

MRI STUDY OF ANKLE: TALAR LENGTH AND MALLEOLAR INDEX

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ABSTRACT: Ankle instability has been correlated with many factors such as peroneal muscle weakness, varus hind foot. However knowledge of the measurement of malleolar index and maximum talar length and their correlation with each other may draw better picture of ankle instability in routine MRI studies of ankle joint. Since very minimal studies are reported till date, this study was taken up. This study was done on 30 MRI films of adult individual ankles. Malleolar index ranged from 8.8° to 32°. Mean malleolar index was found to be 18.46°. Maximum talar length ranged from 46mm to 63mm. Mean talar length was found to be 52.31mm. There was positive correlation between malleolar index and talar length as per Pearson's correlation test with R value being 0.97. Thus, talar length may be correlated with the fibular position. An ankle mortise with a more posteriorly positioned fibula has less structural stability and is more susceptible to sprain.

KEYWORDS: ankle instability, malleolar index, Talar length.

INTRODUCTION: Ankle sprains account for more than 90% of injuries in many sports, including football, hockey, basketball, martial arts, and indoor volleyball. In the United States, it is estimated that 2 million acute ankle sprains occur each year, averaging \$318 to \$914 per sprain.¹ Several diagnostic techniques are available for detecting acute injury to ankle ligaments such as arthrography, arthroscopy, stress radiograph and MRI. The primary requirement of all of them is exact knowledge of orientation to all ligaments.

Stress radiography and arthrography rely on the observer's knowledge of anatomy of ligaments, as ligaments are not visible directly. MRI is more reliable, but its reliability varies with the position of the ankle, associated bony injuries and presence of blood. The direct multi planar imaging, high soft- tissue contrast, and absence of streak artifacts combined with the resolution attainable with surface coils result in excellent visualization of the anatomic structures.

Magnetic resonance imaging provides the best non-invasive means of evaluating the deltoid ligament complex. However, the cost is prohibitive at this point. Ultrasound provides a less costly, non-invasive way to evaluate the deep deltoid². The ankle or talocrural region is the region where the foot and the leg meet.

The ankle includes three joints: the ankle joint proper or talocrural joint, the subtalar joint and the inferior tibiofibular joint. The movements produced at this joint are dorsiflexion and plantar flexion of the foot. Although the ankle is accepted as a simple hinge joint, it also everts, pronates or externally rotates during motion. These extra motions and curvature of the trochlea tali together determine load distribution at dorsiflexion and plantar flexion.

ORIGINAL ARTICLE

Impairment of this mechanism may predispose the ankle to disorders such as impingement, osteochondritis dissecans or instability.³

MATERIALS AND METHODS:

- Study materials included 30 MRI images of subjects between 18- 60 years of age group, irrespective of sex from the Department of Radiodiagnosis, KIMS and RADOCS diagnostic center, Bangalore.

MRI images with congenital abnormalities of ankle or any fractures or dislocations of foot. They were retrospectively reviewed. All scans were obtained with a 1.5 T MRI. The pulse sequence analyzed was both T1 and T2 weighted spin echo sequence. All examinations included sections in the coronal as well as axial images. Even though sagittal sections were present, they were of little help for the study as measurements couldn't be obtained from them. The axial sections of ankle MRI were selected for the study.

In axial images

- Maximum talar length (antero posterior) measured.
- Malleolar index: it is determined as follows: a line is drawn from the anterior border of the medial malleolus perpendicular to the transverse axis of the talus. A second line is drawn from the anterior border of the fibula, intersecting the transverse talar axis line and the medial malleolar line. The malleolar index is defined as the angle between these medial and lateral malleolar lines.

RESULTS: MALLEOLAR INDEX: Malleolar index is determined by: a line is drawn from the anterior border of the medial malleolus perpendicular to the transverse axis of the talus. A second line is drawn from the anterior border of the fibula, intersecting the transverse talar axis line and medial malleolar line. The malleolar index is defined as the angle between these medial and lateral malleolar lines.

The average malleolar index was $18.45 \pm 4.98^\circ$

	Side	N	Mean	SD	SE of mean	Mean difference	T	P value
Malleolar index	Left	17	18.5	5.96	1.44	0.1	0.097	0.92
	Right	13	18.4	3.56	0.99			

TABLE 1: T test for the statistical significance of malleolar index between right and left ankle MRI

No significant difference was observed between left and right side with respect to parameters of malleolar index ($P > 0.05$)

ORIGINAL ARTICLE

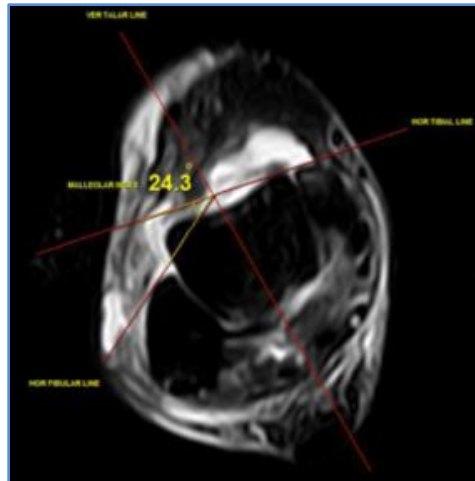


Fig. 1

Fig. 1: Malleolar index, the angle being measured formed between the horizontal tibial and fibular lines with the vertical talar line.

TALAR LENGTH: Sequential axial sections of MR imaging are examined to determine the maximum talar length. In the same sections, the medial and lateral malleolar parts of tibia and fibula are visualized.

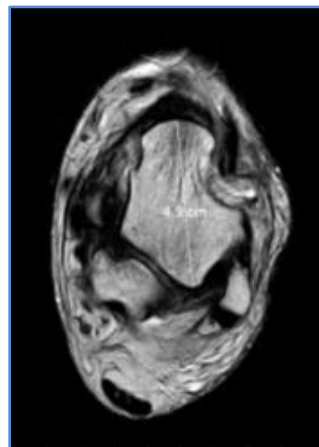


Fig. 2

FIG. 2: Maximum Talar Length measured in the axial section of T2 weighted MR image.

Parameter	Side	N	Mean	Std dev	SE of Mean	Mean Difference	t	P-Value
Talar Length (mm)	Left	17	53.04	3.45	0.84	1.680	1.304	0.203
	Right	13	51.36	3.56	0.99			

TABLE 2: Comparison of Max Talar length of right and left ankle MRI values

ORIGINAL ARTICLE

No significant difference was observed between left and right side with respect to parameters of Talar Length ($P>0.05$).

Parameters	Min	Max	Mean	<Mean		>Mean	
				n	%	n	%
MI	8.8°	32°	18.46	16	53	14	47
TL	46	63	52.31	18	60	12	40

TABLE 3: Max, min and percentage of specimens less than and more than mean values of malleolar index and talar length in ankle MRI

Malleolar Index (MI) ranged from 8.8° to 32°. Whereas, Maximum Talar Length (TL) on axial sections of MRI ranged from 46 to 63 mm.

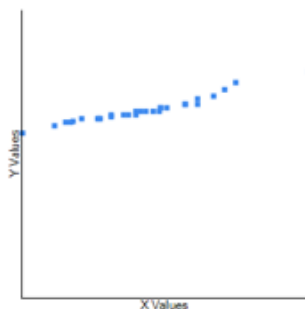
CORRELATION BETWEEN TALAR LENGTH AND MALLEOLAR INDEX:

The mean malleolar index was 18.46°. MI ranged from 8.8° to 32°.

The average Talar length measured on 30 MRI images was 52.31±3.54mm. TL ranged from 46 to 63. Pearson's correlation was done to see the correlation between malleolar index and talar length. The value of R was 0.97, showed a strong positive correlation, which means that high X variable scores go with high Y variable scores (and vice versa).

The value of R^2 , the coefficient of determination, is 0.94

REPRESENTATION 1: Graph showing positive correlation between malleolar index and talar length as per Pearson's Correlation.



There was positive correlation between Talar length and the Malleolar Index as per Pearson's correlation.

DISCUSSION: Magnetic resonance imaging is an excellent technique for imaging the tendons and the ligaments of the ankle. Owing to the advantage of detailed demonstration of soft tissue structures and capability for multiplanar demonstration of the ankle ligaments and tendons. MRI has been increasingly used in the evaluation of the ligamentous and the tendon injuries of the ankle. Knowledge of the normal anatomy and of MRI appearances is essential to recognize pathological appearances.⁴

ORIGINAL ARTICLE

MRI provides a means of depicting ligament injuries and can be used to differentiate ligament tears from other causes of ankle pain and injury. Malleolar index ranged from 8.8° to 32°. Mean malleolar index was found to be 18.46°. There was positive correlation between malleolar index and talar length as per Pearson's correlation test with R value being 0.97. Since the result obtained is in contrast to only available study mentioned above, further studies may help to come to definite conclusion.

MALLEOLAR INDEX: In the present study, malleolar index ranged from 8 to 33 degrees. Mean Malleolar index was 18.45±4.9°.

Studies	Malleolar index
Mc Dermott et al	2 to 30 degrees
Present study	8 to 33 degrees

TABLE 4: Comparison of malleolar index of the present study with the previous study

In a CT scan study on 100 images, 65% of the patients with a more posterior fibular position with a malleolar index of more than 15 degrees had histories of ankle sprains. Out of total 30 MRI images evaluated in the present study, about 23 ankles had malleolar index more than 15 degrees amounting to 76.67%.

Thus it can be concluded that maximum subjects of the evaluated MRI may have increased propensity for ankle sprains. As per the Table 5.38, the p value for the malleolar index between the right and left ankle was found to be 0.92 showing no statistical significance.

TALAR LENGTH:

The talar length ranged from 46 to 63. (Table 5.41)

Mean talar length 52.31±3.47.

STUDIES	MAX TALAR LENGTH
Mc Dermott et al (2004)	56± 4.05
Present study	51.36±3.56

TABLE 5: Comparison of talar length of present with the previous study

It is not just the ligamentous anatomy, but also the talar mortise morphometry that could be a contributing factor for the ankle instability. This has to be further evaluated and confirmed by other studies. As per the table 5.40, the p value for the MRI talar length between the right and left ankle was found to be 0.203 showing no statistical significance. (P >0.05)

CORRELATION BETWEEN TALAR LENGTH AND MALLEOLAR INDEX: John E Mc Dermott, MD et al in his study on 100 MRI and 20 cadaveric ankles for the evaluation of possible etiological factor for chronic ankle instability previously used computerized tomography (CT) scans of the ankle. He concluded that 65% of those with ankle instability had a fibula that was positioned at

ORIGINAL ARTICLE

an angle of 15 degrees or more posterior to the measured relationship of the medial malleolus and the transverse axis of the talus.

However, if a posteriorly positioned fibula predisposes to ankle instability, other, as yet unidentified, and anatomic relationships associated with this finding may exist. Since, fibular position is related to talar length and length of anterior talofibular ligament, we tried to measure talar length and see its significance. Our hypothesis was that a posteriorly positioned fibula might be associated with a longer talus or a longer ATFL.

If present so, these relationships might help, explain why patients with posterior fibulas are more susceptible to recurrent injury. 100 patients showed malleolar index ranging from 2 to 30 degrees. There was no correlation between the Malleolar Index and the Talar Length or the length of the ATFL ligament. They concluded that an ankle joint with a more posteriorly positioned fibula relative to the transverse axis of the talus is prone for chronic ankle instability. An ankle joint with a more posteriorly positioned fibula has less structural stability and is more susceptible to sprain. Neither talar length nor ATF ligament length correlated with the fibular position.⁵

CONCLUSION: There is controversy regarding the increased incidence of ankle instability in relation to maximum talar length. However, in the present study, there was positive correlation between the maximum talar length and the malleolar index with R value of Pearson's correlation test being 0.97. It showed a strong correlation. Thus, a further study on this is required to draw further conclusions. Since very limited studies are present on the talar measurement and its correlation with other morphometric measurements of ankle, further studies on this may through light to draw further conclusions.

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ORIGINAL ARTICLE

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