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Is It an Overlooked Injury? Magnetic Resonance Imaging Examination of Occult Talus Lesions Concomitant to Tibial Shaft Fracture

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ABSTRACT

Long-term studies have shown that 10% to 20% of patients continue to experience ankle pain years after tibial fracture, which causes poor functional results and dissatisfaction. The aim of this study was to show that there could be a talus injury in patients with a tibial shaft fracture and to reveal occult talus lesions with magnetic resonance imaging (MRI) examination. Fifty-two patients with a tibial shaft fracture, with closed epiphyses, not extending to the joint and with no problems in the application of MRI examination were included. All patients underwent intramedullary tibial nailing. Patients with a lesion detected on MRI were planned to be examined by MRI again at mean of 12 months later. Ankle function of the patients were evaluated with the American Orthopaedic Foot and Ankle Society, Freiburg, and Weber scoring systems at 3, 6, and 12 months postoperatively. At the first MRI, 22 (42.3%) patients with tibial shaft fracture were found to have talus lesions: 7 (13.5%) had osteochondritis dissecans, 12 (23.1%) had edema, and 3 (5.8%) had cysts. A second MRI was planned for patients with edema and osteochondritis dissecans at a mean of 12 months. Finally, at 12 months, MRI examinations revealed osteochondritis dissecans and edema in 9 (17.3%) and 8 (15.4%) patients, respectively. In the evaluations of the patients according to the ankle scoring systems, the scores of the patients with pathology determined in the talus were significantly worse statistically than those of patients with no pathology determined at 3, 6, and 12 months postoperatively. A talus lesion accompanied the tibial shaft fracture at a rate of 37%. The talus injuries were seen especially with an indirect mechanism of trauma, in distal third fractures, in spiral fractures, and when the tibial fracture was accompanied by a lateral malleolar fracture. In the presence of findings indicating talus injury in cases of tibial shaft fracture, the talus should be evaluated with ankle MRI.

Surgical treatment of tibial shaft fractures is generally satisfactory from the patient's perspective, with good functional results and high union rates. However, some patients complain of unexplained ankle pain and joint stiffness even when the full union of the tibial shaft fracture has been obtained. Long-term studies have shown that 10% to 20% of patients continue to experience ankle pain years after the trauma, which causes poor functional results (1,2). There has been increasing interest in a subject that has recently come to the fore that there could be ipsilateral ankle injuries concomitant to a fracture of the tibial shaft. These ankle injuries can be said to be primarily posterior malleolar fractures, lateral malleolar fractures, medial malleolar fractures, anteroinferior tibiofibular ligament avulsion fractures, and syndesmosis injuries. However, there has been no mention to date that the talus, which constitutes 1 of the main bones of the ankle, could be affected.

The hypothesis of this study was that tibial shaft fractures are not isolated injuries, and as a result of the forces in the direct or indirect injuries affecting the tibial shaft, occult talus lesions could be created. These injuries could affect functional results in the long term. Therefore, we aimed to define acute lesions of the talus with ankle magnetic resonance imaging (MRI) examination of patients with a tibial shaft fracture and to determine how this entity was reflected clinically.

Patients and Methods

This study included a total of 52 patients who presented to the emergency department with an isolated tibial shaft fracture between November 2014 and June 2016. Exclusion criteria were patients with an epiphysis that was not closed; tibial plateau and tibial

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pilon fractures; tibial shaft fractures extending to the joint; concomitant talus, calcaneus, navicular, cuboid, cuneiform, or metatarsal bone fractures; history of malleolar, talus, or calcaneus fractures; history of tibial fracture; previous ankle complaints; previous arthroscopic and/or open surgery on the foot or ankle; patients who refused surgery for the tibial shaft fracture and/or those for whom conservative treatment was planned; and patients with contraindications to MRI (implant incompatible with MRI, cardiac pacemaker, claustrophobia). In addition to tibial radiographs—including the joint above and below the fracture—anteroposterior ankle radiographs were taken during the evaluation of all patients in the emergency department. Computed tomographic (CT) scanning was applied as an additional imaging method for patients with a distal third tibial fracture.

All patients were operated on by the same surgical team. The prepatellar approach and tibia intramedullary nailing were performed on the patients. The same intramedullary nail was used for all patients in the study (Versa Tibia Nail; Biomet Inc., Warsaw, IN). The patients were mobilized from postoperative day 2. Weightbearing was not permitted until the results were seen on postoperative MRI. Patients with no pathology determined on MRI were permitted partial weightbearing, and patients with edema that recovered and had no development of wound site problems or any other problems were discharged.

An MRI was taken of the ankle of the extremity with the tibial shaft fracture in all patients in the period between postoperative day 2 and the day of discharge. The MRIs were evaluated by an associate professor (D.S.C., with 26 years of experience in musculoskeletal radiology) and a radiology specialist (O.O.Y., with 7 years of experience in musculoskeletal radiology). All ankle structures including bone, cartilage, and connective tissue were evaluated at the MRI examination, and according to the MRI results, the talus was separated into 4 regions. The locations and characteristics of lesions according to these areas were determined and recorded.

Patients found to have pathology in the talus were not permitted weightbearing until postoperative week 6. Those found to have pathology in the talus on the ankle MRI underwent a second ankle MRI to the same extremity at mean of 11 (range 6 to 14) months postoperatively. These MRIs were compared with the first images by the same radiology associate professor (D.S.C.) and specialist (O.O.Y.). The pathology in the talus and final status as observed on the MRI were recorded. Clinical evaluation of the patients was made with Weber, American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot-ankle (3,4), and Freiburg scoring systems at 3, 6, and 12 months.

Statistical Analyses

Statistical analyses were performed using IBM SPSS 23.0 software (SPSS Inc, Chicago, IL). Descriptive statistical methods were used (number, percentage, mean, and standard deviation). In the comparisons of qualitative data and comparisons between groups, statistical differences were evaluated with the Student *t* test, analysis of variance, and post hoc Tukey test. Results are presented as the mean ± standard deviation. Statistical significance was defined at the 5% ($p \leq .05$) level. Values with a probability (p) α of .05 were accepted as significant, and a difference between the groups and values greater than this were not considered significant, with no difference between the groups.

Results

The study included 52 patients, comprising 33 (63.5%) males and 19 (36.5%) females with a mean age of 39.5 (range 19.0 to 76.0) years. The patients were separated as direct and indirect according to the mechanism of injury. Direct injuries included a direct impact on the tibia as a result of traffic accidents within a vehicle, being struck by a vehicle, and industrial accidents, whereas indirect injuries comprised simple falls and torsional injuries. In the evaluation of the results, 24 (46.2%) were injured by indirect trauma and 28 (53.8%) by direct trauma. Distal third tibial fractures, spiral-type tibial fractures, and lateral malleolar fractures concomitant to the tibial fracture were seen more often as a result of indirect trauma. Talus lesions were also seen more often in indirect trauma. That all patients with osteochondritis dissecans (OCD) in the talus experienced an indirect trauma was a highly significant and noteworthy finding. Edema that formed in the talus was associated more often with direct trauma. Both medial and lateral lesions seen in the talus were more common in injuries from indirect trauma. The final postoperative ankle function scores were worse in patients who experienced indirect trauma. These associations were statistically significant ($p \leq .05$).

On the MRI examination, only malleolar fractures and talus lesions were detected, and no ligament injury, syndesmosis injury, or serious effusion was detected. In 10 (19.2%) patients with tibial fracture requiring surgical fixation, there was a concomitant lateral malleolar fracture, and all of these patients (100%) had a distal third tibial fracture. Thus, 10 (37%) of 27 patients with a distal third tibial fracture also had a lateral malleolar fracture. In 8 of these 10 patients with a lateral malleolar fracture, pathology in the talus was determined via MRI. This association was seen to be statistically significant ($p \leq .05$). Additionally, a posterior malleolar fracture was found in 9 (17.3%) patients. Surgical fixation was not performed for posterior malleolar fracture, because all of the posterior malleolar fractures were nondisplaced. For 4 of the 9 patients with a posterior malleolar fracture, pathology in the talus was determined via MRI. This association was not statistically significant ($p > .05$) (Table 1).

The time from the first MRI taken of the patients to the second MRI was a mean of 11.3 (median 12; range 6 to 17) months. On the first MRI, pathology was determined in the talus of 22 (42.3%) patients as edema in 12 (23.1%), OCD in 7 (13.5%), and a cyst in 3 (5.8%). On the second MRI taken of the patients shown to have pathology on the first MRI, edema was seen in 8 (36.4%) patients, OCD in 9 (40.9%), a cyst in 2 (9.1%), and normal findings in 3 (13.6%). A statistically significant correlation was determined between the first and second MRIs ($p < .001$). In 19 (86.4%) of the 22 patients found to have pathology in the talus, there was a lesion in the talus dome. However, 3 (13.6%) patients with >1 intramedullary cyst were withdrawn from the evaluation, because based on the MRI examination, the cysts were found to be degenerative (Table 2). In the regional distribution of the remaining 19 patients as medial or lateral, the lesion was on the lateral side in 8 (15.4%) patients and on the medial side in 11 (21.2%). Case examples are presented elsewhere in this article (Figs. 1*A*–2*D*).

When the distributions of the lesions seen in the talus were examined according to the site of the fracture in the tibia, 16 (84.2%) of the 19 patients had a distal third tibial fracture and 3 (15.8%) had a mid-third tibial fracture. A spiral-type tibial fracture was seen in 13 (68.3%) of the 19 patients with a lesion of the talus.

Patients were evaluated at 3, 6, and 12 months postoperatively for ankle function scores. The mean AOFAS ankle scores at 3, 6, and 12 months were 80.1, 90.3, and 90.4, respectively. The mean Freiburg ankle scores at 3, 6, and 12 months were 80.3, 89.8, and 90.7, respectively. The mean Weber ankle scores at 3, 6, and 12 months were 2.4, 1.0, and 0.9, respectively. A statistically significant improvement was determined in the ankle function scores of the patients at 6 months compared with 3 months ($p \leq .05$). The difference in the scores from 6 months postoperatively to 12 months was not statistically significant ($p > .05$).

In the evaluation at 3 months postoperatively, 13 (25%) patients had poor AOFAS scores, 17 (32.7%) had poor Weber scores, and 20 (38.5%)

Table 1
Relation between talus lesions and other parameters (N = 52)

	With Talus Lesions	Without Talus Lesions	Total
Distal third tibial fracture	18 (34.6%)	9 (17.3%)	27 (51.9%)
Middle third tibial fracture	4 (7.7%)	19 (36.5%)	23 (44.2%)
Proximal third tibial fracture	0 (0%)	2 (3.9%)	2 (3.9%)
Indirect trauma	13 (25%)	11 (21.2%)	24 (46.2%)
Direct trauma	9 (17.3%)	19 (36.5%)	28 (53.9%)
Lateral malleolar fracture	8 (15.4%)	2 (3.9%)	10 (19.2%)
Spiral-type tibial fracture	13 (25%)	10 (19.2%)	23 (44.2%)
Oblique-type tibial fracture	2 (3.9%)	6 (11.5%)	8 (15.4%)
Transverse-type tibial fracture	2 (3.9%)	19 (36.5%)	21 (40.4%)
Posterior malleolar fracture	4 (7.7%)	5 (9.6%)	9 (17.3%)
AOFAS scores 3 months postoperatively	70.6	87.1	—
AOFAS scores 12 months postoperatively	79.1	98.8	—
Freiburg scores 3 months postoperatively	71.6	86.6	—
Freiburg scores 12 months postoperatively	80.0	98.5	—
Weber scores 3 months postoperatively	3.3	1.6	—
Weber scores 12 months postoperatively	1.9	0.1	—

Abbreviation: AOFAS, American Orthopaedic Foot & Ankle Society.

Table 2
First, second, and final magnetic resonance imaging results (N = 22)

First MRI results, no. (%)	OCD, 7 (13.5)		edema, 12 (23.1)		cyst, 3 (5.8)	
Second MRI results, no. (%)	OCD, 7 (13.5)	OCD, 2 (3.9)	edema, 8 (15.4)	normal, 2 (3.9)	normal, 1 (1.9)	cyst, 2 (3.9)
p Value*	<.001		<.001	—		<.001
Final MRI results, no. (%)	OCD, 9 (17.3)		edema, 8 (15.4)	normal, 3 (5.8)		cyst, 2 (3.9)

Abbreviations: OCD, osteochondritis dissecans; MRI, magnetic resonance imaging.
* Pearson χ^2 test and statistically significant correlation was determined between the first and second MRIs ($p \leq .001$).

had moderate scores in the Freiburg classification. At the 12-month postoperative evaluation, 7 (13.5%) patients had poor AOFAS scores, 9 (17.3%) had poor Weber scores, and 10 (19.2%) had moderate Freiburg scores (Table 1).

Discussion

The functional results of tibial shaft fractures are significantly affected by pathologies in the ankle joint. Several studies have been conducted

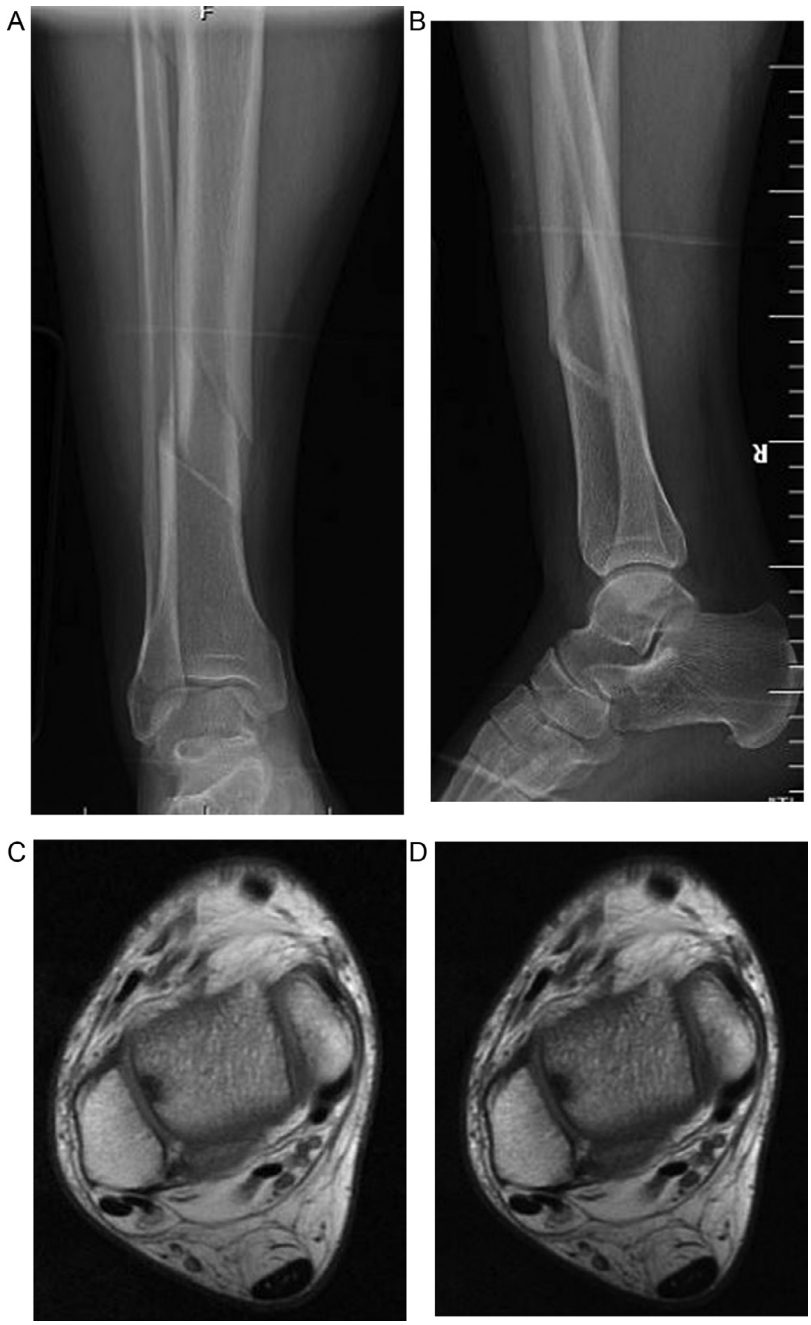

Fig. 1. (*A*) Anteroposterior radiography of the first patient. (*B*) Lateral radiograph of the first patient. (*C*) Ankle magnetic resonance imaging study of the first patient taken at 3 days (osteochondritis dissecans on theanterolateral talar dome). (*D*) Ankle magnetic resonance imaging of the first patient taken at 12 months (osteochondritis dissecans on the anterolateral talar dome).

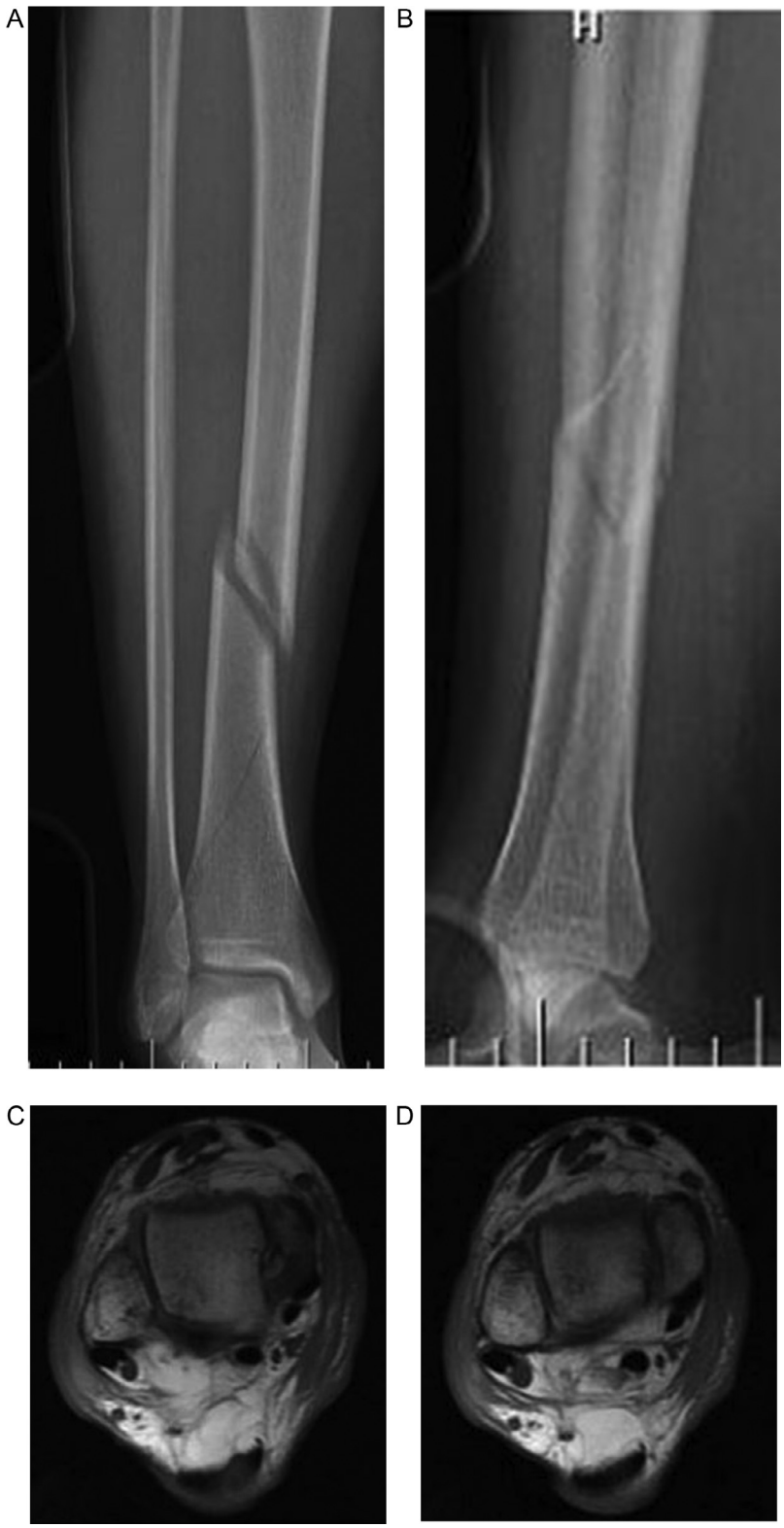

Fig. 2. (*A*) Anteroposterior radiography of the second patient. (*B*) Lateral radiography of the second patient. (*C*) Ankle magnetic resonance imaging study of the second patient taken at 4 days (edema on the anterolateral talar dome). (*D*) Ankle magnetic resonance imaging of the second patient taken at 11 months (edema on the anterolateral talar dome).

that have investigated the combination of tibial shaft fractures and ankle joint injuries, primarily concomitant posterior malleolar fractures (5–12). In a retrospective study by Hou et al (5) based primarily on radiographs, 288 spiral fractures were determined in a total of 1685 tibial fractures; of these, 28 (9.7%) were posterior malleolar fractures. Warner et al (10) applied preoperative radiography and CT imaging to 25

patients with tibial distal third spiral fracture. When the pathology was not determined as a result of this imaging, an ankle MRI was taken. Of the total 25 patients with a tibial distal third spiral fracture, an ankle injury was encountered in 21 (84%). The results of the current study were similar to the previous findings in the literature. Of the total 52 patients, a posterior malleolar fracture was determined in 9 (17.3%) and a lateral malleolar fracture in 10 (19.2%). The posterior malleolar fractures were determined on direct radiographs in 3 (5.8%) cases, on CT in 4 (7.7%), and on MRI in 2 (3.8%). Furthermore, it is an important point that all of the posterior malleolar fractures were concomitant to a spiral-type tibial shaft distal third fracture. In light of these results and the information in the literature, it can be said that there is a high possibility of occult lesions around the ankle in tibial distal third fractures and spiral fractures caused by an indirect mechanism. It must be kept in mind that these injuries may not always be seen on direct radiographs. Therefore, with the identification of these injuries that can cause poor functional results when overlooked, it is possible to increase the success rate of treatment for tibial fractures.

When injuries related to the talus are examined, which was the basic subject of this study, osteochondral injuries of the talus are seen in 6.5% of the population, generally in the second to fourth decades of life, and arthroscopic treatment results of talus osteochondral defects are satisfactory (13). Previous studies have shown that all lateral lesions and approximately one half of medial lesions are secondary to trauma (14). Because most of these lesions are subclinical, they can be masked by other injuries of the ankle, and because they can be overlooked on conventional radiographs, they are less frequently detected (15,16). Occult undifferentiated osteochondral lesion diagnosis is made via MRI because they are generally negative on radiographs in the acute phase (17). Another occult lesion that can form in the talus secondary to trauma is a bone contusion. In the acute phase, this injury is characterized by a low signal on T1A and a high reticular signal increase on T2A in the bone marrow on MRI. These findings indicate a microfracture in the trabecular bone and cannot be detected radiographically. Resolution generally occurs in 8 to 12 weeks. It is important to recognize that when the stress is not eliminated on the trabecular microfracture, it can become a macrofracture (18). After exclusion of patients with cysts that were found to be degenerative on the first MRIs, pathology was determined in a total of 19 (38.5%) patients from the findings of the ankle MRIs taken in the first week after the trauma. These were OCD in 7 (13.5%) cases (4 medial, 3 lateral) and edema in 12 (23.1%) cases (7 medial, 5 lateral). On the MRIs taken 12 months postoperatively of patients found to have pathology, edema had resolved in 2 (3.8%) patients and the pathology was seen to persist in 17 (32.7%). Medial lesions were seen more frequently in the study (11 [57.9%] of 19 lesions were medial). Edema seen on the first MRI in 2 (3.8%) patients had become OCD at the end of 12 months, and in both cases the edema was medial. In another 2 (3.8%) patients with medial edema, this complication had completely resolved by the 12-month follow-up visit and MRI. However, the lesions of all patients with lateral edema and OCD were seen to continue at the end of 12 months.

Another important point is that all patients with OCD in the talus had injuries from a trauma caused by an indirect mechanism. This finding is a clear indicator that excessive weight is loaded on the ankle in tibial shaft fractures that occur with an indirect mechanism of trauma. Another sign is that in injuries occurring with indirect trauma mechanism where a lateral malleolar fracture is concomitant to tibial shaft fracture, the lack of lateral malleolar support in the ankle leads to all of the force being reflected on the talus, thereby causing a lesion. The combination of a lateral malleolar fracture with talus injury in the results of this study confirm this finding; 8 (80%) of the 10 patients with a lateral malleolar fracture also had a lesion in the talus. Another sign that a talus lesion is formed by an indirect mechanism is that in most patients determined to have a talus lesion, a spiral-type fracture was most frequently seen in the tibia with indirect trauma (13 [68.4%] of 19 patients had a spiral-type fracture).

Previous studies evaluating the ankle functions of patients in the long term after tibial fractures have reported that ankle functions are significantly affected. Lefaivre et al (19) applied intramedullary nailing, and although there was no tibial malalignment after a mean of 14 years of follow-up, 14 of 33 patients (42.4%) had a 5° to 20° restriction in ankle range of motion compared with the healthy extremity. From the ankle radiograph examination, a moderate level of osteoarthritis developed in 3 patients (19). Habernek et al (20) applied intramedullary nailing to tibial shaft fractures of 102 patients and at the 3-year follow-up point reported a 10% loss of movement in the ankle at $\leq$33 months postoperatively. Compared with a healthy population, the scores reflecting the clinical ankle problems of the patients operated on for tibial shaft fracture in this study were poor at 3 months postoperatively, particularly for patients with distal third fractures. At 6 months postoperatively, the scores improved with radiologic union and return to daily activities and sport; however, at 12 months, the scores were similar with no great improvement. In other words, ankle problems persisted as they were at 6 months and did not make any further significant improvement. Of the patients treated for tibial shaft fracture in this study, between 13.5% and 9.2% obtained poor results in the ankle function scores. Ankle problems were seen more in the patients with pathology determined in the talus and at a statistically significant higher rate in distal third fractures, spiral fractures, and tibial fractures with a concomitant lateral malleolar fracture. The scores of the patients found to have pathology in the talus were significantly worse statistically than those of patients not determined with pathology at 3, 6, and 12 months postoperatively. The worst scores were obtained by patients determined with OCD, followed by those with edema and cysts.

In this study, lesions in the talus after tibial shaft fractures were clearly shown on MRI. At the same time, the effect of these lesions on poor functional outcomes is an important point. Accompanying ankle injuries may be the cause of poor functional outcomes with talus lesions in the early period. However, despite the complete recovery of all other injuries that could lead to poor functional results in the ankle in the late period, the functional outcomes of patients with talus lesions remained poor. Therefore, we believe that these poor results are caused by talus lesions, because only talus pathologies persisted on MRI in the late period.

There are several limitations to this study. The first is the small sample size. The second is that although there were no previous trauma and ankle complaints in the patients, there was no documentation of patients with pathology on the first MRIs before the trauma. Finally, postoperative diagnostic ankle arthroscopy has not yet been applied.

In conclusion, the results of this study have shown that tibial shaft fractures are not a problem involving only the tibia; however, as a result of the forces formed or transferred, a severe load is placed on the ankle. Although this loading is not greatly reflected in the ankle with direct trauma mechanisms, it is reflected in a severe form in injuries resulting from an indirect mechanism of trauma. In spiral fractures caused by an indirect mechanism in particular, and in lateral malleolar fractures caused by all of the load on the ankle reflected in the talus, again with an indirect mechanism, with the shortening of the force column, the force loaded on the ankle is greatly increased and talus injuries can be seen at rates $\leq$37% in tibial distal third fractures. Therefore, it must not be forgotten that tibial shaft fractures showing these characteristics are a sign of talus injuries. Therefore, in addition to preoperative direct radiographs and/or ankle CT scans, we recommend an ankle MRI for patients with distal tibial fractures. Regarding postoperative rehabilitation, patients found to have pathology in the talus should not be rushed into early weightbearing, and it should not be insisted that they bear weight. Patients must be informed about talus lesions and their course,

and they must be followed closely. However, despite our appreciation of the limitations of our investigation, we believe that the results of this study could be useful in the future development of prospective cohort studies and randomized controlled trials that focus on ankle problems in tibial fractures.

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