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ORIGINAL STUDY

The relation between ankle morphology and osteochondritis dissecans of talus

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The purpose of this study is to describe, if there is, any relation between ankle morphology and development of talus osteochondritis dissecans (OCD) using certain morphological parameters derived from high resolution magnetic resonance imaging (MRI).

Study included a total of 93 patients: 26 patients with traumatic medial talus OCD, 30 patients with idiopathic medial talus OCD and 37 patients with normal ankle as the control group. Five MRI morphological parameters (Maximal Tibial Thickness (MTiTh), Malleolar Width (MalW), Length of Trochlea Tali Arc (TaL), Height of Trochlea Tali Arc (TaH) and Angle of Trochlea Tali Inclination (TaIA)) that are expected to be relevant to talus OCD formation are measured and compared for the three groups.

Significant difference was found between the idiopathic and the traumatic group in terms of age and gender. Two of five morphologic parameters (MalW and TaL) also showed significant difference for the traumatic and idiopathic group compared to healthy volunteers.

Two morphologic parameters that were found to be significantly different from healthy controls may suggest that ankle morphology be a possible factor for talus OCD. Age and gender difference between the traumatic and idiopathic group also may point out different underlying mechanisms for OCD formation.

Keywords : Arthritis ; biomechanics ; trauma ; statistical analysis.

INTRODUCTION

Osteochondritis dissecans (OCD) of talus is a lesion of the subchondral bone that may affect articular cartilage. The lesion usually occurs on the anterolateral or posteromedial surface of the talus. Medial talus is mostly affected, while involvement of lateral and posterior talus is less frequent *(8)*. The cause of OCD is still controversial. Trauma is the most common reason that has been associated with 93-98% of the lateral and

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61-70% of the medial lesions. Ischemia, avascular necrosis and micro-trauma are other implicated factors *(7,9)*. According to ischemic theory, blood supply of the subchondral bone is impaired due to deterioration of neoangiogenesis, which results in avascular necrosis *(6,13)*. Repetitive micro-trauma is another suggested mechanism that could lead to development of OCD especially in young active individuals that participate intensive sports *(1,11)*.

X-ray is the method of choice for the initial evaluation. CT and MRI are used to define the localization and depth of the lesion. MRI is the most valuable method to assess articular cartilage injury and degeneration of the ankle and other joints *(2)*.

Up to our knowledge, no study has evaluated the relation of ankle morphology and geometry with talus OCD. There are few studies analyzing normal ankle morphology. Feesy et al. and Stagni et al. defined certain parameters to evaluate normal ankle morphology *(3,12)*. Chien-Chung Kuo et al. described 31 ankle morphological parameters with 3D-CT in cadaveric ankle specimens to improve total ankle replacement design and positioning (5).

We hypothesize that certain parameters in ankle morphology might be a risk factor for talus OCD. Therefore, the purpose of this study is to describe, if there is, any relation between ankle morphology and geometry with talus OCD formation using high resolution MRI.

MATERIALS AND METHOD

We have reviewed the charts of all patients with talus OCD between 1st of January 2012 and 1st of January 2014. Patients with symptomatic medial talus OCD, diagnosed by MRI and had symptoms at least for three months were elucidated for the study. Any systemic disease, such as rheumatoid arthritis or systemic lupus erythematosus and any pathology in addition to talus OCD that might disrupt ankle morphology were the reasons for exclusion. Each patient enrolled in the study signed an informed consent. Patients were divided into two groups. First group consisted of 26 patients that had OCD of the medial talus and a history of trauma (traumatic group) and second group consisted of 30 patients who had OCD of the medial talus with no specific history of trauma (idiopathic group). Control group consisted of 37 healthy patients that were admitted to outpatient clinic and had normal ankle MRI. MRI was performed by a 1.5 Tesla scanner (Intera, Philips Medical System, Eindhoven, Netherlands) with a dedicated extremity coil. Two senior radiologists with at least 5 years of experience and blinded to randomly presented patient data performed the morphological measurements on the images from high contrast MRI.

Morphologic Parameters: Five morphological parameters, described by Chien-Chung Kuo et al. that might be most relevant to OCD of the talus formation were selected for the study *(5)*. The parameters were:

Maximal tibial thickness (MTiTh) (mm) is described as the A/P distance from the most anterior to the most posterior point on the tibial profile in the sagittal MRI image (Fig. 1).

Malleolar width (MalW) (mm) is described as the distance between the most lateral point of the fibula and the most medial point of the tibia measured on axial MRI image (Fig. 2).

Fig. 1. — Medial view of right ankle, the measurement of MTiTh

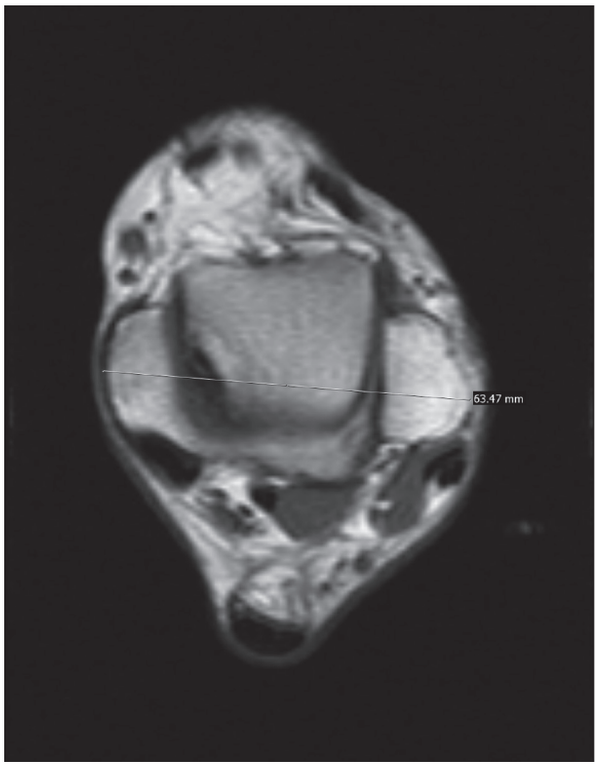

Fig. 2. — Inferior view of right ankle, the measurement of MalW.

Fig. 3. — Medial view of right ankle, the measurements of TaL and TaH

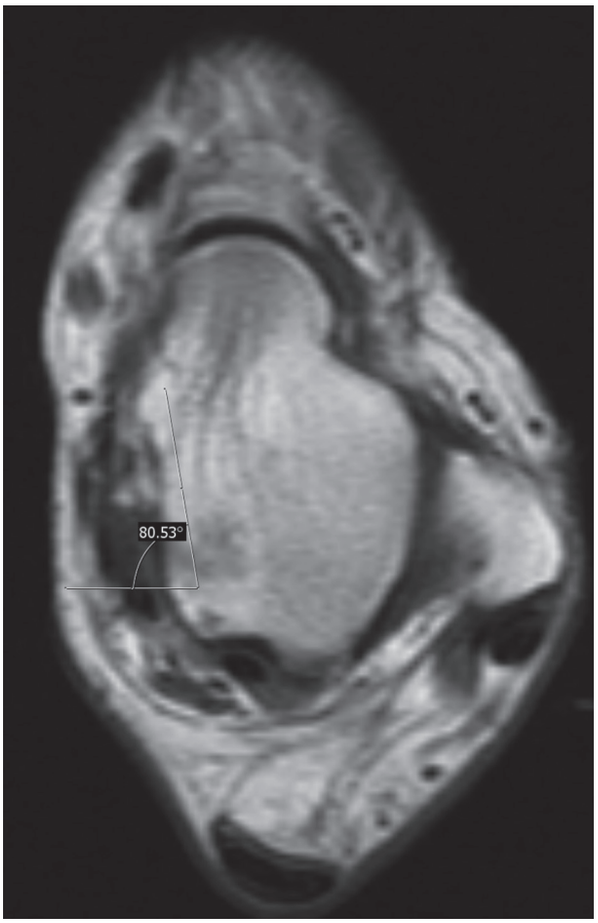

Fig. 4. — Inferior view of right ankle, the measurement of TaIA

The length of trochlea tali arc (TaL) (mm, c.) is described as the distance between the most anterior and posterior and proximal points of the trochlea tali, as seen in the sagittal projection of the talus (Fig. 3). The suffix "c" indicates the corresponding central arc.

The height of trochlea tali arc (TaH) (mm) is described as the height of the trochlea tali, calculated as the superior/inferior distance between the top of the talus and the line in the sagittal projection (Fig. 3).

The angle of inclination of trochlea tali (TaIA) (deg., m.) is described as the inclination angle of the medial crest of the talar dome, identified by the GmFm segments (Fig. 4). The suffix "m" indicates the corresponding medial crest of the talar dome that measured on axial MRI image.

Table I. — Patient demographics

	Traumatic	Non-traumatic	Control	P value
n	22	31	37	-
Mean age	42 (16-86)	54 (20-94)	34 (13-67)	(P<0,001)
M/F ratio	16/6	11/19	23/14	(P=0,022)
Duration of symptoms	2,8 years (0,5-10 years)	2,4 years (0,5-10 years)	-	-

Statistical Analysis: SPSS for Windows 15.0" was used for the statistical analysis of the data. In addition to descriptive statistical methods (mean, standard deviation), One-way analysis of variance (ANOVA) test was used to compare parameters with normal distribution between groups. Tukey's Honest Significant Difference (HSD) test was used to determine the group that caused the difference. Kruskal-Wallis and Mann-Whitney U tests were used to compare the parameters without normal distribution. Intra-group comparisons were performed with repeated-measures of ANOVA and paired t test for parameters having normal distribution; and Friedman test and Wilcoxon index test for parameters without normal distribution. Comparison of qualitative data was performed with Chi-square test. Confidence interval was defined as 95% and the level of significance was set at $P < 0.05$.

RESULTS

The demographic characteristics and morphologic parameters of each group are presented in Table 1 and Table 2. Average age in the traumatic group was 42 years (16-86) with a male/female ratio of 2,7 whereas patients in the idiopathic group were older with an average age of 53,9 years (20-94) and a male/female ratio of 0,57. Age and gender distribution in the traumatic and the idiopathic group showed significant difference ($P < 0,001$ and $P = 0,022$ respectively). Duration of the symptoms was 2,8 years (0,5-10 years) in the traumatic group and 2,4 years (0,5-11 years) in the idiopathic group; where difference was not significant.

Table II. — Values of morphological parameters

Mophological parameters	Traumatic group	İdiopathic group	Control group	P value
MTiTh (mm) (Maximal tibial thickness)	42,26 (36,1-46,12)	39,79 (34,38-48,03)	41,63 (34,29-52,61)	(P=0,075)
MalW (Malleolar width)	64,29 (55,08-69,79)	62,8 (55,08-70,31)	60,32 (54,05-68,91)	(P=0,001) *(P<0,05)
TaL t1 sag	38,12 (31,14- 47,54	37,36 (31,14-47,21)	35,19 (30,36-43,51)	(P=0,004) *(P<0,05)
TaH t1 sag	11,18 (8,77-14,06)	11,09 (8,12-14,88)	11,37 (8,3-14,17)	(P=0,783)
TaIA (deg)	79,80 (72,86-88,48)	80,33 (72,43-86,54)	79,38 (69,21-89,09)	(P=0,832)

* Values after the correction with using covariance analysis of convenience (ANOVA)

MTiTh was higher in the traumatic group compared to control group. However, this parameter was lower in the idiopathic group compared to control group. However, there was no statistical difference between the groups. (P = 0,075)

MalW was significantly higher in the traumatic group and the idiopathic group compared to control group (P = 0,001). After correction using covariance analysis of convenience for age and gender, significant difference survived and traumatic and idiopathic groups remained significantly higher compared to the control group (P < 0,05). Mean value of the traumatic group was higher compared the idiopathic group, but did not reach statistical significance.

TaL was significantly higher in both the traumatic and the idiopathic group compared to control group (P = 0,004). After the correction with using covariance analysis of convenience for age and gender, significant difference survived and traumatic and idiopathic groups remained significantly higher compared to the control group (P<0,05). Mean value of traumatic group was higher than the idiopathic group but did not reach statistical significance.

TaH was lower in the traumatic and idiopathic group compared to control group but the difference was not statistically significant (P = 0,783).

TaIA was higher in the traumatic and idiopathic group compared to control group, but the difference was not statistically significant (P = 0,832).

DISCUSSION

In this study, we aimed to evaluate the effect of talus morphology and geometry to the development of talus OCD by means of analyzing several parameters of the ankle. Interestingly, results from the selected groups formed on random basis of presence or absence of trauma as the inciting factor showed significant difference for age and gender between the groups.

There are limited studies that reported the demographics of OCD of the talus. A few available studies give conflicting results: one study suggests that OCD of the talus is more common in females with a ratio of 1,6:1 *(4)* while another study reported a M/F ratio of 1,7:1 *(14)*. However, we have not found any data reporting the male/female ratio in groups classified as traumatic or idiopathic OCD of the talus. In our study male patients seemed to be effected 2,7 times more than female patients in the traumatic group, whereas female patients were affected 1,72 times more than the male patients in the idiopathic group. This gender difference between the groups was statistically significant (P = 0,022) which may propose gender as a possible causal factor in development of talus OCD.

To our knowledge, there is no study that has reported age distribution for the OCD of the talus. In the present study; mean age of the traumatic group (mean age, 42 years; range, 16 to 86 years) was lower than the idiopathic group (mean age, 54 years; range, 20 to 94 years) where the difference was statistically significant (P < 0,001). Our results indicate that idiopathic OCD probably starts in older ages and females are more susceptible. In contrast, traumatic OCD occur in rather younger ages and males are commonly effected as similar in other traumatic incidents. This age and gender difference between the traumatic and idiopathic group supports the previous studies *(10)* where trauma cannot be the single suspect for all talus OCDs and other underlying mechanisms should be considered at least for the idiopathic talus OCDs.

Several parameters had been used to describe normal ankle morphology *(3,5,12)*, however their relations to ankle pathologies have not been examined to date. Of the five parameters selected for investigation, two were significantly higher in the OCD groups compared to healthy volunteers. Firstly, MalW was higher in traumatic group compared to idiopathic group but the difference was not significant. However, the difference between the OCD groups and the control group was significant, even after correction for age and gender. Any other bony or ligamentous lesion other than OCD that may disturb ankle morphology and lead to increased malleolar width was one of the reasons for exclusion. The other morphologic parameter TaL similarly showed significant difference between the study and the control groups but not between the OCD groups. Other parameters, MTiTh, TaH, and TaIA showed insignificant difference compared to

control group. These results indicate that increased size of the joint in axial plane and increased size of talus but not the tibia in sagittal plane may be a factor for development of OCD of the talus. Additionally, ratios of these parameters rather than their absolute figures may exhibit closer relation to talus OCD formation.

In our search of English medical literature, we did not find any study that investigated the effect of talus morphology onto the development of OCD of the talus, so our study may be the first step to an undiscovered field. Two parameters namely MalW and TaL and age and gender showed significant difference between the OCD and the control group. However, small sample size; inclusion of only OCD of the medial talus and the limited number of morphologic parameters analyzed stand as limitations of our study. Thus, it is not possible to draw solid conclusions concerning the causal factors for development of talus OCD. Therefore, prospective studies in larger groups including lateral and central OCDs that will analyze the relation of these and other morphological parameters with OCD formation would be required to reveal a causal relationship.

Conflicts of interest and source of funding:There is no conflict of interest.

Copyrighted material/consent forms: This study used no previously copyrighted materials or signed patient consent forms.

Ethical 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 2013 Declaration of Helsinki and its later amendments or comparable ethical standards.

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