

## Original Article

# Does the posterior approach offer advantages in short-term in trimalleolar ankle fractures?

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## Abstract

**Objective:** The aim of this study was to compare the early (nine months after surgery) synthesis of the posterior malleolus by direct posterior (P) approach versus the percutaneous anteroposterior (AP) screw in trimalleolar ankle fractures to analyze the early clinical status of the patient (eight months) by studying the American Orthopedic Foot And Ankle Society (AOFAS) scale to compare postsurgical clinical recovery between both approaches, the rate of hospital days in both groups, the quality of joint reduction by computed tomography (CT) study and the rate of most frequent complications (fibular tendinopathy and surgical wound).

**Methods:** A retrospective comparative study was performed between 2016-2020, including 94 patients with trimalleolar ankle fracture type 44-A/B/C (27 percutaneous AP surgical treatment and 67 P approach). Both groups were compared by analyzing demographic variables, clinical-functional status, radiological variables, and complications. Statistical analysis was performed using SPSS-20, with a p-value of 0.05 as significance.

**Results:** Demographically, both groups were comparable, not finding significant differences between them. An increase in the days of admission before surgery was observed in the P approach with a mean of 4 ( $p=0.001$ ). No significant clinical differences were found in the AOFAS scale, with a mean of 85 in both groups. Regarding the radiological result, a better reduction was observed with P approach (good=57, fair=9, poor=0) compared to the AP approach (good=10, fair=7, poor=9) ( $p=0.001$ ). As for the complications, no significant differences were observed for the surgical wound. However, a higher need for fibular plate removal could be observed with P approach ( $n=17$ ) ( $p=0.046$ ).

**Conclusions:** Clinically, both groups observed no significant differences through the AOFAS scale. The posterolateral approach has a higher rate of hospital days before surgery. Radiologically, a better joint reduction is achieved by a direct approach to the posterior fragment.

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

**Keywords:** Ankle fractures; Fracture fixation, internal; Fracture reduction.

## Introduction

Ankle fractures are very common injuries and currently represent around 10% of total fractures in an adult. Its incidence has grown due to the increase in the population's life expectancy, a higher rate of obesity, and other factors such as the increase in sports practice. A recent study reported an incidence as high as 168.7/100,000 person-years with a mean age of 41 years and slightly more frequent in men than women (53% vs. 47%), following a bimodal distribution with peaks in younger men and older women<sup>(1-4)</sup>.

Despite advances in knowledge of posterior malleolus fractures, they remain a controversial issue among surgeons due to the lack of consensus on the most appropriate treatment, which raises questions regarding the type of approach, reduction, and fracture fixation<sup>(5,6)</sup>. Without specific guidelines, until now, synthesis by internal fixation depended fundamentally on the fragment size and the percentage of the joint affected, considering the involvement of more than 25% of the joint surface as sufficient to perform internal fixation<sup>(7)</sup>. However, most recent studies conclude that the posterior

Study performed at the Servicio de Cirugía Ortopédica y Traumatología del Hospital Universitario Marqués de Valdecilla, Santander, Cantabria, Spain.  
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complex, which includes the posterior syndesmosis and the posterior malleolus fracture, is the structure that provides the greatest stability to the ankle (42%). Hence, its anatomical reduction is essential regardless of fragment size<sup>(6)</sup>.

Surgical treatment of displaced posterior malleolar fractures includes two main techniques: indirect reduction and anteroposterior (AP) fixation or direct reduction and posteroanterior (PA) fixation.

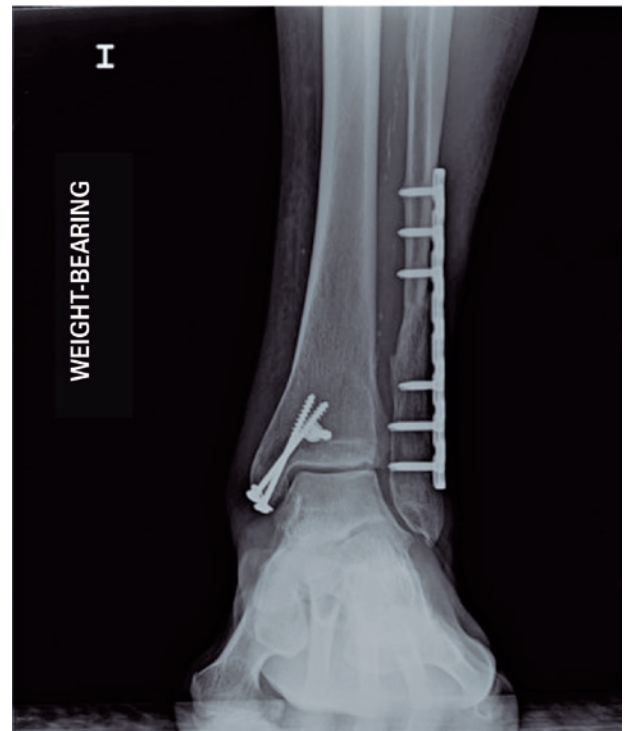
The aim of this study is to compare the early (nine months after surgery) synthesis of the posterior malleolus by direct posterior (P) approach versus the percutaneous AP screw in trimalleolar ankle fractures to analyze the early clinical status of the patient (eight months) by studying the American Orthopedic Foot And Ankle Society (AOFAS) scale to compare postsurgical clinical recovery between both approaches, the rate of hospital days in both groups, the quality of joint reduction by computed tomography (CT) study and the rate of most frequent complications (fibular tendinopathy and surgical wound).

## Methods

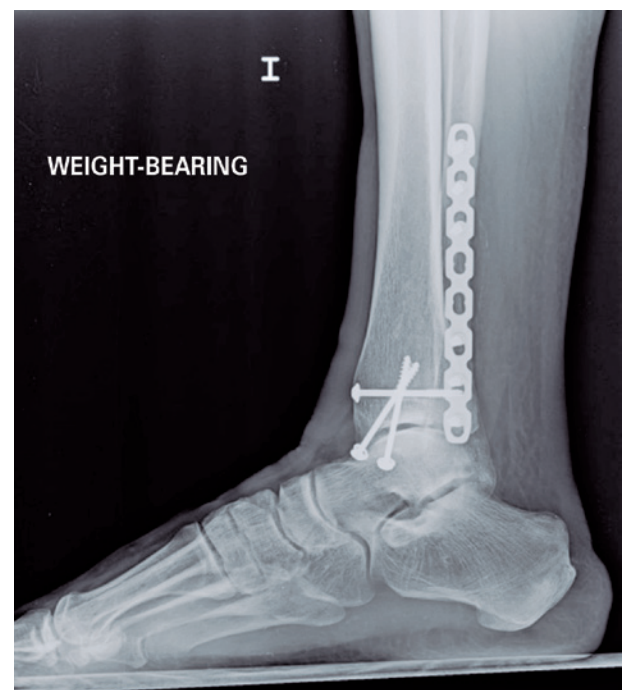
This work has been approved by the Clinical Research Ethics Committee of Cantabria CEIC (IDIVAL). Code 2015.006. All patients signed the informed consent form to report individual cases or case series.

A retrospective comparative study was performed including 173 patients with trimalleolar ankle fractures type 44-A/B/C were studied according to the AO classification. The inclusion criteria were: trimalleolar ankle fractures (AO.44-A3, AO.44-B3, AO.44-C1, and AO.44-C2), whose synthesis of the posterior malleolus was performed by indirect reduction AP fixation with traction or direct reduction screws and PA fixation and who presented a minimum follow-up of nine months. Patients who did not complete the follow-up or did not respond to the AOFAS test at the end of the study were excluded. In addition, patients younger than 16 or those treated with posteromedial approaches were also excluded. The final study included 94 patients, 27 received surgical treatment by percutaneous AP approach (Group 1) and synthesis with 3.5 short cancellous bone screws with washer (Figures 1 and 2). The remaining 67 received surgical treatment by P approach (Group 2) with direct reduction with interfragmentary compression screws or non-slip compression plate (Figures 3 and 4). For this step, the size of the posterior fragment was not considered, and the patients in group 1 were treated between 2015-2017, and group 2 between 2018-2020. The reason why an evolutionary cutoff was set at nine months to make both groups comparable.

All fractures were evaluated with radiographs with two projections and/or CT, in cases in which the posterior fragment was multifragmentary or larger, to perform correct preoperative planning, evaluating the fragment size and location, and with radiographs (at one month, six, and nine months and CT from nine months in the postoperative study (except in two patients one in each group), so we were able to address



**Figure 1.** Ankle anteroposterior radiograph with trimalleolar fracture and synthesis by percutaneous anteroposterior approach.



**Figure 2.** Ankle lateral radiograph with trimalleolar fracture and synthesis by percutaneous anteroposterior approach.

and study the exact size of the fracture as well as the number of fragments, the percentage of joint involvement and the quality of reduction (Figures 5, 6 and 7). All procedures were performed by experienced surgeons in ankle surgery with the assistance of surgical residents. Antibiotic and an-

tithrombotic prophylaxis was performed according to hospital protocol. Patients in group 1 (percutaneous AP reduction) were placed in decubitus and with ischemia. A lateral approach was performed for the fibula fracture. After reduction and fixation with interfragmentary screws, one third tubular plate or reconstruction plate synthesis of the posterior malleolus was performed with a 3.5 cortical or short cancellous bone in ankle dorsiflexion to allow the best indirect reduction of the posterior fragment and scopic control. Patients in group 2 (P approach) were placed in the prone position, also with ischemia. A posterolateral approach was performed through an incision where the fracture of the posterior malleolus was



**Figure 3.** Ankle anteroposterior radiograph with trimalleolar fracture and synthesis by posterior approach.



**Figure 5.** Ankle CT image (sagittal section) showing a good reduction.



**Figure 4.** Ankle lateral radiograph with trimalleolar fracture and synthesis by posterior approach.



**Figure 6.** Ankle CT image (sagittal section) showing a regular reduction.

synthesized with short cancellous 3.5 mm screws or locking compression non-slip plate depending on the size of the fragment and the synthesis of the fibular malleolus with inter-fragmentary screws and small-fragment locking compression plate. The medial malleolus was synthesized with 3.5 short cancellous screws or plate depending on the size and fracture line utilizing a medial approach in the prone position or placing the patient in the supine position in case of more complex fractures. Reduction and intraoperative implant position were evaluated with C-arm fluoroscopy. After surgery, the patient was immobilized with a post-orthopedic plaster splint for about three weeks, and then active and passive mobilization was started. Progressive loading was allowed at six weeks assisted with crutches (both groups followed the same postoperative protocol, regardless of the posterior fragment size). Postoperative radiography was performed at 24 hours (AP and lateral) and later at one, three, six, and 12 months. Finally, a postoperative CT was performed on all patients between nine and 12 months after surgery to evaluate the quality of joint reduction. None of the patients had any loss of reduction that would have caused the final results to be biased.

The following demographic data were evaluated: age, sex, tobacco and alcohol use, diabetes mellitus (DM), arterial hypertension and body mass index (BMI), clinical data (placement of external fixator before definitive reduction by the poor condition of the soft tissues), hospitalization days before and after surgery, time of immobilization and discharge, clinical study with AOFAS scale, radiological data (type of fracture (AO/Haraguchi classification and percentage of posterior fragment preoperative joint on CT)), bimalleolar angle and the tibio-talar angle (TILT) in postsurgical load (six months), quality of postsurgical joint reduction utilizing CT and complications.

The reduction quality was evaluated by postoperative CT scan for residual displacement of the posterior fragment, joint step, and/or joint surface gap. Reduction was considered good (<1mm), regular (1-2mm), and poor (>2mm), as



**Figure 7.** Ankle CT image (sagittal section) showing a bad reduction.

proposed by Ketz and Sanders<sup>(9)</sup>. The postoperative functional result was studied at a mean time of eight months and was evaluated using the AOFAS scale.

Statistical analysis was performed using the SPSS-20 program. For the quantitative variables, the U-Whitney was used, and for the qualitative variables, a Chi-square was performed. Statistical significance was considered a p<0.05.

**Results**

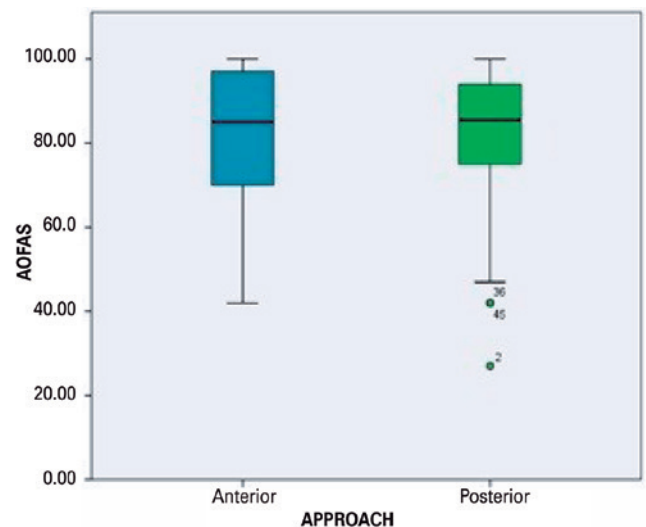
The study was performed including 94 patients after applying the exclusion criteria: 79 women (group 1 = 23 and group 2 = 56) and 14 men (group 1 = 4 and group 2 = 10), all patients completed the follow-up exams. Table 1 shows no differences between the groups regarding the demographic variables, only statistically significant differences were found in the BMI value, where group 1 had a mean of 28 (17-40) while group 2 was 25 (19-38) (p=0.028).

Referring to the clinical variables, no significant differences were found with respect to the AOFAS scale and approach route (Figure 8). However statistically significant differences

**Table 1.** Result of demographic variables

	Posterolateral approach n= 66	Anteroposterior screw n=27	p-value
Sex	Male=10/Female=56	Male=4/Female=23	0.967
Age	M= 53.6 (17-85)	M= 60 (16-86)	0.123
Alcohol	7	5	0.302
MD	3	3	0.162
BMI	M <sub>e</sub> =25	M <sub>e</sub> =28	0.028
Tobacco	15	4	0.547
High energy	6	1	0.441

MD: Mellitus diabetes; BMI: Body Mass Index; Me: Mean value; n: number



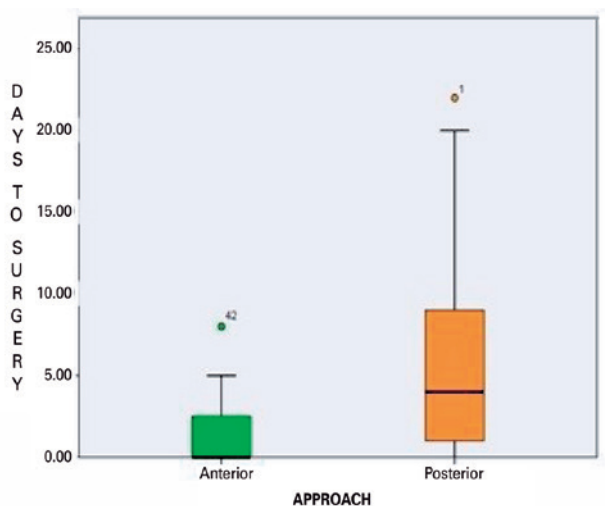
**Figure 8.** Comparative graph of the AOFAS scale and approach.

were found in external fixator use before definitive reduction, which was more frequent in group 2 with 24 patients compared to group 1 where no patient received prior treatment with this device ( $p < 0.001$ ). Furthermore, in the days until surgery, group 1 had a mean of 1.44 days compared to group 2 with 5.7 days (Figure 9). These results may be because in cases where a P approach is performed, there is a tendency to a more complex surgical programming and, therefore, a greater use of an external fixator until surgery since a more refined surgical technique is required. In contrast, in cases of AP approach, it is a simpler and more well-known technique, so on many occasions, the surgery was performed by the medical on-call team (Table 2).

The analysis of the radiographic variables of the patients submitted to preoperative CT (group 1 = 14 and group 2 = 52) can be seen in table 3. Only statistically significant differences

were observed with  $p < 0.001$  regarding the quality of joint reduction, achieving a good quality of joint reduction of 86.36% ( $n = 41$ ) in group 2 and 38.46% ( $n = 11$ ) in group 1, a regular reduction quality of 13.63% ( $n = 9$ ) in group 2 and 26.92% ( $n = 7$ ) in group 1 and a poor quality of reduction of 0% in group 2 and 33.33% ( $n = 9$ ) in group 1 (Figure 10 and Table 3).

The overall complication rate was 24.47% ( $n = 23$ ) between both groups, including those derived from the surgical wound, complex regional pain syndrome, peroneal irritation or Achilles tendinopathy, and delayed union. There were no differences in the number of consolidation delays nor in the rate of surgical wound complications (infections, dehiscence, or need for plastic coverage). However, both groups had significant differences, with a  $p = 0.046$  regarding peroneal tendinopa-



**Figure 9.** Comparative graph of days until surgery according to approach.

**Table 2.** Result of clinical variables

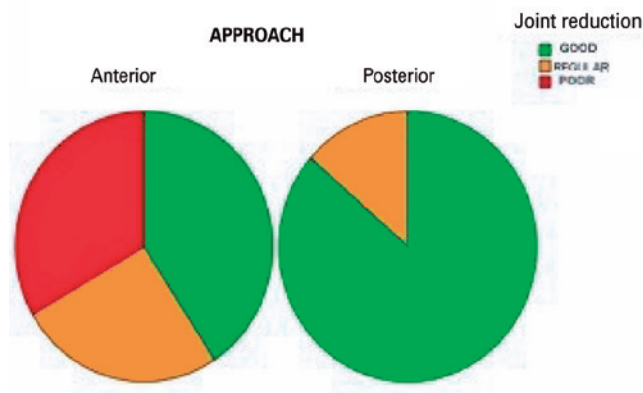
	Posterolateral approach n=66	Anteroposterior screw n=27	p-value
Hospitalization	Me= 4 (0-22)	Me=0 (1-8)	0.001
Pre-surgery (d)	Me= 4 (1-19)	Me= 4 (1-6)	0.031
Post-surgery admission (d)	24	0	0.001
External Fixator	Me= 85 (27-100)	Me= 85 (42-100)	0.757
AOFAS scale	48	7	0.001
Preoperative CT	3,43	3,8	0.278
Immobilization (w)	6,4	6,14	0.905
Discharge (w)	56	18	0.048
Dislocation	32	12	0.723

d: days; w: weeks; n: number; Me: median value; CT: computed tomography; AOFAS: American Orthopaedic Foot and Ankle Society

**Table 3.** Result of the radiographic variables

	Posterolateral approach n= 66	Anteroposterior screw n= 27	p-value
Joint (%)	27.75	23.3	0.187
I	41	11	0.862
Haraguchi II	10	3	
III	1	0	
Talar Tilt	Me=0.73	Me=0.73	0.679
Bimalleolar angle	12.87	12.91	0.765
Joint reduction			
Good	57	10	0.001
Regular	9	7	
Poor	0	9	
Anteroposterior fragment size	16.6	12.3	0.024
Transverse fragment size	24.2	26.4	0.907

n: number; Me: Mean value



**Figure 10.** Quality of joint reduction measured on CT according to approach.

thy (group 1 = 2 and group 2 = 17). In addition, all patients from both groups required surgical revision and removal of the fibular plate placed posteriorly on the fibular malleolus (Figure 11 and Table 4).

A cross-sectional analysis was performed analyzing the complication rate of both groups for age, DM, use of external fixator, and value of the AOFAS scale. No statistically significant differences were observed except for the lower values of the AOFAS scale found in those patients who presented complications (77 vs. 84) (p=0.024) (Table 5).

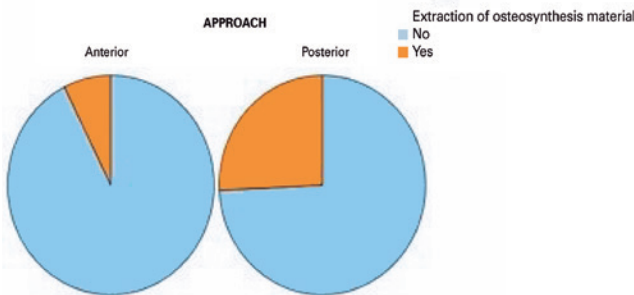
### Discussion

Surgical treatment of displaced ankle fractures includes anatomic reduction and stable fixation that allows early functional rehabilitation<sup>(5,10-16)</sup>. However, the optimal treatment of the posterior fragment in trimalleolar fractures is still a topic of discussion regarding the diagnostic method, type of

treatment, and approach. Despite the number of different published studies, some concepts, such as the choice between indirect reduction and AP fixation and direct reduction and P fixation, remain controversial<sup>(5,17-19)</sup>.

The ankle stability after a fracture is a fundamental factor that must be considered before choosing the treatment for this pathology since it determines the clinical and functional outcomes and future complications. Studies such as Bartoniček et al.<sup>(20)</sup> show that the syndesmosis together with the posterior malleolus are structures with an important weight when it comes to maintaining ankle stability. Hence, they conclude that their surgical treatment is essential, regardless of the fracture size<sup>(8,20-22)</sup>.

Ankle fractures include fractures of the posterior malleolus or Volkmann's malleolus, which is observed in up to 46% of AO/ASIF type B and C fractures<sup>(5,23)</sup>. However, recent studies have shown that nondisplaced posterior malleolus fractures may be missed or underdiagnosed in many patients, leading to iatrogenic displacement during surgery and permanent ankle damage<sup>(24-27)</sup>. Furthermore, in the last ten years, published studies using additional CT and MRI examinations have shown that the incidence of posterior malleolus fractures associated with other tibial fractures increases considerably and are highly under-diagnosed if studied using plain radiographs. Therefore, authors such as Boraiah et al.<sup>(28)</sup> recommend additional ankle CT for patients with distal tibial fractures for proper diagnosis and treatment<sup>(28-30)</sup>. Finally, Bartoniček et al.<sup>(20)</sup> recently concluded that appropriate diagnosis, classification, and treatment require preoperative CT scan, preferably with three-dimensional reconstructions. This is because today, the three-dimensional contour of the fragments, the involvement of the notch, the presence of joint impaction, and intercalated fragments interposed in the fracture line seem to have greater therapeutic relevance than the fragment size and the extension of the fractured articular surface<sup>(8,20,24,31)</sup>. Our study observed that most patients who do not present preoperative CT are treated by the AP approach (Group 1), which agrees with the patients in the first years of the study. This may be because preoperative CT scans were not performed in simple trimalleolar ankle fractures before the publication of these studies. Within the surgical techniques to treat posterior malleolus fractures, indirect reduction and AP fixation with lag screws was the first technique to be applied. Although it tends to be displaced by the direct reduction technique today, it is still used in many centers. In this case, reduction is achieved percutaneously, and fixation is performed with 3.5 mm partially threaded cancellous bone lag screws. However, despite being a simple technique that has provided good results during its use, it has several questions, such as the quality of indirect reduction and the quality of interfragmentary compression with AP fixation if the threaded portion of the screw does not penetrate the smaller fragments completely<sup>(5,17)</sup>. Direct reduction allows for direct reduction using a posterolateral, posteromedial, or modified posteromedial approach, disimpaction of the smaller osteochondral fragments, and definitive fixation with screws or non-slip compression plate. Nowadays, different authors



**Figure 11.** Comparative graph of the need for revision according to approach.

**Table 4.** Result of complications rate

Complications	Posterolateral approach n=66	Anteroposterior screw n=27
Surgical wound	18 (27.2%)	5 (18.5%)
Peroneal tendinopathy	17	2

n: number

**Table 5.** Result of complications

	Complications		p-value
	Yes	No	
Age	M <sub>e</sub> =59	M <sub>e</sub> =54	0.183
MD	6	21	0.162
AOFAS scale	77	84	0.024
External Fixator	33.3	21.7	0.257

n: number; M<sub>e</sub>: Mean value; MD: Mellitus diabetes; AOFAS: American Orthopaedic Foot and Ankle Society.

publish favorable functional results using this technique<sup>(5,17,31)</sup>. Most studies suggest using a single wide posterolateral incision that allows fixation of the posterior fragment of the tibial malleolus and the fibula fracture. However, other authors propose several separate incisions for the approach to malleolar fractures; therefore, they propose to analyze the fracture line to decide the type of approach<sup>(5)</sup>.

Thus, after confirming that the success of surgery depends largely on the posterior malleolus fixation, we present this study comparing two groups of patients with posterior malleolus fracture treated with different techniques, indirect reduction, and AP fixation and direct reduction through posterolateral approach and AP fixation. There was no difference in complications rate between these two groups within a minimum nine months period; however, this period is insufficient to assess complications such as the presence of osteoarthritis, although some studies demonstrated that an intra-articular step of 2mm after reduction is an independent risk factor for a worse clinical outcome and the development of posttraumatic osteoarthritis regardless of the fragment size<sup>(9,20,22,32,33)</sup>. Furthermore, this period is insufficient to evaluate the possible osteoarthritis that could affect this joint in cases the joint reduction presents a step greater than 2mm. This fact could, in theory, change the AOFAS score in the long-term. Direct reduction of the posterior fragment using a posterolateral approach and direct fixation of the fragment is associated with advantages: it provides a technically more stable anatomical reduction under direct visual control and interfragmentary compression than indirect reduction and percutaneous AP fixation, which could be less stable if the threaded portion of the screw does not fully accommodate within small or medium fragments. In addition, direct reduction allows the osteochondral fragments to be addressed, which is very difficult, if not impossible, to achieve with indirect reduction. Moreover, the posterolateral approach allows the reduction and fixation of the fibula utilizing a posterior non-slip plate (with a higher rate of peroneal tendinopathy 25.37% vs. 7.4%) or by reduction and placement of an interfragmentary screw and a neutralization plate, performing it in front of the peroneal tendons, allowing visualization and work from the lateral aspect of the fibula<sup>(5)</sup>. Despite these advantages, indirect reduction and percutaneous AP fixation are still widely used, mainly due to the lack of studies showing that anatomical reduction has better clinical results in the short to medium term<sup>(34)</sup>.

Indeed, more and more authors favor the posterior approach and reduction, presenting better clinical and functional results<sup>(7,33,35)</sup>.

Despite this, in our study, it was not possible to demonstrate better functional results during the follow-up period through the clinical-functional assessment of the AOFAS scale between both groups. This may be because a longer follow-up period is required for complications such as posttraumatic osteoarthritis to appear, causing clinical and functional differences between both groups.

There is a great variety of opinions regarding the timing of the use of trans-syndesmal screws after fixation of the posterior malleolus; however, in case of performing a correct synthesis of the posterior malleolus, utilizing an AP screw or posterior plate that presents good stability to allow correct joint dynamics restoration, it would not be necessary to add the suprasyndesmal screw, although it would be important to keep in mind the patient's BMI<sup>(8,36,37)</sup>.

According to the literature, the most frequent complications of the posterolateral approach are that it increases the risk of peroneal tendinopathy and sural nerve injury<sup>(38)</sup>. Our study presents a statistical significance of tendinopathies in group 2 ( $p=0.046$ ).


The quality of the reduction was significantly better in group 2 (posterior direct approach) compared to group 1 (percutaneous AP reduction) ( $p<0.001$ ), achieving a good joint reduction of 86.36% ( $n=41$ ) in group 2 and 38.46% ( $n=11$ ) in group 1. Shi et al.<sup>(39)</sup> reported an excellent reduction of 53.1% treated with direct reduction and 30.8% in those treated with indirect reduction. Huber et al.<sup>(40)</sup> concluded that in 83% of patients, the anatomical reduction was achieved by direct reduction, while only 27% was achieved by indirect reduction<sup>(3,12,27)</sup>. Further investigation of the specific type of reduction and internal fixation with long-term results is required.

### Study limitations

This study was performed to compare the early results (mainly the quality of joint reduction and the clinical differences between both approaches) after nine months of follow-up, sufficient time to consider the consolidation of the fracture and thus avoid secondary displacement of the fragments. Therefore, one of the study's fundamental limitations is that the nine-month follow-up period is insufficient to evaluate the possible osteoarthritis that could affect the ankle joint due to poor joint unity. This fact could modify the AOFAS scale in a later evaluation.

### Conclusions

- No significant differences were observed utilizing the AOFAS scale in both groups at eight months of follow-up. Although this time is insufficient to evaluate the clinical status of the patient in those cases in which joint arthrosis develops, especially in those patients with insufficient joint reduction (joint step  $>2\text{mm}$ ), it is very useful to show that despite that the anteroposterior approach is less aggressive, since it is a percutaneous technique, the short-term clinical status does not vary between both approaches.
- There is a higher rate of days of admission before surgery with the posterolateral approach.
- A direct approach to the posterior fragment achieves a better joint reduction.
- There is a higher rate of fibular tendinopathies in the posterolateral approach when the posterior fibular plate is placed.
- No differences were observed in surgical wound complications in both groups.

**Author's contributions:** Each author contributed individually and significantly to the development of this article: MHF\* (<https://orcid.org/0000-0002-4642-404X>) Conceived and planned the activities that led to the study, wrote the article, participated in the reviewing process, approved the final version; GGJ\* (<https://orcid.org/0000-0002-2289-387X>) Interpreted the results of the study, participated in the reviewing process; PMZ\* (<https://orcid.org/0000-0002-5415-1723>) Conceived and planned the activities that led to the study, wrote the article, participated in the reviewing process, approved the final version; ELB\* (<https://orcid.org/0000-0003-2319-9641>) Participated in the reviewing process, approved the final version; GMS\* (<https://orcid.org/0000-0003-3161-0752>) Participated in the reviewing process, approved the final version; EGA\* (<https://orcid.org/0001-7354-1260>) Conceived and planned the activities that led to the study, wrote the article, participated in the reviewing process, approved the final version; JHE\* (<https://orcid.org/0000-0002-5258-1615>) Participated in the reviewing process, approved the final version; MIPN\* (<https://orcid.org/0000-0001-6423-260X>) Participated in the reviewing process, approved the final version. All authors read and approved the final manuscript. \*ORCID (Open Researcher and Contributor ID) 

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