ORIGINAL ARTICLE

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Simultaneous Ligament Injury in Osteochondral Lesions of Talus in MRI Scans

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SUMMARY

Introduction. Considering the high prevalence and very difficult treatment of talus osteochondral lesions and uncertainty regarding the exact cause of this type of lesion in the ankle, it is necessary to investigate the accompanying factors. Therefore, using MRI images, this retrograde study was designed to investigate the frequency of chronic ligament injuries in patients with talus osteochondral lesions.

Methods. In a case-control study, 34 MRIs with evidence of osteochondral injury and 25 MRIs without OCD were collected by examining MRIs of the last three years. All MRIs were reviewed for ligament and syndesmosis, and the OCD type and characteristics, including the lesion diameter, anatomical location, type, and depth, were recorded. The study population characteristics were completed using the relevant checklist and pre-existing information. Data were analyzed using SPSS software version 24.

Results. The mean age was 36.2 ± 12.9 and 41.5 ± 11.9 in the case and control groups ($p = 0.118$). There was no significant difference in gender between groups. ATFL, AITFL, and CFL ligaments with a frequency of 61.8%, 44.1%, and 32.4% in the case group and 44%, 24%, and 16% in controls were the most common concomitant detected ligament injuries. Also, the medial and middle regions were the most common OCD sites, with a rate of 88% and 76%, respectively.

Conclusions. The present study indicated more ligament injuries in patients with OCD than in the control group.

KEY WORDS

Osteochondral lesions; talus; ligament; ankle sprain; calcaneofibular.

INTRODUCTION

The talus bone is in the ankle, the lower part of which is connected to the ankle joint, and the upper part is attached to the tibia and fibula. The talus has a special anatomy in that most of its surface, about 60 to 70%, is covered by articular cartilage, and no muscle is attached (1-3). A wide joint surface limits blood supply, which exposes the patient to the risk of osteonecrosis after trauma and limits the repair of osteochondral lesions in the talus. Talus osteochondritis dissecans (OCD) is a type of damage to the upper surface of the talus, in which the cartilage of a part of the upper surface of the talus is destroyed due to the not reaching blood to the bone under this cartilage, causing mild to severe pain in the ankle (4). Possible causes for osteochondral lesions in the talus include local osteonecrosis, local vasculopathy, acute trauma, repeated multiple concussions, degenerative changes, organ alignment disorders, and genetic background. There is history of trauma in more than 85% of cases, which reaches 98% in lateral lesions (5, 6). The definition of osteochondral lesions includes any defect that involves both cartilage and subchondral bone surfaces (7). As the considerable prevalence and difficult treatment of osteochondral lesions of the talus and uncertainty regarding the exact cause of this type of lesion in the ankle is unknown (8, 9), it is necessary to investigate the accompanying problems.

Whether primary trauma causes osteonecrosis or chronic instability inducing repeated traumas leads to arthrosis and osteochondral changes is unknown. Ankle sprains usually

recover without complications; however, 20-30% of cases develop chronic or recurrent disease (10-12). On the other hand, 2-7% of ankle sprains lead to osteochondral lesions (13, 14). It has been reported to be a common secondary lesion of chronic lateral ankle instability with a frequency of 37% (15). Therefore, there is a relationship between these lesions and chronic subtle instabilities without clear clinical evidence.

MRI, a diagnostic modality of choice in detecting osteochondral lesions, which is also the best non-invasive method for detecting ligaments (16), may show the association between osteochondral lesions and chronic instabilities because most chronic ligament injuries are non-clinical (subtle). Therefore, this retrograde study was designed to investigate the presence of a chronic ligament insufficiency in the form of tear, avulsion, or weakening of the ligament that has caused chronic instability using MRI images.

METHODS

Ethics

This research was presented in the Organizational Ethics Committee of the Faculty of Medicine of Mashhad University of Medical Sciences under the title of "Investigation of the frequency of ligament injuries in osteochondral lesions of the talus in MRI" and number 970478 and approved with the ethical approval code IR.MUMS. MEDICAL. REC.1397.700 – date of approval: October 06, 2018.

The required information was obtained using the existing data in the files of the Mashhad Faculty of Medical Sciences teaching hospitals. None of the individual characteristics of the investigated cases were entered into the software. To keep the information confidential, all the files were given a code specific to the project, and the analysis was done based on it.

Study procedure

A descriptive pilot case-control study examined MRI images of 34 patients with osteochondral lesions and 25 MRIs of patients without osteochondral lesions. This study was conducted in the Research Center of Qaim Hospital (AJ) and under the supervision of the Department of Orthopedics of Mashhad University of Medical Sciences.

As shown in **figure 1**, all MRIs were evaluated for ligaments and syndesmosis. Ligament injury was defined as a finding of detachment, discontinuity, thickening, thinning, contour irregularity of the ligament, a bright rim sign 5, or an associated bony avulsion. The type and characteristics of OCD were also investigated and recorded in the group with these problems. This information included the diameter of the lesion, its anatomical location, the type of lesion, and depth. The age and gender of the study subjects were also completed using the respective checklist and the information that was already available.

Sample size

Considering that the frequency of ligament injuries in OCD is mentioned as 80-90 percent (16), the minimum suitable sample size was calculated by taking into account the alpha

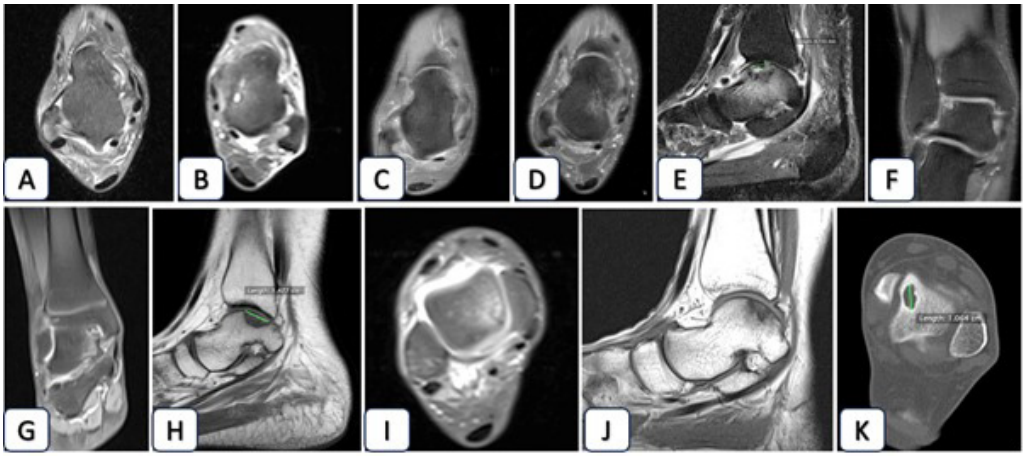


Figure 1. Different features of osteochondral and ligament injuries were detected in our study.

(A) Normal thin hyposignal intensity without bone marrow edema; **(B)** Medial cystic lesion with the thick isointense signal; **(C)** Thick isointense signal and hyperintense signal in ATal.FL as old rupture; **(D)** Weak hypointense signal, previous rupture; **(E)** Osteochondral detached grade 4 with bone marrow edema and multiple osteochondral fragments as osteochondritis dissecants; **(F)** Small osteochondral lesion without edema; **(G)** Small osteochondral fracture grade 2 without complete detachment but with large bone marrow edema; **(H)** Large necrosis confined to the lesion without edema; **(I)** Small lesion with edema **(J)** Geographic necrosis with some edema; **(K)** Cystic lesion.

error of 0.05, d = 0.2p, and p = 0.8, equivalent to 25 people in each group.

Statistical analysis

The normal distribution of the data was measured using the Kolmogorov-Smirnov test. Then, descriptive statistics, including central and dispersion indices, were calculated. An Independent T-test was used in the analysis of continuous variables. The chi-square test was used in data analysis with a nominal scale, and Fisher's Exact Test was used in cases where more than 20% of the expected frequencies of the tables were less than 5 (Cochran). Data were analyzed using SPSS 24, and the significance level was less than 0.05.

RESULTS

A total of 59 MRIs, including 34 cases of OCD lesions and 25 subjects of control, were included in the study. The characteristics of the study population are shown in **tables I** and **II**. The mean age of the control and OCD groups was 41.5 ± 11.9 and 36.2 ± 12.9, respectively. Subjects included 29 males and 30 females. The distribution of gender and age were similar between the two groups (p = 0.497 and p = 0.118, respectively). However, necrosis, edema, and cysts were significantly higher in the OCD lesions group (p < 0.01). Evaluation of MRI signals in different ligaments revealed a significant difference in tear/weak signal at the calcaneofibular ligament (p = 0.007) between OCD patients and controls. However, other signals in were similar between the two groups (p > 0.05). Results are shown in **table III**. So, the frequency of Calcaneofibular Ligament injury was significantly higher in the OCD group than in the controls. As shown in **tables IV, V** and **VI**, comparing lesion diameter and MRI stage in OCD subjects indicated no significant difference between injured and healthy ligaments (p > 0.05). However, a significantly lower frequency of necrosis

Table I. Characteristics of the study population.

Characteristics	Control (n = 25)	OCD (n = 34)	P-value
Age	41.5 ± 11.9	36.2 ± 12.9	0.118
Sex			0.497
Male	11 (44%)	18 (52.9%)	
Female	14 (56%)	16 (47.1%)	

Table II. Characteristics of the talus osteochondritis dissecans.

Characteristics		Control (n = 25)	OCD (n = 34)	P-value
Concomitant necrosis	No	25 (100%)	17 (50%)	**< 0.01**
	Yes	0 (0.0%)	17(50%)	
Concomitant cyst	No	25 (100%)	24 (70.6%)	**< 0.01**
	Yes	0 (0.0%)	10 (29.4%)	
Concomitant edema	No	25 (100%)	18 (52.9%)	**< 0.01**
	Yes	0 (0.0%)	16 (47.1%)	

Table III. Comparing MRI signal types in OCD subjects and controls in different ligaments.

Characteristics	Signal type	Control (25)	OCD (34)	P-value
Anterior talofibular	Tear/weak	6 (24.0%)	17 (26.5%)	0.0.060
	Thickening	5 (20.0%)	5 (14.7%)	0.729
Calcaneofibular ligament	Tear/weak	0 (0.0%)	9 (20.6%)	**0.007**
	Thickening	1 (4.0%)	2 (5.9%)	1.00
Anterior inferior tibiofibular	Tear/weak	3 (12%)	11(29.4%)	0.120
	Thickening	3 (12%)	3 (8.8%)	0.691
Interosseous talocalcaneal	Tear/weak	3 (12%)	10 (26.5%)	0.203
	Thickening	1 (4.0%)	1 (2.9%)	1.00
Posterior inferior tibiofibular	Tear/weak	0 (0.0%)	3 (8.8%)	0.255
	Thickening	0 (0.0%)	1 (2.9%)	1.00

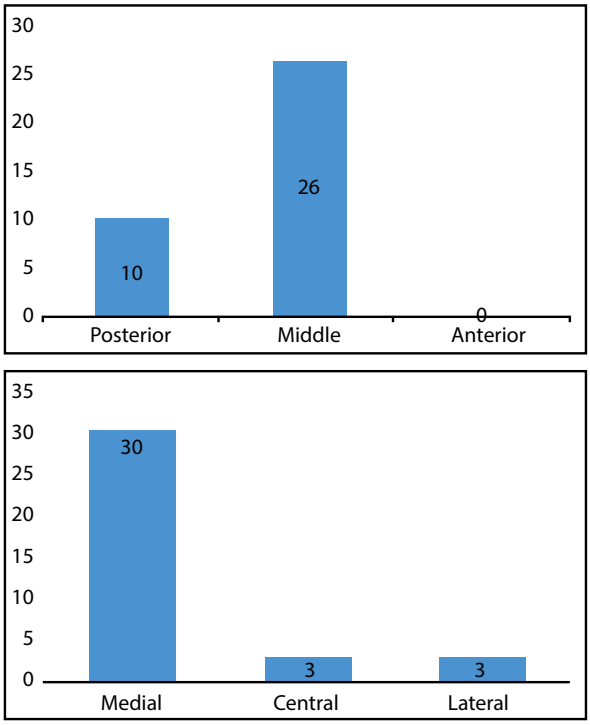
Table IV. Frequency of ligament injuries in patients with OCD lesion and control group.

Ligament	Injury	Control (25)	OCD (34)	P-value
Anterior talofibular	No	14 (56.0%)	13 (38.2%)	0.176
	Yes	11(44.0%)	21 (61.8%)	
Calcaneofibular ligament	No	24 (96.0%)	23 (77.6%)	**0.008**
	Yes	1 (4.0%)	11 (32.4%)	
Anterior inferior tibiofibular	No	19 (76.0%)	19 (55.9%)	0.111
	Yes	6 (24.0%)	15 (44.1%)	
Interosseous talocalcaneal	No	21 (84.0%)	23 (77.6%)	0.154
	Yes	4 (16.0%)	11 (22.4%)	
Posterior inferior tibiofibular	No	25 (100.0%)	30 (88.2%)	0.130
	Yes	0 (0.0%)	4 (11.8%)	

was found in anterior talofibular ligament injury ($p = 0.015$). Moreover, all types of injured ligaments were observed to have a significantly higher frequency of tear/weak signals. Results are shown in **table VII**.

The location of the lesion in patients with OCD showed that 30 patients were injured in the medial region, three in the central area, three in the lateral area, nine in the posterior region, and 26 in the middle part; no lesions were observed in the anterior and subtalar regions (**figure 2**). Further analyses indicated no association between the ligament and the location of OCD.

Figure 2. The frequency of OCD lesion position.



DISCUSSION

Considering the prevalence and difficult treatment of osteochondral lesions of the talus and uncertainty regarding the exact cause of this type of lesion in the ankle (8, 9), it is necessary to investigate the accompanying factors. Therefore, this study investigated simultaneous ligament injury in osteochondral lesions of the talus. In this regard, MRI was used as the best non-invasive modality in detecting osteochondral lesions, and various factors, such as the location of the lesion, the type and ligament injuries, and other factors associated with osteochondral lesions were discussed. Our

Table V. Comparing OCD lesion diameter between injured and healthy ligaments.

Ligament	Ligament injuries/OCD size		P-value
	No	Yes	
Anterior talofibular	10.3 ± 4.0	12.1 ± 6.6	0.352
Calcaneofibular ligament	11.1 ± 5.3	11.8 ± 6.9	0.770
Anterior inferior tibiofibular	11.1 ± 5.9	11.8 ± 5.9	0.745
Interosseous talocalcaneal	11.6 ± 6.9	10.9 ± 3.9	0.735
Posterior inferior tibiofibular	11.4 ± 5.9	10.7 ± 5.4	0.819

Table VI. Comparing MRI OCD stages between injured and healthy ligaments.

Ligament	Stage	Ligament injuries		P-value
		No	Yes	
Anterior talofibular	1	2 (15.4%)	6 (28.6%)	0.836
	2	4 (30.8%)	6 (28.6%)	
	3	5 (38.5%)	6 (28.6%)	
	4	2 (15.4%)	3 (14.2%)	
Calcaneofibular	1	5 (21.7%)	3 (27.3%)	0.571
	2	8 (34.8%)	2 (18.2%)	
	3	6 (26.1%)	5 (45.5%)	
	4	4 (17.4%)	1 (9.1%)	
Anterior inferior tibiofibular	1	3 (15.8%)	5 (33.3%)	0.690
	2	6 (26.1%)	4 (26.7%)	
	3	7 (36.8%)	4 (26.7%)	
	4	3 (15.8%)	2 (13.3%)	
Interosseous talocalcaneal	1	4 (17.4%)	4 (36.4%)	0.552
	2	8 (34.8%)	2 (18.2%)	
	3	8 (34.8%)	3 (27.3%)	
	4	3 (15.8%)	2 (18.2%)	
Posterior inferior tibiofibular	1	7 (23.3%)	1 (25%)	0.552
	2	10 (33.3%)	1 (25%)	
	3	9 (30.0%)	1 (25%)	
	4	4 (13.3%)	1 (25%)	

Table VII. Comparing concomitant features and MRI signal types between injured and healthy ligaments based on OCD characteristics.

Ligament	Concomitant features	Ligament injuries with tear/weak signals	Healthy ligament	P-value
Anterior talofibular	Necrosis	9 (52.9%)	6 (46.2%)	1.00
	Cyst	5 (29.4%)	4 (30.8%)	1.00
	Edema	8 (47.1%)	6 (46.2%)	1.00
Calcaneofibular	Necrosis	8 (88.9%)	8 (34.8%)	**0.015**
	Cyst	1 (11.1%)	9 (39.1%)	0.210
	Edema	5 (55.6%)	10 (43.5%)	0.699
Anterior Inferior tibiofibular	Necrosis	5 (45.5%)	11 (57.9%)	0.707
	Cyst	4 (36.4%)	5 (26.3%)	0.687
	Edema	4 (36.4%)	10 (52.6%)	0.466
Interosseous talocalcaneal	Necrosis	4 (40.0%)	13 (56.5%)	0.465
	Cyst	4 (40.0%)	5 (21.7%)	0.400
	Edema	5 (50.0%)	11 (47.8%)	1.00
Posterior Inferior tibiofibular	Necrosis	2 (66.7%)	15 (50.0%)	1.00
	Cyst	2 (66.7%)	8 (26.7%)	0.212
	Edema	1 (33.3%)	14 (46.7%)	1.00

findings indicated that the frequency of ligament injuries in patients with osteochondral lesions of the talus was higher than those without these lesions. Also, involvement of anterior talofibular and tibiofibular ligaments showed the highest frequency among patients with osteochondral lesions. Most injuries were of tear type, and the most common places of conflict were the medial and middle places. No significant relationship was observed between the injured and intact ligaments in osteochondral lesions of the talus in terms of diameter, stage, and type of injury.

The present study's average age of patients with OCD lesions was 36.2 years. In line with this finding, in Joshy *et al.*'s study in 2010, the average age of patients with osteochondral lesions was reported to be 39 years (17). Also, in 2014, Galli *et al.* reported the average age of patients with osteochondral lesions of the talus as 41.9 years (18). Another study examined 130 patients with osteochondral lesions of the talus, whose average age was 35.1 years (19). The examination of gender showed that men constituted a higher rate of patients with OCD (52.9%). Similarly, previous studies have highlighted the higher frequency of the disease in men than women (between 60% and 56.7%) (20, 21). Another study reported a 6.9-fold higher risk of OCD in men than women in a multivariate logistic regression analysis of men aged 12 to 19 (22). In a systematic review that examined 52 studies and 1,361 patients with osteochondral lesions of the talus, 63% of the patients were male, which is in line with the results of the present study (21). In most of the studies conducted so far, the frequency of men with osteochondral lesions of the talus has been reported to be higher than that of women, which can be due to job conditions and the possibility of frequent traumas in men. Although a case series of 1,169 patients introduced older age and male sex as risk factors for osteochondral lesions (15), these features may not relate to the prognosis of the disease (23).

In this study, the ligament injuries were investigated separately in chondral injuries, and the results showed that the anterior talofibular and tibiofibular ligaments were the most common injuries in patients with osteochondral lesions (in 61.8% and 44.1% of these patients, respectively). Previous reports that investigated the general injury of ligaments showed that talofibular ligaments (62%) and tibiofibular ligaments (38.8%) were the most common types of injuries, which is in line with the results of the present study (18). In a study considering OCD patients, ATFL (26%) and combined ATFL and CFL (62%) were reported as the most common ligament injuries (15). Moreover, in another study, ATFL, with a rate between 67 and 72%, and CFL, between 26 and 47, were the most frequent injuries in subjects with osteochondral lesions of the talus (24). This study highlighted that the accompanying osteochondral lesions of the distal tibia and fibula were not a rare finding in the MRI of patients with osteochondral lesions of the talus, and this could probably emphasize a greater relationship between the frequency of this disease and ankle ligament and tendon lesions.

In the present study, the frequency of ligament injury in patients with osteochondral lesions was higher than in patients in the control group; however, the difference was significant only for the calcaneofibular ligament. Contrary to our findings, in Galli *et al.*'s study no significant relationship was found between ligament injury and the presence of osteochondral lesions (18). Also, based on our results, the medial and middle areas showed the most involvement in OCD patients, while the anterior and subtalar areas had no lesions. In the study of Ambrosi *et al.*, the most affected areas were anterior (46.15%), medial (38.5%), and lateral (36.5%) (21). In a study on 582 patients with osteochondral lesions, medial (56%) and lateral (44%) areas were the most commonly involved regions. In another study in which 424 MRIs were examined, 80% had lesions in the central region, and 62% had lesions in the medial area (25). The controversy between studies may arise from the sample size and different readers, as a study considering similar MRI reports by two professionals highlighted the importance of the experience level of reviewers in detecting lesion areas (24).

The strengths of the present study were designed for the first time in Iran, and the study groups were matched in age and sex. Subgroup analyses were also performed to compare OCD subjects and controls regarding the characteristics of the talus osteochondritis dissecans, MRI signal types, and the frequency of ligament injuries. Furthermore, injured and healthy ligaments were compared for OCD lesion diameter and MRI OCD stages. However, several limitations should be acknowledged. An MRI examination was performed based on data from a teaching hospital at Mashhad University of Medical Sciences. Initial radiology reports were used to collect the information. Therefore, our study did not include osteochondral lesions of the talus that were missed on the initial MRI examinations. Moreover, the sample size could have been higher; consequently, the results may only be generalized to some populations.

CONCLUSIONS

According to the present study's findings, the calcaneofibular ligament was the most specific concomitant injury in patients with OCD lesions. Also, we emphasize the importance of MRI images in diagnosing associated injuries that may need simultaneous surgical consideration.

FUNDINGS
None.

DATA AVAILABILITY
Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS
AM: conceptualization. AGK: investigation. ME: methodology. NH: formal analysis.

CONFLICT OF INTERESTS
The authors declare that they have no conflict of interests.

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