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The relationship between osteochondral lesion of the talus and the foot arch angles in adults: A retrospective study

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Abstract

Aim: The current study aimed to compare the arch angles of the foot, Achilles tendinopathy, subcutaneous fat tissue thickness of the heel, and epin calcanei (EC) in patients with osteochondral lesion of the talus (OLT).

Materials and Methods: The magnetic resonance images (MRI) of the ankle performed by the radiology clinic between March 2020 and October 2021 were examined. Based on the MRI findings, the patients diagnosed with OLT were included in the study group (n = 55) and those not diagnosed with OLT formed the control group (n = 118). All the patients included in the study were investigated for their demographic characteristics and presence of EC. Weight-bearing lateral X-ray images were used to measure the lateral talus-first metatarsal angle (Meary's angle), lateral talocalcaneal angle (LTCA), and calcaneal inclination angle (also known as the calcaneal pitch).

Results: The study and control groups had no significant difference in terms of gender distribution (P = 0.575). The patients in the study group had a significantly higher mean age than the control group ($P < 0.001$). Evaluation of the arch angles of the foot showed the patients with OLT to have higher LTCA and calcaneal pitch angles and greater subcutaneous fat thicknesses ($p < 0.001$, $p < 0.001$, and $p = 0.004$, respectively). In addition, the study group showed higher rates of patients with EC and Achilles tendinopathy (p = 0.076 and p = 0.019, respectively). According to the binary logistic regression analysis model, each unit of increase in the patients' age increases the presence of osteochondritis dissecans (OCD) of the talus by 1.063 times (95% confidence interval (CI): 1.012-1.116; P = 0.015). Each unit of increase in LTCA increases the presence of OCD of the talus by 1.360 times (95% CI: 1.219-1.516; $P < 0.001$).

Conclusion: Our study demonstrated that sex had no effect on OLT incidence, whereas changes in the LTCA and pitch angles elevated the risk of OLT. Furthermore, increased age was found to be associated with a higher risk of OLT formation. We also showed that Achilles tendinopathy and EC were significantly higher in patients with OLT. A considerable number of future studies are needed to establish whether this significant relationship is causal.

Introduction

Feet are integral parts of the human skeletal system and play an important role in locomotion and movement [1]. In addition to supporting the body weight, feet are also in charge of maintaining the balance of the body in the presence of external forces [2]. The arch in the sole of the foot allows it to adapt to hard and soft surfaces and owing to its flexibility, absorbs the forces imposed on the foot in closed, kinetic chain activities. Additionally, also because of their flexibility, feet in their normal posture act as highly, foot arches act as highly effective levers during walking [3].

The arch of the foot comprises the medial longitudinal, transverse, and lateral longitudinal arches. Since the weight load of the body is especially concentrated on the medial longitudinal arch in the standing position, it is essential for the foot arch to be within the normal ranges of height and shape [3,4]. The deformation of the foot arch angles causes distortion in the distortion in the anatomy of the feet during its contact with the ground, consequently resulting in recurrent microtraumas, the degeneration of the vessels facilitating the anastomosis between the subchondral layer and bone, and the formation of localized

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osteochondral lesions [5,6].

Osteochondral lesion of the talus (OLT) is an injury involving the joint cartilage and subchondral bone. Kappis first described OLT in 1922 and named it osteochondritis dissecans (OCD) [7]. OLT is the most common injury of the joint cartilage of the ankle. OLT develops in approximately 50% of acute ankle sprains, majorly associated with sports injuries [8]. To the best of our knowledge, there has been no study in literature investigating the relationship of OLT with both Achilles tendinopathy (AT) and the deformation of the foot arch.

Hence, this study intended to investigate the frequency of incidence of AT in patients with OLT and the assess foot arch angles of these patients in terms of their impact on the risk of OLT development. We hypothesize that foot arch deformation increases the risk of OLT development. Therefore, the deformed angles of the foot arch increase the risk of OLT, while Achilles tendinitis and epin calcanei (EC) are more common in those with OLT. While this situation was not statistically significant in EC, it was statistically significant in AT.

Materials and Methods

This retrospective single center study was conducted in the Orthopedics and Traumatology Department of our hospital, with contributions from the Radiology Department, between March 2020 and October 2021. This study was planned with at least 55 patients in each group. The sample was determined to use G-Power with an effect of 0.8, power of 0.8, and significance level of $\alpha = 0.05$.

The current study evaluated the magnetic resonance images (MRI) of the ankles of patients, which were taken by the radiology clinic between March 2020 and October 2021. Based on the MRI findings, the patients diagnosed with OLT were included in the study group (n = 55) and those not diagnosed with OLT were included in the control group (n = 118). The exclusion criteria included a

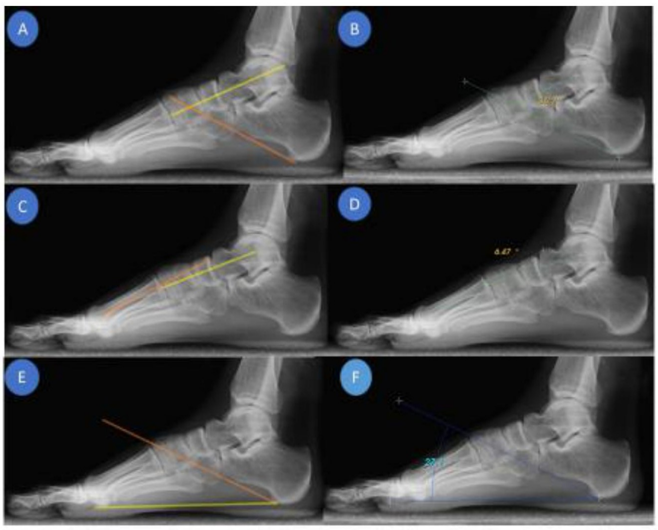

Figure 1. Angle drawn on a weight-bearing lateral foot radiograph. A,B: Lateral Talocalcaneal Angle C,D: Lateral Talar-First Metatarsal Angle (Meary's Angle) E,F: Calcaneal Pitch Angle.

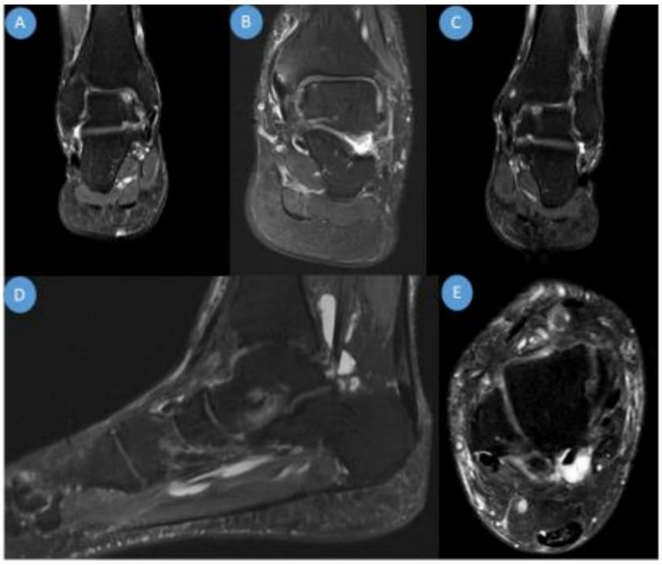

Figure 2. Magnetic resonance imaging -T2 sequence image. A,B,C: Osteochondral Lesion of Talus (OLT) D,E: Achilles Tendinopathy.

history of previous foot surgeries, ligament injuries, any bone pathologies or foot injuries, including congenital deformity of the lower extremity and space occupying lesions, patients who could not undergo a standard lateral X-ray and MRI, and patients younger than 20 years of age. The images were scanned via a 1.5 Tesla MRI device (Koninklijke Philips N.V., Eindhoven, Netherlands). The images were obtained with a slice thickness of 4 mm on the sagittal, coronal, and axial planes. The MRI sequences acquired included T1A- and proton density-weighted images in the sagittal, coronal, and axial planes. Unloaded heel fat pad thickness (UHPT) measurements were performed using the sagittal images. Weight-bearing lateral X-ray images were used to measure the lateral talus-first metatarsal angle (Meary's angle), lateral talocalcaneal angle (LTCA), and calcaneal inclination angle (also known as the calcaneal pitch) (Figure 1). All measurements were performed using the standardized method described by Flores et al. [9] and were conducted using the digital radiographic viewer at our clinic with the picture archiving and communication systems. MRI investigated the presence of Achilles tendinitis, OLT, and EC (Figure 2) in the patients. All x-ray and MRI images were evaluated by a radiologist and orthopedic and traumatology specialist with at least 5 years of experience. Each observer evaluated the data twice in total, each time from one of the two lists where the available data were differently presented. In addition, patient information, including age, gender, and affected leg, was obtained through the digital registration system.

The present study protocol was reviewed and approved by the Turgut Ozal University Institutional Review Board of the authors (Approval no. 2021/41). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical analysis

The sample size was based on the literature regarding the differences observed in the frequencies of incidence of AT and foot arch angle deformation in patients with OLT. A power of 80% and a confidence level of 95% yielded the sample size. Statistical analysis of the study data was conducted using the SPSS version 25.0 program (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). To confirm the normal distribution of the variables, histogram graphs and Kolmogorov–Smirnov test were used. Descriptive analyses were presented as mean, standard deviation, and median, IQR values. Categorical variables were compared with Pearson's Chi-square test and Fisher's Exact Test. For the intergroup analyses of the non-normally distributed (non-parametric) variables, Mann Whitney U test was performed. For the intergroup analyses of the normally distributed (parametric) variables, Independent Samples Test was performed. The factors affecting the presence of OCD of the talus were analyzed on the binary logistic regression model. $P < 0.05$ was considered as statistically significant. In addition, intraclass correlation coefficient (ICC) was used to determine interobserver reliability.

Results

The quality score of all the websites showed almost perfect interobserver agreement (ICC = 0.974). A total of 173 people (65 males and 108 females) were included in the study. The study and control groups showed no significant difference in terms of gender distribution ($p = 0.575$). The mean age of the study group was significantly higher than the control group ($p < 0.001$). With regard to the arch angles of the foot, the patients with OLT showed higher LTCA and calcaneal pitch angles and greater subcutaneous fat thicknesses ($p < 0.001$, $p < 0.001$, and $p = 0.004$, respectively). In addition, the study group had a higher number of patients with EC and AT ($p = 0.076$ and $p = 0.019$, respectively) (Table 1). According to the binary logistic regression analysis model, with each unit of increase in the age of the patients, the incidence of OCD of the talus increased by 1.063 times (95% confidence interval (CI): 1.012-1.116; $P = 0.015$). Furthermore, with increase in each unit of LTCA, the incidence of OCD of the talus increased by 1.360 times (95% CI: 1.219-1.516; $P < 0.001$) (Table 2).

Discussion

This study investigated the relationship between OLT and the foot arch angles in adults. OLT are common injuries among ankle pathologies and, in most cases, traumas are etiologically responsible for OLT [10].

The etiology of OCD of the talus is commonly considered to be trauma. However, several patients with osteochondral lesions have no history of injury and some lesions are asymptomatic [11]. Therefore, it can be argued that the deformation of the foot arch angles increases the risk of OLT. Sugimoto et al. reported a greater tibial medial malleolus angle (the angle between the tibial shaft and the joint surface of the medial malleol) on the anteroposterior radiography images of those patients with more severe chondral lesions [12]. In our study, we found that the increase in the LTCA and calcaneal inclination angle significantly increased the risk of OLT incidence.

Gender is also among the demographic characteristics investigated by studies on OLT in the literature. Recent studies have reported various observations regarding gender and OLT incidence. In a study by Orr et al. including US soldiers, a large-scale incidence of OLT was investigated and a higher incidence rate of OLT in women than in men was reported [13]. Kim et al. analyzed 364 cases where they investigated the incidence rate of OLT in individuals with chronic ankle instability and found that women were more affected than men [14]. In a case series, Wang et al. included 1,169 patients with chronic ankle instability and reported the incidence of OLT to be higher in men than in women [15]. Although the incidence of OLT in women was higher than in men in our study, this difference was not statistically significant.

Orr et al. demonstrated that the frequency of OLT incidence increased with age.13 Wang et al. also reported that the incidence of OLT increased statistically with advanced age [15]. Kim et al. investigated the relationship of cartilage degradation with age and found that advanced age significantly increased cartilage degradation [16]. In our study, we also concluded that the incidence of OLT is more common at an advanced age. Furthermore, according to regression analysis performed herein, each unit of increase in patient age increased the presence of OLT by 1.063 times.

In a prospective study, Prichasuk et al. showed that a group of patients with plantar heel pain had a higher incidence rate of plantar calcaneal spurs (PCS) compared with the control group (65.9% vs. 15.5%, respectively) [17]. Shama et al. studied a group of patients with radiographically proven deformed foot arch angles and reported a statistically significant correlation of PCS formation with the deformed angles of the foot arch [18]. In contrast to the abovementioned studies, Menz et al. demonstrated that the radiographic measurements of the foot posture have no effect on PCS formation [19]. In our study, we found the incidence rate of EC to be significantly higher in the group of patients with OLT, whose etiology we attributed to the deformed angles of the foot.

Numerous studies have shown variations in lower extremity biomechanics, including lower extremity kinematics and muscle activity, to be associated with the etiology of AT [20,21]. In particular, AT is thought to be caused by anatomical misalignment and unequal loading and stress because of repeated microtraumas [22]. In our study, the incidence rate of AT was significantly higher in the patients with OLT.

Koc et al. showed that the deformation of the ankle ligaments and the foot arch angles following an ankle sprain caused an increase in the incidence of OLT [23]. In their study, based on the retrospective analysis of MRI reports, Stasko et al. demonstrated that pathologies occurring in the ligaments responsible for ankle stability, such as peroneal tendon, were statistically significantly correlated with OLT [24]. Moreover, the risk of OLT increases as age advances. We also showed that AT and EC had significantly higher incidence rates in the patients with OLT. In our study, when examined in terms of their foot arch

Table 1. Demographic and clinical characteristics of the participants.

	Talus OCD						
	No		Yes		Total		p
	n	%	n	%	n	%	
Gender							
Male	46	(38.98)	19	(34.55)	65	(37.57)	0.575[1]
Female	72	(61.02)	36	(65.45)	108	(62.43)	
Age	44.47±13.31		52.49±11.87		47.02±13.37		<0.001[3]
Right/Left							
Right	67	(56.78)	31	(56.36)	98	(56.65)	0.959[1]
Left	51	(43.22)	24	(43.64)	75	(43.35)	
Meary's Angle	2.8 (1.6-3.7)		2.6 (1.6-3.6)		2.8 (1.6-3.6)		0.679
Talocalcaneal	25 (21.7-28)		40.3 (34.9-43)		27.7 (22.9-35.9)		<0.001[2]
Pitch Angle	17.1 (14.1-21)		23.5 (20-28)		19.4 (14.6-23.8)		<0.001[2]
Subcutaneous Fat	14 (11.8-16.2)		14.9 (13.3-18.1)		14.2 (12-16.9)		0.004[2]
Epin Calcanei							
No	99	(83.90)	39	(70.91)	138	(79.77)	0.076[1]
Yes	19	(16.10)	16	(29.09)	35	(20.23)	
Achilles tendinopathy							
No	117	(99.15)	51	(92.73)	168	(97.11)	0.036[1*]
Yes	1	(0.85)	4	(7.27)	5	(2.89)	
Plantar fasciitis							
No	69	(58.47)	30	(54.55)	99	(57.23)	0.627[1]
Yes	49	(41.53)	25	(45.45)	74	(42.77)	

[1]Pearson Chi-Square ([1*]Fisher's Exact Test), [2]Mann Whitney U Test (Median (IQR)), [3]Independent Samples Test (Mean±S.D).

Table 2. Factors associated with the risk of Talus OCD.

	B	S.E.	p	Exp(B)	95% C.I.for EXP(B)	
					Lower	Upper
Age	0.061	0.025	0.015	1.063	1.012	1.116
Talocalcaneal	0.307	0.056	<0.001	1.360	1.219	1.516
Pitch Angle	0.021	0.053	0.692	1.021	0.920	1.134
Subcutaneous fat	0.139	0.081	0.086	1.149	0.981	1.346
Epin calcanei (Yes)	0.643	0.678	0.343	1.901	0.504	7.177
Achilles tendinopathy (No)	0.805	1.453	0.580	2.236	0.130	38.580
Constant	-17.029	3.256	0.000	0.000		

Binary Logistic Regresyon.

angles, the study group had higher LTCAs and calcaneal pitch angles. This finding indicates that changes in the LTCA and calcaneal pitch angle increases the risk of OLT, whereas gender has no impact on OLT incidence. We believe that the deformed angles of the foot arch may lead to chronic ankle instability, and this long-term pathology may then cause OLT.

This study has some limitations. First, since this was a retrospective study and the cases were evaluated only radiologically, we were unable to incorporate other factors that could affect the study results, such as the patients' daily activities and the period they remain in a standing position per day. The evaluation of these factors may be useful in establishing a correlation between the symptoms and the demographic and radiological characteristics of the patients. The second limitation is the lack of further measurements, such as the calcaneal-first metatarsal angle, which may facilitate a more comprehensive evaluation of the patients' radiological characteristics, leading to more objective results.

Conclusion

Usually, osteochondral lesion treatment specifically targets the lesion and not the cause. However, such treatments have limitations, at least in part because they do not deal with the associated morphological abnormalities. Therefore, we think that early diagnosis and treatment of foot arch disorders will be effective in preventing the formation of OLT. Clinical trials with larger sample groups will be useful in identifying more risk factors for OLT and establishing screening programs.

Ethics approval

The present study protocol was reviewed and approved by the Turgut Ozal University Institutional Review Board of the authors (Approval no. 2021/41). The study was conducted in accordance with the principles of the Declaration of Helsinki.

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