mobility (foot flexion and extension), hindfoot mobility (inversion and eversion), ankle and hindfoot stability and alignment.

The evaluation questionnaires should be reproducible in time, and should therefore produce equal or similar results in two or more administrations for the same patient. Evaluations involving a particular intervention should use well-defined clinical and radiological criteria. Nowadays there is consensus concerning the need for standardized systems of evaluation of clinical and functional criteria and of quality of life, allowing the comparison of results of different treatment methods in patients with the same problem, analyzing the effectiveness of a particular treatment in a more reliable manner.¹⁹

It is necessary not only to know whether a given treatment or surgical technique obtained positive or negative results, but also to ascertain the impact of this treatment on the patient's quality of life, in relation to what they are feeling and how they pursue their everyday activities.

The main postoperative complications described in open surgeries with fixation using plate and screw include suture dehiscence, infection, fibular tendinitis and sural nerve lesions, with percentages ranging from 0.4% to 27%.²³⁻²⁵

As regards the excluded studies, they all presented unsatisfactory quality, with performance, detection and follow-up biases. Furthermore, in analyzing the results of these studies we

Table 1. Studies excluded from the review.

Study	Fractures	Mean Age	Sanders Classification	Time to surgery	Follow-up	Surgical technique	AOFAS result	Number of Complications
MASSARI	17	49.5 (75-18/ years)	6 (II) 0 (III) 1 (IV)	Not specified	20.8 (6-26 months)	Open w/ plate and screw	Mean 70.6% Scores (80-100)	4 (23%)
PRADO JR	21	40.6 (24-61 years)	15 (II) 6 (III)	6 days (3-12 years)	3.5 years	Open w/ plate and screw	Mean 89.28% Scores (80-100) 81%	4 (18.4)
SCHEPERS	61	46 +/- 12 years	II (38%) III (28%) IV (28%) Others (6%)	Not specified	35 +/- months	Percutaneous w/ cannulated screw	Score (80-100) 72% Mean (83 +/-14 pts)	14
GAVLIK	15	41.1 years	Sanders II	Not specified	14 months (12-28)	Percutaneous w/ canul. screw-assisted by	93.7 points	0

Table 2. Randomized comparative clinical trials included in the review.

Study	Fractures	Mean Age	Sanders Classif.	Time to surgery	Follow-up	Surgical technique	Resultado AOFAS	Number of complications
EMARA e ALLAN	20	Not specified	III	1 week (3-14 days)	20 months (18-28)	Open w/ plate and screw	88.6 +/- 6 points average	6 (30%)
	12	Not specified	III	3 - 4 weeks	20 months (18-28)	Closed w/ Ilizarov external fixator	88.2 +/- 6.3 points average	4 (33.3%)
LI X, LI Q., ZHANG Z., WEN X YAN H.	36	33 years	31 II e 5 III	4 hours to 10 days	12-48 months	Open w/ plate and screw	87.5 average (81.6% good or excellent)	7 (18.4%)
	47	36 years	40 II e 7 III	4 hours to 10 days	12-48 months	Closed w/ Kirschner wire	90.6 average (87.8% good or excellent)	2 (4.1%)
WEBER e LEHMANN	26	40 years	20 II e 6 III	8 days	24.6 months	Open with plate and screw	82.65 average (66% good or excellent)	4 (15%)
	24	42.6 years	20 II e 4 III	8.2 days	31.2 months	Mini-incision with screw	87.2 average (84% good or excellent)	1 (4.2%)

observed the lack of a scoring standard among them, with the use of score percentages (Massari; Prado Jr.), average points (Gavlik) and both data (Schepres).

In the three studies analyzed, the numbers of postoperative complications were lower in the less invasive intervention when compared to the more conventional surgical technique, which involves open surgery and fixation with plate and screws. This phenomenon is probably due to the widespread injury to soft parts that occurs in open surgery. Likewise, the clinical and functional analysis (AOFAS) indicated superiority of the less invasive methods in comparison to the more conventional technique. With the exception of the Ilizarov external fixation technique, which was used in feet in the study analyzed, in which the conditions of the soft parts in the preoperative period were worse than in the compared group, whereas this is the author's criterion of choice, and also because the time to surgery is twice to three times as long as the other techniques, which may very likely have influenced the end result.

The two other studies evaluated the preoperative conditions

and the time to surgery were similar, a fact that did not contribute as a bias to the analysis of results.

Finally, we wish to point out the lack of a description of the statistical methods and calculations, as well as the insufficiency of an approach to the data gathered and used in the studies, compromising the statistical analysis. Timely measures (without standard deviations) of variables, whose distribution is not mentioned, among other faults, precluded a comparison of the techniques used by means of an inferential statistical method.

CONCLUSION

The studies compared presented a superior result for the percutaneous fixation technique with Kirschner wire, according to the AOFAS questionnaire. This technique obtained a higher score than the others, as well as a smaller number of complications. It was possible to notice that less invasive treatment methods appear superior, although studies with a high level of scientific evidence are needed to affirm the efficacy of these treatments in relation to other surgical techniques.

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