ORIGINAL ARTICLE

The common comorbidities leading to poor clinical outcomes after the surgical treatment of ankle fracture-dislocations

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ABSTRACT

BACKGROUND: The ankle fracture-dislocations are a significant traumatic incident for the bone and the soft tissue surrounding the ankle. Bone stabilization, joint immobilization, anatomic reduction and intervention for soft tissue protection should be performed as early as possible. The present study aims to determine the frequency of major comorbidities that can be seen after surgery in patients with ankle fracture-dislocations and the relationship between the trauma mechanism and clinical status with these comorbidities.

METHODS: Thirty-eight patients (25 males, 13 females) who underwent surgery with ankle fracture-dislocations between May 2014 and February 2017 were evaluated retrospectively in this study. All patients were evaluated clinically and radiologically at least 24 months postoperatively. Arthrosis, synostosis, presence of the chondral lesion and AOFAS scores were detected for all patients.

RESULTS: Mean AOFAS score was lower in open ankle fracture-dislocations than in closed dislocations (p=0.044). An accompanying osteochondral lesion (OCL) and increased patient age were found to be strongly associated with the development of arthrosis (p=0.005 and p=0.017; respectively). Four of 29 patients who received primer definitive surgery and four of nine patients who received step-by-step surgery had poorly calculated AOFAS scores (p=0.071). There was no significant relationship between dislocation direction and AOFAS scores (p=0.087).

CONCLUSION: Clinical and functional results were found to be worse in patients with open ankle fractures, the rate of arthrosis increased with age, and the use of syndesmosis screw had a positive but not a statistically significant effect on clinical and functional outcomes.

Keywords: Ankle arthrosis; ankle fracture-dislocation; ankle osteochondral lesion; syndesmosis fixation.

INTRODUCTION

Ankle fracture-dislocations are a medical emergency encountered by foot-ankle surgeons. Serious complications may occur if the ankle mortise is not assessed and reduced in time.[1] Emergency reduction of the ankle fracture-dislocations reduces post-injury fatigue, prevents more damage to the articular cartilage and decreases pain in the ankle.[2] However, incorrect and inadequate reduction maneuvers may cause tibial, fibular and talar chondral injuries. The literature has shown that chondral injuries are very common in acute ankle fractures.[3] Ankle fracture-dislocations are often observed in young men after high-energy trauma, such as motor vehicle accidents or as a result of sports injuries.[4,5] Low energetic, rotational ankle fracture-dislocations have been reported less frequently in the literature.[6] Open ankle fractures are observed with complications, such as amputation, infection and nonunion that threaten the extremity and which can be a devastating event.[7]

Cite this article as: Yalın M, Aslantaş FÇ, Duramaz A, Bilgili MG, Baca E, Koluman A. The common comorbidities leading to poor clinical outcomes after the surgical treatment of ankle fracture-dislocations. Ulus Travma Acil Cerrahi Derg 2020;26:943-950.

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Ulus Travma Acil Cerrahi Derg 2020;26(6):943-950 DOI: 10.14744/tjtes.2020.35392 Submitted: 07.11.2019 Accepted: 24.02.2020 Online: 26.10.2020

The ankle fracture-dislocations are a considerable traumatic incident for the bone and the soft tissue surrounding the ankle. Bone stabilization, joint immobilization, anatomic reduction and intervention for soft tissue protection should be performed as early as possible.[8] The management of patients with ankle fracture-dislocations is challenging because of the deterioration of ankle mortise and the possibility of instability.[9] This study aimed to determine the frequency of major comorbidities that can be seen after surgery in patients with ankle fracture-dislocations and the relationship between the trauma mechanism and clinical status with these comorbidities. We hypothesized that clinical scores would worsen and complications would increase depending on the type of fracture and dislocation direction, especially in the presence of concomitant chondral injury and ligament injury requiring repair.

MATERIALS AND METHODS

After the local ethical approval (IRB protocol code: 2017/430, application ID: 2017-18-30) was obtained, thirty-eight patients (25 males, 13 females) who underwent surgery with an ankle fracture-dislocation between May 2014 and September 2017 were retrospectively evaluated in this study. Patients older than 18 years, no previous ankle injury, follow-up >24 months, no other concurrent injuries on the same lower limb were included in this study. The exclusion criteria were insufficient file records, previous foot and ankle trauma history, follow-up <24 months, diabetes mellitus, peripheral artery disease, and psychiatric disorders. Before the reduction of the dislocated ankle, anteroposterior (AP) and lateral ankle X-rays were routinely performed. Ankle AP and lateral X-rays and CT were also re-evaluated after the reduction. The dislocations which could not be reducted, patients who could not be examined due to patient incompatibility, and patients with suspected vascular injury were performed to reduction and external fixation in the operating room as soon as possible. The decision of the time of definitive treatment for patients who underwent temporary surgery was based on the wrinkle test and the wound status if there was an open fracture-dislocation. MRI display was performed in the postoperative period to investigate the talus osteochondral lesions. MRI was used after an average follow-up period (six to eight months after surgery) to study the incidence of talus OCL in the present study. MRI was reported by an independent radiologist for each patient.

Thirty-eight patients were followed clinically and radiologically at least 24 months (follow-up between 24 and 48 months) postoperatively. Radiologically, ankle arthrosis was evaluated on the standard ankle X-rays using the Kellgren-Lawrence (K-L) scale, which is the most frequently used scale for the classification of arthrosis. The K-L scale, which scale was chosen by the World Health Organization as the accepted reference standard that consists of a physician-based assessment of four radiological features, including osteophyte formation, joint space narrowing, the existence of cysts in subchondral bone, and bone end sclerosis.[10] The K-L scale has comparable inter- and intra-observer reliability, as well as similar correlation coefficients, in comparing radiographic classification to arthroscopic findings as with other grading systems.[11] In some studies, it was found that the Kellgren-Lawrence scale was associated with clinical outcomes, unlike the other scales, with increasing Kellgren-Lawrence scores, all clinical scores decreased, more pain and more disability were noted.[12] Grade 3 is characterized by multiple osteophytes, narrowing of joint space, deformity, and sclerosis at bone margins and grade 4 is characterized by large osteophytes, severe narrowing of joint space, severe sclerosis and obvious deformities at bone margins. In the present study, grade 3 and grade 4 arthritis were considered as the presence of arthrosis. AP, lateral and mortis X-rays of the ankle of patients were evaluated in three groups as non-synostosis, incomplete bone bridge and complete synostosis in the current study. Patients with incomplete bone bridge and complete synostosis formed the synostosis group. The functional assessments were based on the American Orthopedic Foot and Ankle Score (AOFAS) protocol. The AOFAS protocol is an assessment based on clinical parameters and does not include radiological parameters. Clinical parameters, including pain, functional assessment and alignment, are numerically assessed and reported as good or poor results. Patients whose score above 70 out of 100 are considered good results and patients whose scores below 70 are considered poor results.[13]

Statistical Analysis

Descriptive statistics (mean, standard deviation, minimum, median, maximum) were used to describe continuous variables. The relationship between the two independent variables was investigated using the Mann-Whitney U test. Chi-Square (or Fisher Exact test at appropriate locations) was used to examine the relationship between categorical variables. The statistical significance level was determined as $p<0.05$. The statistical calculation used for the analysis of each parameter was indicated as an upper case of the p value in the tables. Analyses were performed using the MedCalc Statistical Software version 12.7.7 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2013)

RESULTS

The descriptive features of the patients are presented in Table 1. Male sex, high-energy trauma, Weber type C fracture, primary (definitive) surgery, closed fracture and good AOFAS score was the prominent demographic features. Closed fractures showed a statistically significant difference concerning fracture type according to the AOFAS score ($p=0.044$) (Table 2). The AOFAS score was poor in four of nine patients treated with temporary surgery, whereas the AOFAS score was poor in four of 29 patients treated with primary definitive surgery. Although no significant difference was found con-

Table 1. Demographic characteristics of the patients

		Min-Max (Median)	Mean±SD
Age (years)		15–74 (31)	33.9±14.6
Time to surgery (days)		0–12 (5)	4.7±3.2
AOFAS Score		44–100 (80)	80.9±12.7
Body mass index (kg/m^2)		21–37 (27)	28.02±4.05
Follow-up		24–48 (33)	33.6±10.8
		n	**%**
Gender	Male	25	65.8
	Female	13	34.2
Trauma mechanism	High energy	26	68.4
	Low energy	12	31.6
Deltoid repair	Yes	6	15.8
	No	32	84.2
Direction of dislocation	Anterior	5	13.2
	Lateral	13	34.2
	Medial	3	7.9
	Posterior	17	44.7
Lauge Hansen Classification	PA	9	23.7
	PER	15	39.5
	SA	4	10.5
	SER	10	26.3
Weber Classification	Type A	1	2.6
	Type B	5	13.1
	Type C	32	84.2
Treatment method	Temporary surgery	9	23.7
	Primary/definitive	29	76.3
Smoking	No	24	63.2
	Yes	14	36.8
Alcohol	No	29	76.3
	Yes	9	23.7
Type of fracture	Open	8	21.1
	Closed	30	78.9
Presence of arthrosis	No	22	57.9
	Yes	16	42.1
Presence of chondral injury	No	30	78.9
	Yes	8	21.1
Synostosis	No	33	86.8
	Yes	5	13.2
Syndesmotic screw	No	21	55.3
	Yes	17	44.7
Posterior stabilization	No	20	52.6
	Yes	18	47.4
Body mass index (kg/m^2)	Not obese (<30)	28	73.7
	Obese (>30)	10	26.3
AOFAS	Poor	8	21.1
	Good	30	78.9

AOFAS: The American Orthopaedic Foot and Ankle Society, PA: Pronation-adduction, PER: Pronation-external rotation, SA: Supination-adduction, SER: Supination-external rotation.

Table 2. The relationship between the presence of arthrosis and variables and the comparison of the variables concerning effects on AOFAS scores

		Presence of Arthrosis		p[1]
		No	Yes	
		Mean±SD Median (Min.-Max.)	Mean±SD Median (Min.-Max.)	
Age (years)		29.1±11.9 26 (19–60)	40.6±15.6 38 (21–74)	0.017
Follow-up (months)		30.4±8.6 28 (25–39)	32±7.3 (26–41)	0.472
		No	Yes	p[2]
		n (%)	n (%)	
Gender	Male	14 (63.6)	11 (68.8)	1.00
	Female	8 (36.4)	5 (31.3)	
Direction of dislocation	Anterior	3 (13.6)	2 (12.5)	0.731
	Lateral	9 (40.9)	4 (25)	
	Medial	1 (4.5)	2 (12.5)	
	Posterior	9 (40.9)	8 (50)	
Chondral lesion presence	No	21 (95.5)	9 (56.3)	0.005
	Yes	1 (4.5)	7 (43.8)	
Posterior stabilization	No	12 (54.5)	8 (50)	1.00
	Yes	10 (45.5)	8 (50)	
BMI (kg/m^2)	Not obese (<30)	17 (77.3)	11 (68.8)	0.713
	Obese (>30)	5 (22.7)	5 (31.3)	
		AOFAS Score		p[1]
		Poor	Good	
		Mean±SD Median (Min.-Max.)	Mean±SD Median (Min.-Max.)	
Age (years)		36.5±20.5 31 (21–74)	33.3±12.9 31 (19–63)	0.986
Time to surgery (days)		3.5±2.7 4 (0–7)	5±3.2 5 (0–12)	0.297
BMI (kg/m^2)		28.5±3.2 27 (26–35)	27.9±4.3 26.5 (21–37)	0.449
		Poor	Good	p[2]
		n (%)	n (%)	
Direction of dislocation	Anterior	2 (25)	3 (10)	0.087
	Lateral	1 (12.5)	12 (40)	
	Medial	2 (25)	1 (3.3)	
	Posterior	3 (37.5)	14 (46.7)	
Type of fracture	Open	4 (50)	4 (13.3)	0.044
	Closed	4 (50)	26 (86.7)	
Synostosis	No	8 (100)	25 (83.3)	0.563
	Yes	0 (0)	5 (16.7)	
Syndesmotic screw	No	1 (12.5)	16 (53.3)	0.053
	Yes	7 (87.5)	14 (46.7)	

AOFAS: The American Orthopaedic Foot and Ankle Society; BMI: Body mass index; SD: Standard deviation. p[1]: Mann–Whitney U test, p[2]: Chi-square test (Fisher's test).

cerning the AOFAS scores according to the surgery method, the mean AOFAS score was found to be remarkably high in the primary definitive surgery groups (p=0.071). It was noteworthy that the syndesmotic screw was used with a higher percentage in patients with poor scores although the use of syndesmotic screw did not differ significantly on AOFAS scores (p=0.053). There was no statistically significant difference concerning synostosis according to the use of syndesmotic screw (Fig. 1a-e). Ankle arthrosis was seen in seven of eight patients with chondral lesions and nine of 30 patients without chondral lesions (Fig. 2a-d). Also, one patient had to have talectomy (Figs. 3a-f). A statistically significant correlation was observed between the presence of a chondral lesion and the occurrence of arthrosis (p=0.005). A strong relationship was found between increased patient age and the development of arthrosis (p=0.017) (Table 2).

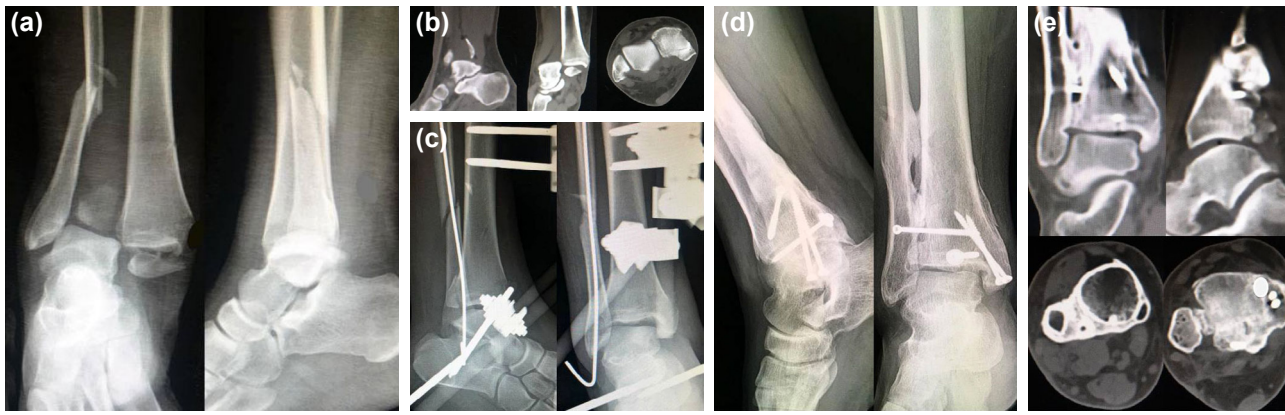

Figure 1. 29-year-old male, admission due to the motorcycle accident. **(a)** Plain radiographs show the left ankle fracture dislocation, **(b)** CT sections show the medial and posterior malleolus fractures and fibular distal diaphyseal fractures accompanying the left ankle lateral dislocation, **(c)** Temporary fixation was achieved with a monoplanar external fixator and one K-wire. Definitive fixation was applied on the 13th day after the trauma using two malleolar screws and syndesmosis screw. **(d)** Plain radiographs obtained 28 months after treatment show the synostosis of the distal tibiofibular joint, (**e)** CT sections show the posttraumatic arthritis, joint narrowing and the synostosis of the distal tibiofibular joint.

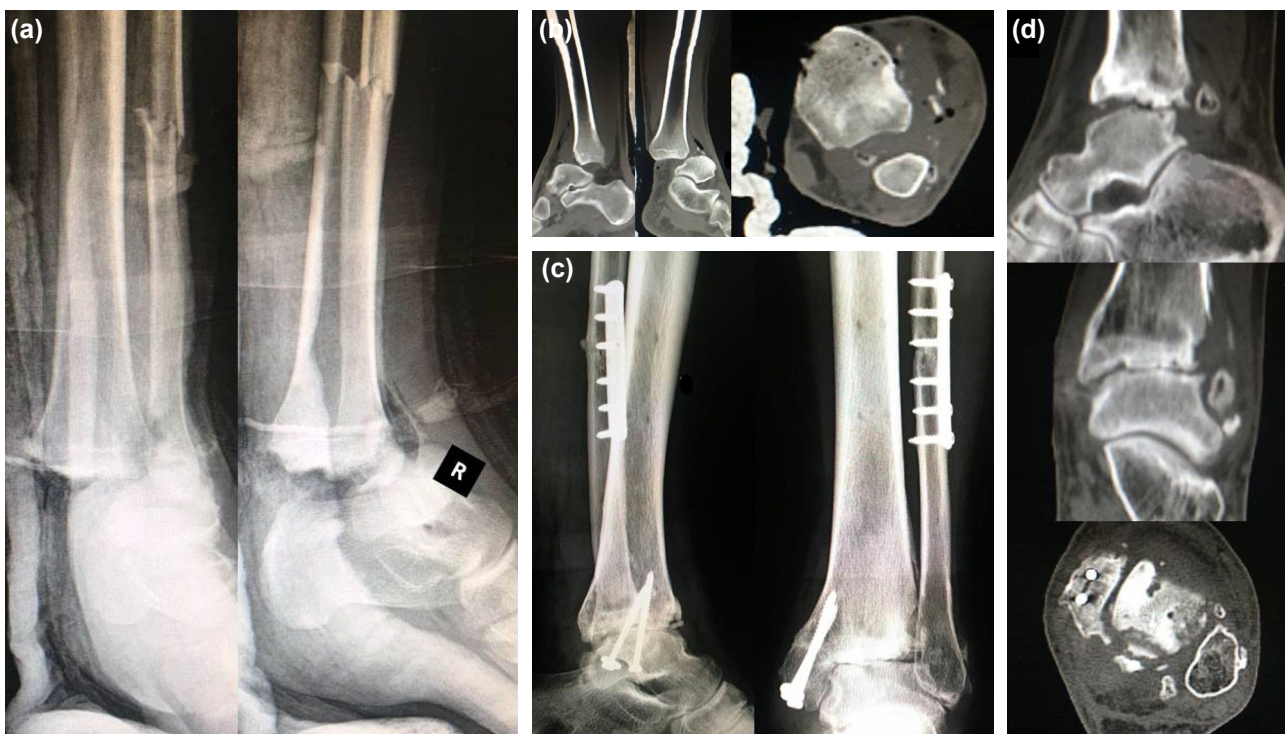

Figure 2. 34-year-old female, admission due to pedestrian crash. **(a)** Plain radiographs show the right ankle fracture dislocation, **(b)** CT sections show medial malleolus fracture and fibula diaphyseal fracture accompanying the right ankle anterior dislocation. Definitive treatment was performed on the second day of the trauma using tubular plate-screw fixation for fibula fracture and two malleolar screws for medial malleolus. **(c)** Plain radiographs obtained 43 months after treatment show the severe arthrosis of the tibiotalar joint, **(d)** CT sections show the severe posttraumatic tibiotalar arthritis and joint narrowing of the tibiotalar joint.

Figure 3. 48-year-old male, admission after falling from a height. **(a)** Plain radiographs show the right ankle fracture-dislocation, **(b)** CT sections show the comminuted talus fracture and syndesmotic injury accompanying the right talus posterior dislocation, **(c)** Definitive treatment was emergently achieved with talectomy, syndesmotic fixation and deltoid ligament repair using a bone anchor-screw. **(d)** Plain radiographs obtained 39 months after treatment show the severe arthrosis of the tibiotalar joint, **(e)** CT sections show the distal tibiofibular osteophytes and tibio-calcaneal joint, **(f)** the patient has ankle joint range of motion to allow daily life activities.

DISCUSSION

The most important findings of the present study were that (1) the clinical and functional results of the open ankle fracture-dislocations were lower, (2) the talar chondral lesion formed after the ankle fracture dislocation led to the arthrosis, (3) the arthrosis rate increased with the older patient age. Previous papers stated that open ankle fractures had lower AOFAS scores than closed fractures.[14,15] In the current study, functional and clinical outcomes of patients with closed fractures were found to be higher than patients with open fracture and our study supports the literature. Khan et al.[16] compared external fixator and open reduction internal fixation (ORIF) in open ankle injuries and encountered a deep infection requiring an implant extraction in four cases in the ORIF group, one case of deep vein thrombosis in the external fixator group, one case of necrosis of distal fibula end. Fewer infectious findings have also occurred in the external fixator group than plate application in the study of Pedrini at el.[17] In our study, only one superficial tissue infection and one deep tissue infection that was required patient debridement therapy were observed. In one patient, arthroscopic debridement was performed due to the intensive synovitis tissue formed after ORIF. Post-traumatic talectomy was performed in one patient. Vacuum-assisted closure (VAC) treatment due to open wound formed independently of the incision field was applied in two patients, and then skin grafts were applied to those two patients by plastic surgery. The results of AOFAS scores of patients who had temporary and primer definitive treatment were compared in the present study. No statistically significant difference was found concerning thetreatment method according to AOFAS scores, but the AOFAS scores of patients treated with primary definitive treatment were remarkably high (p=0.071).

The number of studies that had a long-term follow-up of the ankle arthrosis (more than 10 years) after malleolar fractures are very rare and most of the relevant studies have examined one or two factors in a small group.[18] After malleolar fractures, there are some situations in which the risk of ankle arthrosis is high. These situations are increased age,[19] fracture severity,[20] the presence and localization of cartilage lesions, especially medial malleolus,[21] fracture reduction quality and the presence of fracture-dislocation. In the present study, there was a strong correlation between patient age and the presence of arthrosis, and the incidence of arthrosis in older ages was high (p=0.017). Lübbeke et al.[22] stated that Weber Type C injuries, being over 30 years old at the time of injury, being obese or overweight at the time of injury and having a long follow-up period from the surgery are closely related to the development of arthrosis. In the current study, no statistically significant difference was found concerning fracture type, presence of obesity and duration of follow-up period according to the presence of arthrosis. The reason is that the number of obese patients in our study was limited, and the follow-up period was relatively short (at least 24 months and average 33.6 months) to evaluate the presence of arthrosis. Stufkens et al.[21] noted that the most significant cause of arthrosis development was malunion after an ankle fracture and the importance of correct reduction and fixation was pointed out. Varus/valgus alignment of the distal tibia, ligament injury-causing ligamentous instability, and arthrofibrosis development are also important reasons for ankle osteoarthritis.

Also, Regan et al.[23] emphasized that a talus OCD developed during injury may lead to late posttraumatic arthrosis. In our study, a statistically significant correlation was shown between the presence of a chondral lesion and the development of arthrosis (p=0.005). However, one of the disadvantages of our study was the lack of treatment of chondral lesions that were found due to the descriptive and retrospective nature.

When a syndesmotic injury is detected, the importance of using trans-syndesmotic screws in treatment has been previously pointed out.[24] However, syndesmotic screws may occasionally cause additional morbidity.[25] Tibiofibular fixation may block normal ankle motion and rigid fixation may lead to tibiofibular ligament injury.[25,26] Screws may break after a certain period of loading and may cause chronic pain in the inferior tibiofibular joint.[26] In the present study, all patients with syndesmosis injury (revealed by intraoperative fluoroscopic stress X-ray) were fixed with trans-syndesmotic screws. The use of the syndesmotic screw was not obtained a statistically significant difference concerning AOFAS scores, but it was found that the application of syndesmotic screw was moderately correlated with high AOFAS scores (p=0.053). Marvan et al.[27] found that the rate of synostosis in men was significantly higher. Another parameter that is statistically significant in the same study is the rate of synostosis seen after Weber Type B fractures is 8% and after Weber Type C fractures are 17%. They have also argued that the use of the syndesmotic screw is a powerful cause for the development of synostosis. Previous studies reported that the rate of synostosis after Weber Type C fractures was significantly higher than the rate of synostosis after Weber Type B fractures.[28,29] In addition, Hinds et al.[29] emphasized that posterior malleolar osteosynthesis or PITFL repair may be necessary and sufficient in the treatment of syndesmotic damage. They also stated that the use of a syndesmotic screw, the presence of male gender and a history of tibiotalar dislocation play an important role in the development of distal tibiofibular synostosis. In the present study, no statistically significant difference was found concerning sex, Weber classification, and presence of syndesmotic screws. This may occur since the number of patients with synostosis is not large enough to produce a statistical result. The limitations of this study were retrospective design, small sample size, lack of randomization, and relatively short follow-up, especially for the assessment of ankle arthrosis. On the other hand, the strengths of this study were to evaluate the relationship between the direction of dislocation, acute repair of accompanying ligament injury, different fracture classifications, different treatment methods (temporary or primary) and complications.

In conclusion, clinical and functional results were found to be worse in patients with open ankle fractures and with the presence of chondral lesion due to the initial trauma. Also, the rate of arthrosis increased with older ages. We should note that surgeons should be more careful and alert about chondral lesions formed during the trauma and should be more intensive about the treatment of them. Although a good surgery and treatment are performed, the patients should be informed in detail that the poor results may occur.

Ethics Committee Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Peer-review: Internally peer-reviewed.

Authorship Contributions: Concept: M.Y., M.G.B.; Design: M.Y., M.G.B.; Supervision: A.D., M.G.B.; Resource: M.Y., F.Ç.A.; Materials: M.Y., A.K., E.B.; Data: M.Y., A.K., E.B; Analysis: A.D., M.G.B.; Literature search: M.Y., F.Ç.A., A.D.; Writing: M.Y., A.D.; Critical revision: A.D.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

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ORİJİNAL ÇALIŞMA - *ÖZET*

Ayak bileği kırıklı çıkıklarında cerrahi tedavisi sonrası zayıf klinik sonuçlara yol açan yaygın komorbiditeler

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AMAÇ: Ayak bileği kırıklı çıkığı kemik ve ayak bileğini çevreleyen yumuşak doku için büyük travmatik bir olaydır. Kemik stabilizasyonu, eklem immobilizasyonu, anatomik redüksiyon ve yumuşak doku koruması için müdahale mümkün olduğunca erken yapılmalıdır. Bu çalışmanın amacı, ayak bileği kırıklı çıkığı olan hastalarda ameliyat sonrası görülebilen majör komorbiditelerin sıklığını ve travma mekanizması ile bu komorbiditelerin klinik durumu arasındaki ilişkiyi belirlemektir.

GEREÇ VE YÖNTEM: Mayıs 2014–Şubat 2017 tarihleri arasında ayak bileği kırıklı çıkığı olan 30 hasta (25 erkek, 13 kadın) geriye dönük olarak incelendi. Tüm hastalar ameliyat sonrası en az 24 ay klinik ve radyolojik olarak değerlendirildi. Tüm hastalarda artroz, sinostoz, kondral lezyon varlığı araştırıldı ve AOFAS skorları ile fonksiyonel sonuçlar incelendi.

BULGULAR: Açık ayak bileği kırıklı çıkıklarında ortalama AOFAS skoru kapalı kırıklı çıkıklardan daha düşüktü (p=0.044). Eşlik eden bir osteokondral lezyonun (OCL) ve artmış hasta yaşının artroz gelişimi ile güçlü bir şekilde ilişkili olduğu bulundu (sırasıyla, p=0.005 ve p=0.017). Primer cerrahi uygulanan 29 hastanın dördü ve basamaklı cerrahi uygulanan dokuz hastanın dördünde AOFAS skorları kötü saptandı (p=0.071). Çıkık yönü ile AOFAS skorları arasında anlamlı ilişki bulunmadı (p=0.087).

TARTIŞMA: Açık ayak bileği kırıklı çıkığı olan hastalarda klinik ve fonksiyonel sonuçların daha kötü olduğu, artroz oranının yaşla arttığı ve sindezmosis vida kullanımının klinik ve fonksiyonel sonuçlar üzerinde istatistiksel olarak anlamlı bir etkiye sahip olmadığı gözlenmiştir.

Anahtar sözcükler: Ayak bileği artrozu; ayak bileği kırıklı çıkığı; ayak bileği osteokondral lezyonu; sindesmoz fiksasyonu.

Ulus Travma Acil Cerrahi Derg 2020;26(6):943-950 doi: 10.14744/tjtes.2020.35392