

# ANALYSIS OF CLINICAL AND FUNCTIONAL OUTCOME AND COMPLICATIONS OF TALAR NECK FRACTURES

Leonardo Ribeiro Bastos<sup>1</sup>, Ricardo Cardenuto Ferreira<sup>2</sup>, Marcelo Tomanik Mercadante<sup>3</sup>

## ABSTRACT

*Objective:* To evaluate the clinical, functional and radiographic results from talar neck fractures in patients treated at the Foot and Ankle Surgery Group of Santa Casa de São Paulo. *Method:* We evaluated 20 patients. The mean follow-up time was 71 months. One fracture was classified as Hawkins Type I, 12 as Hawkins type II, five as Hawkins type III, two as Hawkins type IV and four fractures were open. *Results:* One patient was treated conservatively, 16 were treated with open reduction and internal fixation (three with primary subtalar arthrodesis), one was treated with talectomy and two with tibiototalcalcaneal arthrodesis. The reduction obtained was anatomical in seven feet, acceptable in six feet and poor in four. Seven patients had early complications. There was one case of delayed consolidation and four of talar body osteonecrosis. Four patients required secondary reconstruction procedures. No significant radiographic impairment of the ankle joint was found in 62% of the patients and of the subtalar joint in 25%. Of the patients who did not undergo secondary procedures, 81% complained about the treated foot, 37.5% showed some deformity, 44% presented diminished sensitivity and 50% had to retire from work. The mean loss of motion in the ankle was 49%, and in the subtalar joint, 80%. The average AOFAS score was 73 points. *Conclusion:* Talar neck fractures are associated with high rates of clinical, functional and radiographic complications.

**Keywords** – Talus/injuries; Fractures, bone/complications; Adult

## INTRODUCTION

Fractures of the talar neck account for 1% of all skeletal fractures, 3% of foot fractures and 50% of all talar fractures, and they present great incidence of associated lesions<sup>(1-3)</sup>.

Non-surgical treatment for talar neck fractures is indicated in situations in which there is no dislocation between the fractured fragments, and this is achieved through the use of a plaster-cast boot for a mean period of 10 weeks<sup>(4)</sup>. In cases of deviated fractures, surgical treatment seeks to achieve anatomical reduction of the fractured fragments and stable internal osteosynthesis with compression between the fragments, in the same way as desired for all joint fractures<sup>(5,6)</sup>. Thus, it is hoped to avoid the appearance of residual deformities caused by

defective consolidation, and to avoid the development of post-traumatic arthrosis caused by joint incongruence.

Despite adequate treatment, high complication rates can be expected over the medium and long terms in patients with talar neck fractures<sup>(2-5,7-19)</sup>. Among the possible complications, the following stand out: skin necrosis, infection, defective consolidation, talar body osteonecrosis and post-traumatic arthrosis of the ankle and subtalar joints. Consequent to this, patients may develop chronic pain and joint stiffness.

The aim of the present study was to evaluate the clinical-functional and radiographic results from patients who were treated due to talar neck fractures, by the Foot and Ankle Surgery Group, Santa Casa de Misericórdia de São Paulo, and to seek to identify ways to prevent occurrences of complications.

1 – MSc in Medicine; Orthopedist and Specialist in Foot and Ankle Surgery; First Medical Lieutenant of the Brazilian Army, serving at the Central Hospital of the Army, Rio de Janeiro.

2 – PhD in Medicine; Assistant Professor and Head of the Foot and Ankle Surgery Group, Department of Orthopedics and Traumatology, Santa Casa de São Paulo.

3 – PhD in Medicine; Adjunct Professor and Attending Physician in the Trauma Group, Department of Orthopedics and Traumatology, Santa Casa de São Paulo.

Work performed in the Department of Orthopedics and Traumatology, School of Medical Sciences, Santa Casa de São Paulo (DOT-FCMSC-SP), “Fernandinho Simonsen” Wing. Director: Prof. Dr. Osmar Avanzi.

Correspondence: Rua da Aldeia 216, Ed. Potira, Ap. 406, 29165-150 Laranjeiras, Serra, ES. E-mail: leorbastos@gmail.com

We declare that there is no conflict of interests in this article

## METHODS

Over the period between November 1985 and August 2004, 37 skeletally mature patients (37 feet) with talar neck fractures were treated by the Foot and Ankle Surgery Group of the Department of Orthopedics and Traumatology, Irmandade da Santa Casa de Misericórdia de São Paulo. After attempts to contact these patients by telephone and post, 20 patients presenting a minimum follow-up of 12 months made themselves available for reassessment. The data in the medical files were examined and the radiographic and clinical-functional reevaluations on these patients were made by an orthopedist who had not been involved in the initial treatment. The data on the patients who, at the time of the reevaluations, had already undergone some type of secondary reconstructive procedures were analyzed separately.

Eighteen patients (80%) were male and four were female (20%). The mean age at the time of the trauma was  $30 \pm 11$  years (Table 1). The commonest trauma mechanism was a fall from a height, which occurred in

eight cases (40%), followed by car accidents in the cases of five patients (25%), motorcycle accidents in another five (25%) and being run over in two cases (10%). Four feet (20%) presented exposed fractures of the talar neck, which were classified as type I in three patients and type II in one patient, according to the classification of Gustilo and Anderson<sup>(20)</sup> (Table 1).

All cases in which radiographs on the foot in lateral view showed that the inferior extremity of the main outline of the fracture occupied the region of the sinus tarsi, while sparing the posterior facet of the subtalar joint, were classified as talar neck fractures<sup>(21)</sup>.

According to the modified Hawkins classification<sup>(2,22)</sup>, there was one type I fracture (5%), twelve type II (60%), five type III (25%) and two type IV (10%) (Table 1). Nine patients had also suffered fractures other than talar neck fractures (54%) (Table 1).

On the immediate postoperative radiographs, we classified the quality of the reduction obtained into three types: anatomical (absence of unevenness, angles or gaps between the bone fragments), acceptable (une-

**Table 1** – Epidemiological data on the patients who were treated for talar neck fractures, in sequence according to the date of fracture occurrence, including sex, age at the time of the trauma, side fractured, mechanism of the accident that caused the fracture, presence of bone exposure at the fracture focus, occurrence of other fractures simultaneously with the talar neck fracture and talar neck fracture type according to the modified Hawkins classification<sup>(2,22)</sup>

Patient	Sex	Age	Side	Trauma mechanism	Bone exposure	Fractures associated	Hawkins classification
1	M	18	L	Motorcyclist	No	R radius and L medial malleolus	2
2	M	66	L	Run over	No	L tibia	3
3	M	41	L	Fall from height	No	No	2
4	M	33	L	Fall from height	No	No	2
5	F	14	R	Car accident	No	L ulna, R femur	3
6	M	30	R	Motorcyclist	No	L leg and R radius	2
7	F	27	L	Run over	No	No	2
8	F	32	R	Fall from height	Yes – type I	No	4
9	M	23	L	Fall from height	No	No	2
10	M	22	L	Car accident	No	L acetabulum	2
11	M	21	R	Car accident	Yes – type II	No	3
12	M	30	R	Fall from height	Yes – type I	No	2
13	M	39	R	Fall from height	No	No	2
14	F	34	L	Car accident	Yes – type I	R calcaneus, L femur and L fifth metatarsal	2
15	M	31	L	Fall from height	No	No	1
16	M	35	L	Fall from height	No	No	3
17	M	26	R	Motorcyclist	No	L calcaneus	2
18	M	32	R	Car accident	No	R humerus, R ankle and L leg	4
19	M	27	R	Motorcyclist	No	R medial malleolus	3
20	M	20	R	Motorcyclist	No	No	2

Legends: M – Male, F – Female, R – right, L – left

Note: Type I and type II in the column “Bone exposure” refer to the type of bone exposure according to the classification of Gustilo and Anderson<sup>(20)</sup>

Source: Medical Archives and Statistics Service, Central Hospital of Santa Casa de São Paulo (SAME)

venness or gaps between the bone fragments of up to three millimeters or angles of up to five degrees), or poor (unevenness or gaps between the bone fragments of more than three millimeters or angles of more than five degrees)<sup>(16)</sup>. Patients who had undergone primary tibiototalcalcaneal arthrodesis or talectomy were excluded from this evaluation.

On radiographs produced after a follow-up of more than six months, the following were evaluated: occurrences of loss of the initial reduction, delayed bone consolidation (consolidation occurring after a period greater than six months after the initial treatment)<sup>(23)</sup>, pseudarthrosis (non-occurrence of consolidation)<sup>(16)</sup> and osteonecrosis or collapse of the talar body. Patients who had undergone primary tibiototalcalcaneal arthrodesis or talectomy were excluded from this evaluation, along with patients who had undergone these procedures less than six months after the initial treatment.

We evaluated the presence of radiographic signs of arthrosis of the ankle and other tarsal joints, and classified them as: mild (minimal subchondral sclerosis, osteophytes of up to two millimeters and slight reduction of the joint space), moderate (subchondral sclerosis, osteophytes larger than two millimeters and accentuated reduction of the joint space) or severe (pronounced sclerosis and subchondral cysts; large osteophytes, apparently blocking the joint movement; and minimal joint space)<sup>(15,16)</sup>.

The clinical functional evaluation consisted of interviews with the patients and performing a physical examination. To grade the results obtained, we used the AOFAS (American Orthopaedic Foot & Ankle Society) scale<sup>(24)</sup> and the clinical-functional scale for talar neck fractures proposed by Hawkins<sup>(2)</sup>. We investigated whether, after the treatment, patients returned to their original work; whether there had been a need for them to change their professional activity; or whether they were still off work (retirement).

We asked the patients about any complaints relating to the treated foot, and classified the responses as: absence of major problems, occasional complaints of pain in the foot or ankle, occasional complaints of difficulty in walking, or combined complaints of pain and difficulty in walking. To grade the pain intensity, we asked the patients to characterize it in one of the following four categories: absent, mild, moderate or severe.

In the physical examination, we evaluated the alignment of the foot and ankle and classified this according to the AOFAS method<sup>(24)</sup>, as good (plantigrade

foot with absence of deformity or slight deformity), regular (plantigrade foot with moderate misalignment) or poor (non-plantigrade foot or presenting accentuated deformity).

We measured the joint range of motion in the foot and ankle joints, in accordance with conventional examination methods, using a goniometer<sup>(25)</sup>. We compared the joint range of motion of the fractured foot with that of the same patient's contralateral foot (which was used as a control), and the difference was taken to be the loss of joint amplitude, expressed in percentage values. In the patients who had suffered some type of fracture in the contralateral foot on the same occasion as the fracture of the talar neck, the value used as the control for the joint range of motion was obtained from the mean value measured in the control foot of the patients with unilateral fractures.

To evaluate the presence of lesions in the sensory nerves of the foot and ankle, we examined the sensitivity using a Semmes-Weinstein 5.07 monofilament<sup>(26)</sup>, which was applied to the areas innervated by the tibial, sural, saphenous, superficial fibular and deep fibular nerves, and comparisons between the affected and contralateral foot were made.

The statistical analysis was performed using the Epi Info™ software, version 3.3.2 (Centers for Disease Control and Prevention, CDC). The chi-square and Fisher exact tests were used to investigate associations between the predictive variables and the clinical results. The Mann-Whitney test was used to evaluate occurrences of statistical significance in the differences between clinical-functional results that were measured numerically. Statistical significance was defined as  $P < 0.05$ .

The present study was approved by the Research Ethics Committee of Irmandade da Santa Casa de Misericórdia de São Paulo, under the number 355/08.

## RESULTS

### Initial treatment

At the time that the patients first came to the walk-in clinic, those that presented closed and dislocated talar neck fractures underwent attempts to reduce them. Non-surgical treatment was indicated for the only patient with a type I closed fracture (patient 15).

Among the other 19 patients, 16 underwent open reduction and internal fixation (ORIF; 80%), two underwent primary tibiototalcalcaneal arthrodesis (10%)

**Table 2** – Data on the initial treatment of the patients with talar neck fracture, in sequence according to the data of fracture occurrence, including the type of treatment performed, time that elapsed between the occurrence and the start of fracture treatment among the patients with surgical treatment, access route used for the patients treated with open reduction and internal fixation, material used for bone fixation, use of bone grafts at the fracture focus, quality of the reduction achieved from the fractured fragments, and occurrence of complications during the immediate postoperative period

Patient	Initial treatment	Emergency or elective	Access route for ORIF	Fixation type	Bone graft in fracture	Quality of reduction	Early complications
1	ORIF	Elective	Anteromedial	4.0 mm screws	Yes	Poor	No
2	ORIF	Emergency	Lat + ant-lat	4.0 mm screws	No	Anatomical	Nec
3	ORIF	Emergency	Anteromedial	4.0 mm screws	No	Anatomical	No
4	ORIF	Emergency	Lat + ant-lat	4.0 mm screws	No	Acceptable	No
5	ORIF	Emergency	Lat + ant-lat	4.0 mm screws	No	Acceptable	No
6	ORIF	Elective	Lat + ant-lat	4.0 mm screws	No	Acceptable	No
7	ORIF	Elective	Anteromedial	4.0 mm screws	No	Acceptable	No
8	Talectomy	Emergency	NA	Kirschner wires	NA	NA	Hem
9	ORIF	Elective	Lat + ant-lat	4.0 mm screws	No	Anatomical	No
10	Tibiotalocalcaneal arthrodesis	Elective	NA	Intramedullary nail	NA	NA	No
11	ORIF	Elective	Ant-lat	6.5 mm screw	No	Anatomical	Nec, Infec
12	ORIF	Elective	Anteromedial	4.0 mm screws	No	Acceptable	Nec, Infec
13	ORIF	Elective	Lat + ant-lat	4.0 mm screws	Yes	Acceptable	No
14	ORIF	Elective	Lat + ant-lat	6.5 mm screw	No	Poor	No
15	Surgical	NA	NA	NA	NA	Anatomical	NA
16	ORIF + subtalar arthrodesis	Elective	Lat + ant-lat	6.5 mm screw	Yes	Poor	Nec
17	ORIF + subtalar arthrodesis	Elective	Lat + ant-lat	4.0 mm screws	Yes	Anatomical	No
18	ORIF	Elective	Lat + ant-lat	Kirschner wires	No	Poor	Infec
19	Tibiotalocalcaneal arthrodesis	Elective	NA	Intramedullary nail	NA	NA	Infec
20	ORIF + subtalar arthrodesis	Elective	Lat + ant-lat	6.5 mm screw	Yes	Anatomical	No

Legends: ORIF – open reduction and internal fixation, NA – not applicable, ant-lat – anterolateral, lat – lateral, mm – millimeters, Nec – cutaneous necrosis, Hem – Hematoma, Infec – Infection.

Notes: “Emergency or elective” – refers to the time that elapsed between the occurrence of the fracture and the start of the treatment

Source: Medical Archives and Statistics Service, Central Hospital of Santa Casa de São Paulo (SAME)

and one underwent primary talectomy (5%) (Table 2). In three feet, primary subtalar arthrodesis was performed simultaneously with ORIF, because of the large degree of osteochondral fragmentation observed at the time of the surgery (Table 2).

Four of the 16 patients who underwent ORIF (25%) were operated immediately after hospital admission, while 12 patients (75%) were operated on an elective basis after achieving improvements in their skin condition. The operations in the latter group took place on average 10 days after the trauma, ranging from four to 22 days (Table 2).

In four of the 16 feet that underwent ORIF (25%), a single anteromedial access route was used. One foot (6%) was operated by means of a single anterolateral access route. Combined access routes were used in 11 feet (69%). In these cases, an anterolateral approach

was used to view the main outline of the fracture and a lateral submalleolar approach was used to view the subtalar joint (Table 2).

In four of the 16 feet that underwent ORIF (25%), it was decided to use internal fixation with a partially threaded cannulated screw of 6.5 mm in diameter, introduced from posterior to anterior. Partially threaded screws of four millimeters in diameter were used in 11 feet (69%). Kirschner wires of two millimeters in diameter were used alone in one foot (6%) (Table 2). In patients in whom primary subtalar arthrodesis was performed, a partially threaded screw of 6.5 mm in diameter was used for fixation and joint compression.

Additional provisional transarticular fixation using a Kirschner wire of two millimeters in diameter was needed in five of the 16 feet that underwent ORIF (31%). In four of these (patients 6, 9, 11 and 13), the

fixation included the subtalar joint and was indicated in order to maintain the alignment of this joint, which had become destabilized because of complete lesion of the interosseous ligament. In another foot (patient 20), talonavicular transarticular fixation was necessary because of accentuated stability caused by an extensive capsule-ligament lesion.

A spongy bone graft taken from the crest of the iliac bone or the metaphysis region of the tibia was impacted to fill a bone failure in the talar neck that was present in five of the 16 feet that underwent ORIF (Table 2).

Among the 34 patients who underwent either non-surgical treatment or ORIF, the reduction obtained was classified as anatomical in seven cases (41%), as acceptable in six cases (35%) and as poor in four cases (24%) (Table 2).

In three of the 20 feet treated (15%), joint repair was not possible. Total primary talectomy was performed in one of these patients (patient 8) and tibiotalar arthrodesis fixed with a locked retrograde intramedullary nail and interposition of bone graft material was performed in the other two (patients 10 and 19).

After the surgery, the limb that had been operated was immobilized with a leg-to-foot plaster brace. Routine suction drainage was used for a 24 to 48-hour period. Immediately after removal of the plaster immobilization, physiotherapy treatment was instituted. Loading was only started when signs of bone consolidation could be seen.

In the event of radiographic signs of osteonecrosis in the talar body, patients were kept without loading on the affected limb or a molded polypropylene orthosis was used, with loading on the patellar tendon, thereby seeking to avoid talar body collapse. This management was maintained for around nine months.

## Early postoperative complications

Early complications occurred in seven (37%) of the 19 patients who underwent surgical treatment (Table 2). Postoperative hematoma requiring surgical drainage was observed in one foot (patient 8). Necrosis on the edges of the operative wound occurred in an isolated manner in two feet (patients 2 and 16), and was associated with infection in another two feet (patients 11 and 12). None of the patients presented vascular complications.

Four patients presented postoperative infections. Two cases were superficial (patients 12 and 18), which were treated with intravenous antibiotic therapy, and the other two were deep. One of the latter (patient 19) was treated with antibiotic therapy and removal of the osteosynthesis material, while the other (patient 11; Figures 1A, 1B and 1C) was treated with talectomy four months after the initial treatment.

The patients operated because of type III or IV fractures according to the modified Hawkins classification<sup>(2,22)</sup> presented significantly greater incidence ( $P = 0.002$ ) of early complications (86%) than did the patients operated because of type II fractures (8%). The incidence of early complications was also greater among the patients with exposed fractures (75%) than among those with closed fractures (27%), although this difference was not statistically significant ( $P = 0.1$ ). Among the patients treated with open reduction and internal fixation, there was no significant difference in the incidence of early complications between those who underwent an approach using a single access and those with a combined access ( $P = 0.5$ ), and also there was no significant difference between those operated on an emergency basis and those whose procedures were elective ( $P = 0.6$ ).



**Figure 2** – Patient 18 – Radiograph of the ankle in lateral view, after six months of postoperative follow-up, presenting delayed consolidation (2A) and after 14 months of postoperative follow-up (2B), presenting defective consolidation of the fracture focus

### Initial radiographic result

On the radiographs produced during the outpatient follow-up, we noted the presence of radiographic signs of osteonecrosis in the talar body in four feet (25%) and delayed consolidation in a single foot (6%), while there were no cases of pseudarthrosis or loss of reduction (Table 3). Four patients were excluded from this evaluation: two who underwent tibiototalcalcaneal arthrodesis and two who underwent talectomy less than six months after the initial treatment.

The difference in the incidence of osteonecrosis between the patients with type III or IV fractures (75%) and those with type I or II fractures (8%) was statistically significant ( $P = 0.02$ ). There was no statistically significant difference in the incidence of osteonecrosis

between the following patients: with exposed or closed fractures ( $P = 0.55$ ); operated as an emergency or electively ( $P = 0.72$ ); operated using a single or a combined access ( $P = 0.24$ ); and with different qualities of initial reduction ( $P = 0.17$ ).

The patient who presented delayed consolidation (patient 18; Figure 2A) was treated with open reduction and internal fixation using Kirschner wires, in a closed fracture of Hawkins type IV, which evolved with superficial infection in the immediate postoperative period. In addition to delayed consolidation, osteonecrosis of the talar body also occurred. This patient was then treated with a body weight-offloading orthosis until evidence of radiographic consolidation appeared, which occurred 14 months after the trauma (Figure 2B).

**Table 3** – Data relating to the need to carry out secondary reconstructive procedures after the initial treatment on the patients with talar neck fracture, in sequence according to the date of fracture occurrence, including occurrences of initial radiographic complications such as osteonecrosis, delayed consolidation and pseudarthrosis; length of radiographic follow-up; and radiographic presence of arthrosis or arthrodesis involving the subtalar or ankle joints, on the last radiograph evaluated

Patient	Secondary procedure	$\Delta T$ (months)	Reason for secondary surgery	Initial radiographic complications	Length of follow-up (months)	Ankle arthrosis/arthrodesis	Subtalar arthrosis/arthrodesis
1	No	NA	NA	No	169	Severe	Moderate
2	No	NA	NA	No	142	Mild	Severe
3	No	NA	NA	No	113	No	Severe
4	No	NA	NA	No	100	No	Moderate
5	No	NA	NA	Osteonecrosis	96	Moderate	Severe
6	No	NA	NA	Osteonecrosis	101	Severe	Moderate
7	No	NA	NA	No	98	Mild	No
8	Panarthrodesis	18	Arthrosis	NA	90	Arthrodesis	Arthrodesis
9	No	NA	NA	No	67	No	No
10	No	NA	N	NA	70	Arthrodesis	Arthrodesis
11	Talectomy	4	Osteomyelitis	NA	61	Talectomy	Talectomy
12	Panarthrodesis	35	Arthrosis	No	60	Arthrodesis	Arthrodesis
13	No	NA	NA	No	46	Mild	Moderate
14	No	NA	NA	No	41	Mild	Mild
15	No	NA	NA	No	43	No	Mild
16	Ankle arthrodesis	28	Arthrosis	Osteonecrosis	33	Arthrodesis	Arthrodesis
17	No	NA	NA	No	25	No	Arthrodesis
18	No	NA	NA	Osteonecrosis + delayed consolidation	26	Moderate	Moderate
19	No	NA	NA	NA	22	Arthrodesis	Arthrodesis
20	No	NA	NA	No	14	Mild	Arthrodesis

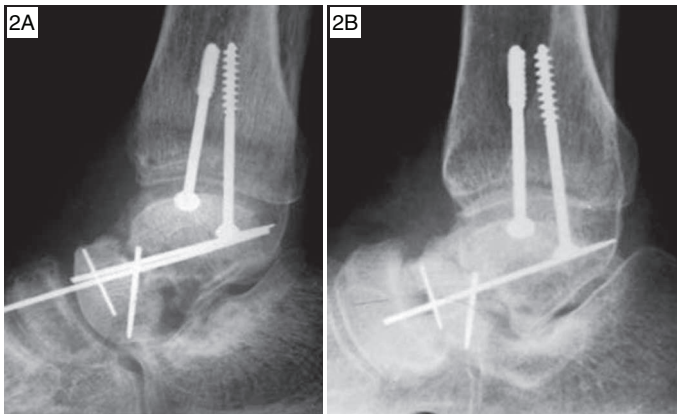
Legends:  $\Delta T$  – Time that elapsed between initial treatment and secondary procedure; -1 – patient with outpatient follow-up shorter than six months; -2 – patient with outpatient follow-up shorter than 12 months; NA – not applicable.

Notes: The columns “Ankle arthrosis/arthrodesis” and “Subtalar arthrosis/arthrodesis” refer to the degree of arthrosis in these joints or the presence of arthrodesis or talectomy at the time of the reassessment.

Osteonecrosis refers to the radiographic observation of osteonecrosis of the talar body

Delayed consolidation refers to consolidation that occurred more than six months after the initial treatment

Source: Medical Archives and Statistics Service, Central Hospital of Santa Casa de São Paulo (SAME)



**Figure 1** – Patient 11 – Radiographs on ankle in lateral view, showing the fracture (1A), initial postoperative period after fracture reduction and osteosynthesis (1B) and immediate postoperative period after total talectomy total performed to treat osteomyelitis (1C)

### Secondary reconstructive procedures

After a mean follow-up of  $71 \pm 42$  months (ranging from 14 to 169 months), four patients (Table 3) had already undergone a secondary reconstructive procedure of some type (20%) (Figures 3A, 3B and 3C).

There was significantly greater incidence ( $P = 0.01$ ) of secondary reconstructive procedures among the patients with exposed fractures (75%), compared with those with closed fractures (6%). Among the seven patients who presented early postoperative complications, the incidence of secondary reconstructive procedures (four patients; 57%) was significantly greater ( $P = 0.009$ ) than the incidence among the patients who did not present these complications (0%). There was also greater incidence of secondary reconstructive procedures among the patients with type III and IV fractures (43%), in relation to those

with type I and II fractures (8%), according to the modified Hawkins classification<sup>(2,22)</sup>, although this difference did not show statistical significance ( $P = 0.1$ ).

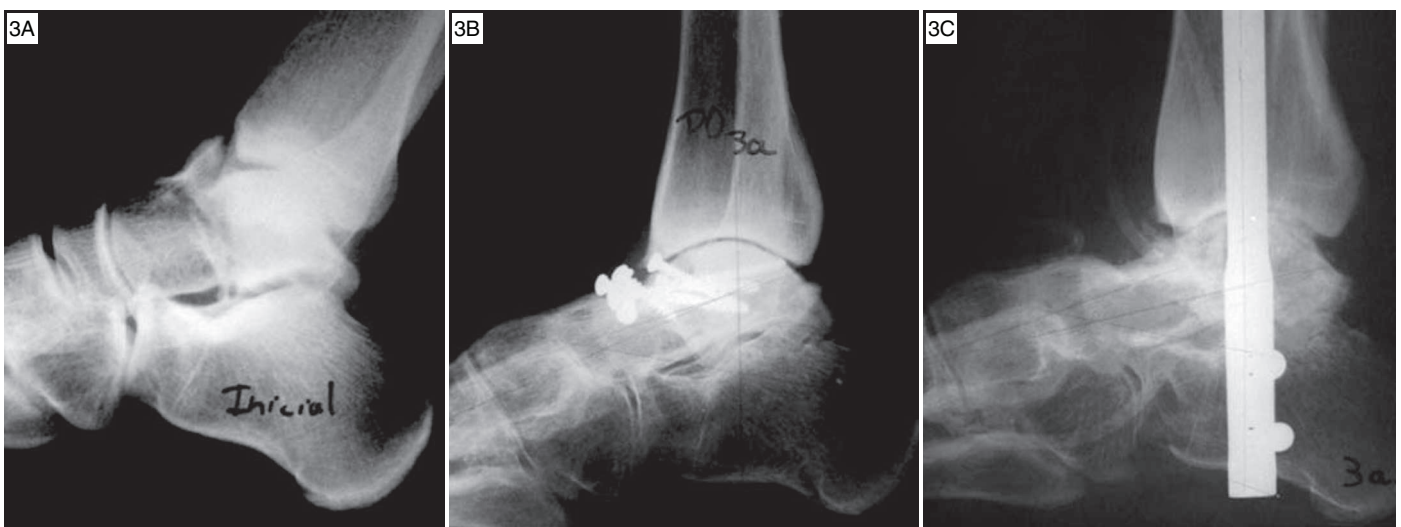
There was no statistical relationship between the incidence of secondary reconstructive procedures and the following variables: open reduction with internal fixation via a single or a combined access ( $P = 0.21$ ); time elapsed between the occurrence of the fracture and its fixation ( $P = 0.39$ ); quality of the initial reduction ( $p = 0.9$ ); or osteonecrosis of the talar body ( $P = 0.45$ ).

### Late radiographic result

In evaluating the radiographs produced during the outpatient treatment, collapse of the trochlear of the talus was observed in two of the four feet with a previous diagnosis of osteonecrosis. In patient 6, the collapse was seen 27 months after the initial treatment; and in patient 18, the collapse was seen 14 months after the initial treatment.

The radiographic assessments on the ankle joints of the 16 reevaluated patients who did not undergo secondary procedures showed that: five feet (31%) did not present signs of arthrosis; five feet (31%) presented mild arthrosis; two feet (12.5%) presented moderate arthrosis; two feet (12.5%) presented severe arthrosis; and two ankles (12.5%) had undergone primary arthrodesis (Table 3).

The subtalar joint did not show any signs of arthrosis in two feet (12.5%), whereas it showed mild arthrosis in two feet (12.5%), moderate arthrosis in five feet (31%) and severe arthrosis in three feet (19%); four joints (25%) had undergone primary arthrodesis (Table 3).



**Figure 3** – Patient 12 – Radiographs of the ankle in lateral view, showing dislocated talar neck fracture with dorsal fragmentation (3A), 36 months after the operation with arthrosis of the ankle and subtalar joints (3B) and the result after tibiototalcalcaneal arthrodesis performed to treat pain (3C)

There were no cases of moderate or severe arthrosis in the ankles of the patients whose reduction obtained after the initial treatment was classified as anatomical, while among the patients whose reduction was classified as acceptable or poor, the incidence of moderate or severe arthrosis was 50%. However, this difference did not show statistical significance ( $P = 0.069$ ). The difference in the incidence of moderate and severe arthrosis was statistically significant between the patients who presented osteonecrosis of the talar body (100%) and those who did not present this complication (9%;  $P = 0.01$ ).

### Clinical-functional result

At the time of the assessment, 13 out of the 16 patients (81%) who had not undergone secondary reconstructive procedures reported complaints of some type in

relation to the fractured foot. One of these patients presented only a complaint of difficulty in walking (6%), six complained only of pain in the foot or ankle (37.5%), while another six presented combined complaints of pain and difficulty in walking (37.5%). Among the 12 patients with painful complaints, the anterior region of the ankle and the sinus tarsi were the most frequent locations of the pain. Among these patients, seven classified their pain as mild (44%) and five classified it as moderate (31%) (Table 4).

The joint alignment was classified as: good in 10 feet (62.5%); regular in four (25%), of which two presented varus deformity (patients 15 and 29), one presented varus and cavus deformity (patient 8) and one presented varus, cavus and adduction deformity (patient 18); and poor in two feet (12.5%), which both presented equinus deformity (patients 24 and 35) (Table 4).

**Table 4** – Data relating to the final clinical-functional result among the patients with talar neck fracture, in sequence according to the date of fracture occurrence, including the length of clinical follow-up; return to work activities prior to fracture occurrence; presence of complaints relating to the treated foot; presence, location and intensity of residual chronic pain; presence and location of sensory deficit in the treated foot; presence, type and classification of the deformity according to the AOFAS method<sup>(37)</sup>; score obtained on the AOFAS clinical-functional scale<sup>(37)</sup>; and score obtained in the Hawkins clinical-functional classification<sup>(2)</sup>

Patient	Length of follow-up (months)	Return to work	Main complaint	Residual chronic pain		Sensory deficit	Alignment		AOFAS	Hawkins result
				Location	Intensity		Deformity	Classification		
1	169	Yes	Pain	Ankle	Mild	Absent	Cavus + varus	Regular	77	Excellent
2	142	Yes	Absent	Absent	Absent	No	Absent	Good	90	Good
3	113	No	Pain + incap	Ankle + sinus tarsi	Mild	No	Varus	Regular	74	Good
4	100	Yes	Pain + incap	Ankle	Mild	Sup fib	Absent	Good	82	Excellent
5	96	No	Pain	Ankle + sinus tarsi	Moderate	Saphenous	Absent	Good	69	Good
6	101	Yes	Absent	Absent	Absent	Sup fib + sural	Cavus, varus + adduction	Regular	82	Good
7	98	Yes	Pain + incap	Ankle	Mild	No	Absent	Good	87	Excellent
8	90	₋₃	₋₃	₋₃	₋₃	₋₃	₋₃	₋₃	62	Regular
9	67	Yes	Incap	Absent	Absent	No	Absent	Good	94	Excellent
10	70	No	Pain	Ankle	Moderate	No	Equinus	Poor	44	Poor
11	70	₋₃	₋₃	₋₃	₋₃	₋₃	₋₃	₋₃	67	Regular <sup>3</sup>
12	61	₋₃	₋₃	₋₃	₋₃	₋₃	₋₃	₋₃	64	Regular
13	46	Yes	Absent	Absent	Absent	Sup fib	Varus	Regular	89	Excellent
14	41	No	Pain	Ankle	Mild	Sup fib + sural	Absent	Good	69	Good
15	43	No	Pain	Sinus tarsi	Moderate	No	Absent	Good	71	Good
16	33	₋₃	₋₃	₋₃	₋₃	₋₃	₋₃	₋₃	42	Regular
17	25	Yes	Pain	Sinus tarsi	Mild	Sural	Absent	Good	82	Good
18	26	No	Pain + incap	Sinus tarsi	Moderate	No	Absent	Good	48	Regular
19	22	No	Pain + incap	Ankle+ base of fifth metatarsal	Moderate	Sup fib	Equinus	Poor	32	Poor
20	14	No	Pain + incap	Ankle	Mild	No	Absent	Good	79	Good

Legends: Incap – functional incapacity, Sup fib – superficial fibular, -1 – patient with outpatient follow-up shorter than six months, -2 – patient with outpatient follow-up shorter than 12 months, -3 – patient who underwent secondary reconstructive procedure, AOFAS – clinical-functional classification for hindfoot and ankle of the American Orthopaedic Foot and Ankle Society<sup>(37)</sup>, Hawkins result – clinical-functional result according to the classification proposed by Hawkins<sup>(2)</sup>

Source: Medical Archives and Statistics Service, Central Hospital of Santa Casa de São Paulo (SAME)



We observed that seven of the feet (44%) presented sensory deficits: three in the area innervated by the superficial fibular nerve; one in the area of the sural nerve; one in the area of the saphenous nerve; and two in the areas innervated by the sural and superficial fibular nerves (Table 4). One of the patients with sensory deficit had initially undergone tibiototalcalcaneal arthrodesis, while the other five had undergone open reduction with internal fixation via a combined access route.

At the time of the reassessment, eight patients had returned to the same work activity as performed prior to fracturing the talar neck (50%) and eight were off work and receiving sickness benefit (50%) (Table 4). None of the patients had changed their original professional activity because of limitations caused by the talar neck fracture.

With regard to loss of joint range of motion, we observed a mean loss of  $49 \pm 31\%$  in joint range of motion of the ankle;  $80 \pm 21\%$  in the subtalar joint;  $49 \pm 32\%$  in the adduction/abduction axis of the midfoot and fo-

refoot; and  $35 \pm 35\%$  in the pronation/supination axis of the midfoot and forefoot (Table 5).

The loss of movement in the ankle and subtalar joints was greater in the patients who presented early complications. In the ankle, the mean loss of range of motion was  $84.5 \pm 21\%$  in the patients who presented these complications, compared with a loss of  $42 \pm 27\%$  in the other patients ( $P = 0.04$ ). In the subtalar joint, the mean loss of range of motion was  $95 \pm 9\%$  in the patients who presented early complications, compared with a loss of  $79 \pm 21\%$  in the patients who did not present these complications, although this difference did not present statistical significance ( $P = 0.13$ ).

From the AOFAS scale<sup>(24)</sup>, we observed a mean score of  $73 \pm 18$  points among the 16 reassessed patients who did not undergo secondary reconstructive procedures (Table 4). According to the Hawkins clinical-functional classification<sup>(2)</sup>, there were five excellent, eight good, one regular and two poor results.

**Table 5** – Data relating to length of clinical follow-up and joint range of motion at the last assessment, observed in the ankle, subtalar and midfoot joints of the patients treated for talar neck fracture, and the percentage loss of joint range of motion, compared with the joint range of motion of the contralateral foot

Patient	Length of follow-up	Ankle (flexion + extension)		Subtalar (varus and valgus)		Midfoot (adduction and abduction)		Midfoot (supination + pronation)	
		Range	Loss	Range	Loss	Range	Loss	Range	Loss
1	169	30	60%	10	78%	10	67%	30	14%
2	142	20	60%	0	100%	10	67%	10	50%
3	113	70	0	0	100%	10	50%	20	0
4	100	60	33%	5	83%	5	83%	20	78%
5	96	50	29%	20	33%	20	33%	35	0
6	101	30	63%	10	67%	20	20%	75	17%
7	98	60	33%	10	67%	30	0	75	0
8	–3	–3	–3	–3	–3	–3	–3	–3	–3
9	67	35	50%	5	83%	10	67%	75	17%
10	70	0	100%	0	100%	0	100%	0	100%
11	–3	–3	–3	–3	–3	–3	–3	–3	–3
12	–3	–3	–3	–3	–3	–3	–3	–3	–3
13	46	30	50%	5	83%	20	33%	40	27%
14	41	90	0	15	52%	30	0	65	0
15	43	60	25%	15	50%	30	0	75	0
16	–3	–3	–3	–3	–3	–3	–3	–3	–3
17	25	35	55%	0	100%	15	48%	40	38%
18	26	5	94%	5	84%	5	83%	10	84%
19	22	0	100%	0	100%	5	83%	15	83%
20	14	45	36%	0	100%	15	50%	15	57%

Notes: The "Range" columns refer to the joint range of motion of the fractured foot

The "Loss" columns refer to the percentage loss of joint range of motion of the fractured foot, in comparison with the contralateral foot

Legends: –3 – patient who underwent secondary reconstructive procedure.

Source: Medical Archives and Statistics Service, Central Hospital of Santa Casa de São Paulo (SAME)

The patients whose reduction obtained after the initial treatment was classified as poor presented a mean result ( $65 \pm 15$  points) that was significantly inferior ( $P = 0.04$ ) to the result among the patients whose reduction was classified as anatomical or acceptable ( $82 \pm 8$  points). The patients who developed osteonecrosis of the talar body also presented a mean result ( $66 \pm 17$  points) that was inferior to the result among the patients without this complication ( $81 \pm 8$  points), although this difference did not show statistical significance ( $P = 0.11$ ).

Among the patients who underwent surgical treatment but did not undergo secondary procedures, we observed that the result was worse, according to the AOFAS scale<sup>(24)</sup>, among those who presented early complications after the initial treatment. These patients presented a mean score of  $56 \pm 30$  points, compared with the score of  $77 \pm 13$  points among the others ( $P = 0.38$ ). Regarding the results among the patients who underwent secondary procedures, we observed a statistically significant difference ( $P = 0.02$ ), with a mean of  $57 \pm 19$  points among the patients who presented early complications, compared with the mean of  $77 \pm 13$  points among those without these complications.

## DISCUSSION

Fractures of the talus correspond to 26% of the fractures that occur in the feet of motorcyclists who are involved in accidents<sup>(27)</sup>. This is particularly important in a municipality like São Paulo, in which around 150,000 people are victims in traffic accidents every year and 23% of the fatalities are motorcyclists<sup>(28)</sup>. Another trauma mechanism seen very often in these injuries is falls from a height. One common point between these two mechanisms is that they occur among young male adults, frequently while conducting their professional activities.

Half of the patients reassessed in this study had never returned to their professional activity, although this proportion was much lower than what is found in the medical literature<sup>(2,15,19,23,29-31)</sup>. The mean score obtained, according to the AOFAS scale for the hindfoot and ankle<sup>(24)</sup>, was 73 points (Table 4). This was lower than what has been found among patients treated at our service for calcaneal fractures (85 points)<sup>(32)</sup>, peritalar dislocation (83 points)<sup>(33)</sup> and fracture-dislocation of the Lisfranc joint (83 points on the midfoot scale)<sup>(34)</sup>, which demonstrated the worse prognosis for patients with talar neck fractures.

A large proportion of the complications consequent to talar neck fractures are due to the high energy of the

trauma, which not only causes osteoarticular lesions like dislocation, bone fragmentation and damage to the joint cartilage, but also causes injuries to soft tissues, compromising the integrity of the skin and vascular structures of the foot<sup>(15)</sup>. These lesions may be worsened through delays in reducing the joint dislocation<sup>(8,35)</sup> and through the surgical trauma, thus giving rise to complications such as skin necrosis, hematoma, suture dehiscence and infection<sup>(2,3,19)</sup>.

The treatments for these complications, consisting of flap rotation, debridement, antibiotic therapy, removal of synthesis material and possibly talectomy, make patient rehabilitation difficult and frequently lead to poor clinical and functional results<sup>(36)</sup>, with a greater need for secondary reconstructive procedures, greater loss of ankle and subtalar joint mobility, and worse clinical-functional results, as demonstrated in the present study sample.

With the aim of avoiding worsening the soft-tissue lesions that result from the initial trauma, all dislocations should be reduced and stabilized immediately<sup>(19)</sup>. When the dislocation cannot be reduced through manipulation and the definitive fixation cannot be performed on an emergency basis, reduction of the joint surfaces can be achieved through the areas of bone exposure or small accesses along the path of the route used for the definitive fixation. Joint stabilization can be accomplished through the use of external fixators in the most severe fractures<sup>(7)</sup>, through Kirschner wires inserted percutaneously into fractures that remain unstable after reduction, or through immobilization alone, in cases of stable fractures. Thus, open reduction and internal fixation of fractures may be performed after improving the skin condition, as recommended for calcaneal and tibial pilon fractures<sup>(37,38)</sup>, and by a team with greater experience in treating these lesions.

Although there are no joints in the talar neck, angular dislocations along its axis affect the movement and alignment of the entire foot<sup>(39)</sup>, which leads to the development of arthrosis<sup>(36,40)</sup> and, in the presence of varus dislocation, to stiffness and overload on the edge of the foot<sup>(39)</sup>.

While performing surgical reduction of talar neck fractures, adequate viewing of the fracture surfaces and comprehension of the local anatomy contribute decisively towards the quality of the reduction obtained. Limited access routes may lead surgeons to carry out inadequate reductions on the fracture surface that is not viewed, which commonly leads to defective consolidation with varus and dorsiflexion, along with possible rotational dislocation<sup>(40)</sup>.

The difficulty in achieving adequate reduction was evident in our sample, in which an anatomical reduction was obtained in only one third of the patients. Furthermore, there were three feet (7.5%) in which it was necessary to perform tibiototalcalcaneal arthrodesis or primary talectomy, given the complete impossibility of correctly reducing the joint surfaces (Table 1).

In view of the difficulty in obtaining anatomical reduction by means of the access routes used in the present study, the idea of combining an anteromedial access route (between the anterior and posterior tibial tendons) with an anterolateral access route (which could be made immediately laterally to the extensor tendons or could be of Ollier type), both centered on the sinus tarsi, seems to us to be reasonable. The approach associated with this makes it possible to access the medial and lateral surfaces of the talar neck and to access the subtalar joint, which facilitates reduction of the angular and rotational dislocations and enables removal of the intra-articular bone and chondral fragments<sup>(40)</sup>. Special care needs to be taken, such that injury to the cutaneous nerves is avoided: this occurred in 44% of the patients treated in the present study, particularly among the patients who underwent the approach using the anterolateral access route.

Pseudarthrosis and delayed consolidation occur infrequently after treatment for talar neck fractures<sup>(2,7,15,19,22,29,35)</sup>. Although the only case of delayed consolidation in our sample occurred in a patient who also presented osteonecrosis of the talar body, bone consolidation can be expected even when this complication occurs<sup>(35)</sup>. It seems to us that it is prudent, as also mentioned by other authors<sup>(15,16,29)</sup>, to await the presence of radiographic signs of consolidation before starting to place loading on this region, thus avoiding occurrences of dislocations at the fracture focus. On the other hand, we believe that in cases in which rigid internal fixation is achieved, early mobilization can be started and immobilization for consolidation is unnecessary, contrary to what some authors have indicated<sup>(23,29)</sup>.

Osteonecrosis occurs when there is interruption or significant reduction in the blood supply to the bone. Vascular insufficiency leads to death of the organic part of the bone tissue, which reduces its resistance and favors occurrences of microfractures, with consequent joint collapse, particularly in bones that bear the load of the body weight and that have blood irrigation as peculiar as that of the talar body<sup>(41)</sup>.

Two factors seem to be directly related to occurrences of post-traumatic osteonecrosis of the talar body:

the magnitude of the initial dislocation of the fracture fragments and the extent of soft-tissue injury<sup>(15,16,22)</sup>. In our sample, we found that there was significantly greater occurrence ( $P < 0.01$ ) of osteonecrosis of the talar body in type III and IV fractures than in type I and II fractures. This relationship is due to the greater injury to the blood irrigation of the talar body that occurs in fractures with greater initial dislocation<sup>(36,42)</sup>.

Some authors have taken the view that anatomical reduction and fixation of the talar neck fracture carried out as emergency procedures, along with the use of a surgical access route that leads to lower vascular damage, reduce the incidence of post-traumatic osteonecrosis of the talar body<sup>(10,14,21)</sup>, although none of these studies have demonstrated the impact of this management on the incidence of osteonecrosis. In our sample, we also did not observe any significant difference in the incidence of osteonecrosis between patients operated electively and those operated as emergencies, and we did not observe any difference between patients operated using a single access and those operated using a combined access. We believe that factors relating to the severity of the initial trauma and the extent of the soft-tissue injury are the determinants for the development of osteonecrosis<sup>(16,17)</sup>.

The radiographic diagnosis of osteonecrosis was shown to be one of the main prognostic factors for the final result from treating talar neck fractures. One of the main concerns in treating patients with a diagnosis of osteonecrosis of the talar body is the occurrence of joint surface collapse<sup>(21,43)</sup> (Figure 3). In seeking to avoid this complication, some authors have advised that feet affected osteonecrosis of the talar body should be kept without body weight loading for a long period<sup>(2,21)</sup>, and this approach was used in the present study. Thus, restructuring of the bone matrix would impede joint surface collapse. Other authors have contested this, by affirming that joint collapse occurs despite the absence of loading on the fractured limb<sup>(15,18,19)</sup>.

In our sample, collapse of the trochlear of the talus occurred in two of the four reassessed patients who presented prior signs of osteonecrosis. This incidence rate was similar to what was seen in previous studies<sup>(2,7,15,31)</sup>. The time that elapsed between the initial treatment and the radiographic diagnosis of collapse in the two feet with this complication was 14 and 27 months, which is in line with the theory that the collapse does not occur during the sclerotic phase, but only after the start of the revascularization, when the remodeling of the avascular elements forms trabeculae that are more fragile and

more liable to suffer microfractures, thus leading to joint disorganization<sup>(8,44)</sup>.

In view of the long period between the initial treatment and the occurrence of the collapse, along with the absence of signs that would demonstrate an increase in bone resistance, we believe that it is not viable to keep patients without loading or for them to use orthoses while the osteonecrosis of the talar body is under treatment. Moreover, according to some authors, many patients with collapse of the trochlear of the talus do not present symptoms that would indicate the need for additional surgical procedures, for long periods<sup>(2,19,22,29)</sup>.

Although talectomy is a treatment option in cases of osteomyelitis or in multifragmented fractures, we advise that this procedure should not be used as the only treatment, given the high incidence of poor results. Among our sample, this procedure was used on two feet, and both cases had unsatisfactory results. In the literature too, we found high incidence of poor results associated with this procedure, generally related to pain and residual deformities<sup>(2,8,19,22,31,35)</sup>.

We believe that when talectomy is indicated, this procedure should be implemented in association with tibial-calcaneal and tibionavicular arthrodesis, as part of the same procedure or a subsequent procedure. This arthrodesis can be performed through the use of en-bloc grafting to maintain the length of the limb, in feet without infection, or through the use of osteodistrac-tion techniques for bone lengthening, in conjunction with arthrodesis.

The development of post-traumatic arthrosis is a frequent event, especially in the subtalar joint. Many authors have considered this to be the main complication resulting from treatment of this fracture<sup>(9-10,13,16,18,43)</sup>. Arthrosis may be a consequence of joint injury at the time of the trauma, thereby giving rise to fragmentation of the fracture focus or cartilage damage<sup>(8)</sup>, or it may arise through changes to the joint mechanism, secondary to defective consolidation of the talar neck.

In the present sample, 80% of the reassessed feet presented moderate or severe subtalar arthrosis, or had already undergone arthrodesis on this joint. Since the incidence of radiographic arthrosis correlated with the mean loss of movement of this joint among the patients who did not undergo secondary procedures (80%), it seems to us to be appropriate to perform primary subtalar arthrodesis in cases in which the initial surgery demonstrates the presence of severe chondral lesions and bone comminution.

Ankle arthrosis was shown to be less frequent than subtalar arthrosis, especially among the patients who did not present osteonecrosis and in whom anatomical reduction was achieved in the initial treatment for the talar neck fracture. In our view, primary arthrodesis on the ankle for treating talus fractures presents indications limited to cases in which reduction of the fractured fragments is impossible. Great care needs to be taken in positioning the ankle. In our sample, both of the cases that underwent primary arthrodesis on the ankle and subtalar presented equinus deformities.

The presence of arthrosis suggests that the clinical results found tend to deteriorate with increasing length of follow-up, and it is probably necessary to carry out arthrodesis on other patients, as demonstrated by Sanders *et al*<sup>(31)</sup>.

The present study presents certain limitations. The first of these relates to the retrospective nature of the patient assessments, in which a large number of patients were not reassessed (46%). Although this is common in studies that evaluate the results from treatments for traumatic lesions, it creates difficulty in establishing precise prognoses, especially in relation to assessing complications such as osteonecrosis of the talar body and joint collapse.

Another import factor relates to the limitations of the clinical-functional classification used to define the results (AOFAS classification). This presents a high score relating to a single question about pain, and it was shown to be poorly reproducible in previous studies<sup>(45)</sup>.

## CONCLUSION

In our sample, we observed that:

Talar neck fractures with dislocation led to a high incidence of clinical-functional and radiographic complications;

There was difficulty in achieving anatomical reduction of dislocated talar neck fractures, which suggests that there is a need to use combined access routes;

Fracture fragment reduction that was classified as poor, occurrence of early postoperative complications and development of osteonecrosis of the talar body were the main factors relating to poor clinical-functional results.

## ACKNOWLEDGEMENT

We thank CAPES for the support it provided for accomplishing this work.

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