

## THE ROLE OF MRI IN THE DIAGNOSIS OF ANKLE LIGAMENTS INJURY

Noran Yousif Taher, Kassim Amir Hadi Taj Al-Dean

Department of Radiology, College of Medicine, University of Babylon. Babylon, Iraq.

**A**nkle is a complex mechanism consisting of two joints: the true ankle joint and the subtalar joint. MRI is increasingly being utilized in assessing patients with residual symptoms after initial conservative treatment because of its superior soft-tissue resolution.

**Purpose.** To highlight on useful role of MRJ in investigation about ankle ligaments injuries.

**Materials and methods.** A cross sectional study was carried out in Babylon teaching hospital from 1 st August 2021 to 1st September 2022. the study enrolled patients with ankle sprain. was performed with GE general electric 1.5 Tesla. For this purpose, the patients were positioned in a powerful magnetic field in supine position with feet first, ankle angle of 90 degrees. Data was collected and analyzed using SPSS 23.

**Results.** The study enrolled 40 patients with ankle pain the 26 female and 14 male with age range 20-50 years (mean age 36.1±8.4 year). Ligaments injuries by MRJ study revealed: 40% anterior talo-fibular ligament, 17.5% posterior talo-fibular ligament, 20% calceneo-fibular ligament, 15% deltoid ligament, 5%, anterior tibio-fibular ligament and 2.5% posterior tibio-fibular ligament were affected. Regarding to pathological finding, ligament sprain was seen in 16 patients, partial tear were found in 10 patients and complete tear of ligament present in 14 patients.

**Conclusions.** MRI is vitally significant in diagnosing abnormalities of ligaments and tendons of ankle trauma and plays a significant role in detecting lesions of tendons and ligaments.

Keywords: ankle ligaments injury; calceneo-fibular ligament; tibio-fibular ligament; talo- fibular ligament; tear.

Corresponding author: Noran Yousif Taher, e-mail: Medicalresearch68@yahoo.com

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## РОЛЬ МРТ В ДИАГНОСТИКЕ ПОВРЕЖДЕНИЙ СВЯЗОК ГОЛЕНОСТОПНОГО СУСТАВА

Норан Юсиф Тахер, Кассим Амир Хади Тадж Аль-Дин

Медицинский колледж Вавилонского Университета. Вавилон, Ирак.

**Г**оленостопный сустав представляет собой сложный механизм, состоящий из двух суставов: собственно голеностопного сустава и подтаранного сустава. МРТ все чаще используется для обследования пациентов с остаточными симптомами после первоначального консервативного лечения из-за высокой разрешающей способности при визуализации мягких тканей.

**Цель.** Продемонстрировать возможности МРТ в исследовании повреждений связок голеностопного сустава.

**Материалы и методы.** Поперечное исследование проводилось в клинической больнице Вавилон с 1 августа 2021 года по 1 сентября 2022 года. В исследование были включены паци-

енты с растяжением связок голеностопного сустава. МРТ выполнялась на аппарате General Electric 1,5 Тесла, в положении лежа на спине, ногами вперед. Голеностопный сустав размещался под углом в 90 градусов. Сбор и анализ данных проводился в программном пакете SPSS 23.

**Результаты.** В исследование было включено 40 пациентов с болями в голеностопном суставе, из них 26 женщин и 14 мужчин в возрасте от 20 до 50 лет (средний возраст 36,1±8,4 года). МРТ позволила выявить повреждения передней таранно-малоберцовой связки в 40% случаев, задней таранно-малоберцовой связки – в 17,5%, пяточно-малоберцовой связки – в 20%, дельтовидной связки – в 15%, передней межберцовой связки – в 5% и задней межберцовой связки – в 2,5% случаев. По характеру повреждений растяжение связок наблюдалось у 16 пациентов, частичный разрыв был обнаружен у 10 пациентов и полный разрыв связки – у 14 пациентов.

**Выводы.** МРТ имеет важное значение в диагностике повреждений связок при травме голеностопного сустава.

Ключевые слова: повреждение связок голеностопного сустава, пяточно-малоберцовая связка, межберцовая связка, таранно-малоберцовая связка, разрыв связок.

Контактный автор: Норан Юсиф Тахер, e-mail: Medicalresearch68@yahoo.com

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**I**ntroduction.  
One of complex joint in the body is ankle joint, it comprised two joint subtalar joint and true joint [1]. Trauma to ankle consider common disaster might be associated with sport activity, falling walking or car accident [2]. Frequent site of injuries in ankle are ligaments during sprain and some time in relation with bone fracture or avulsion [2]. Ankle sprain contributes to 20-45% of sport injury. Eighty five percent of ankle sprain are due to inversion damage in high velocities type of sport such as football and basketball. Lateral ligaments group are mostly effected by this type of injuries. From these complex group the weakest one ATFL are frequently damage. In addition, ATFL injuries least common among talar connection because it support by dense fibrocartilage high bone density in comparison to fibular connection [3]. While eversion damage frequently affected the medial ligaments group, which range about 5% of all types of injuries, occur in gymnastic and rugby [4]. Injury for syndesmotoc ligaments account about 8% of ankle sprain and frequently seen in sport activity it about 40% of injury in athlete. It presented with special types of sport such as football, running and skiing [8]. In acute injuries MRI can illustrated the blurry edges, uneven contour, wavy shape or sloppy fiber, irregular signal and lose of usual hypo- intense signals in-

side ligaments [1]. The injuries can sub class in partial, complete and interstitial tear [5]. Impingement syndrome resulted from alteration in anatomy of ligaments making difference mechanism of joint damage, cause chronic unstable joint [6]. Chronic tear of anterior talofibular ligament is granulation tissues sometime become fibrosis in anterolateral groove similar to meniscus, clinically causes anterolateral impingement syndromes [7, 8]. A study reported MRI accuracy about 85% in investigation and detection of osteochondral lesion in the talus and peroneus brevis tendons tear [9].

Aim of the study. To highlight on useful role of MRI in investigation about ankle ligaments injuries.

**Patient and method.**

Study design. The study design as cross section was carried out in Babylon teaching hospital from 1st August 2021 to 1st September 2022, the study enrolled patients with ankle sprain.

Study sample. The sample consists from 40 patents. Whose referred to MRI unite in radiological department of hospital. Patients were selected according to having the ankle sprain without open wound or fracture.

Data collection. A structured questionnaire was prepared and data was gathering according to it, it consist from demographic part such as age gender residence of patients, pre-

vious surgical and medical history and history of present illness in detail side of foot effected period of illness and concomitant injury and last part about image findings.

Exclusion criteria:

- when ankle or foot of affected side had clear bone fractures,
- had history of interventional surgery in ankle of affected side,
- ankle instabilities of functional type,
- avulsion injuries in fibular or talus connection.

MRI protocol. MRI study was achieved with equipment of general electric 1.5 Tesla. The patients put on magnetic field in supine position with feet first, and angle in 90 degree with special surface coil. Field of view about 13-17 cm to ensure good pictures for ankle and feet of high resolution. Three planes were included for ankle examination. Firstly the sagittal plane, coronal plane and axial planes. For every plane had specific types of ankle damage. Coronal planes used to assess the tendons injuries, whereas ligament can be assessed by axial and coronal plane. While the injury to bone of tibia, fibula and talus evaluated by sagittal and coronal plane in combination. Standard slice thickness used are less than 3 mm, sometime reach as larger as 5 mm in thickness was employed in work. T1 and T2 weighted images pulse sequence were used in evaluation of ankle joint, with addition of fat suppress.

#### Evaluation of MRI images.

Assessment of images concentrated on three aspect:

- signal intensity was calculated for ligaments and tendons for ATFL by using region of interest. All contour of the ATFL will be defined as region of interest and signal intensity is measure of ATFL. in addition for compute the signal intensity to normalized level the signal noise ratio should be measured,
- ATFL length measure by line extend from anterior and inferior edges of fibula to necks of talus bone,
- width of ATFL it measured by equation: area of ATFL /length of ATFL.

Outcome measurements. For diagnosis of ligaments tear we used specific criteria such as lack of visible ligaments, ligaments appear irregular and thicken, signal images show heterogeneity. Result of study categories as normal, partial tears and complete tears. Complete tear show definitive break in ligament and bond of neighboring tissues. Partial tear define as incomplete adhesives of ligaments and rough cut fibers with integral continuities.

Statistical analysis. Data was collected and included in a data based system and ana-

lyzed by statistical package of social sciences (SPSS, Inc., Chicago, IL, USA) version 23. Parametric data were expressed as mean± standard deviation (SD). While non-parametric data were expressed as percentages and were analyzed using chi square, such as relation between ligament injuries and time of presentation. P-value < 0.05 was considered statistically significant.

Results. The enrolled 40 patients with ankle pain the 26 female and 14 male with age range 20-50 years (mean age 36.1±8.4 year). Twelve patients were not working and 28 were working in various occupation, as in table №1.

Acute presentation was seen in 77.5% of patients whereas 22.5% come with chronic complain. Clinical finding by orthopedic only show by eight patients. Seventy percent of patients had right joint affected and 30% left ankle. Majority of causes of ankle pain was during walking 45%, 17.5% accidentally, 10% during sport activity and 27.5% during football. Regarding the clinical presentation, patients mainly give more than one sign and symptom, limitation of movement seen in 70%, swelling of joint in 92.5% and tingling and numbness in 15% of patients, as in table №2.

Ligaments injuries by MRI study reveal 40% anterior talo-fibular ligaments, 17.5% posterior talofibular ligaments, 20% Calcaneofibular ligaments, 15% deltoid ligament, 5%, anterior tibiofibular ligaments and 2.5% Posterior tibiofibular ligaments were affected, as shown in table №3.

Regarding to pathological finding, ligament sprain was seen in 16 patients, partial tear were found in 10 patients and complete tear of ligament present in 14 patients these result in table №4. Table №5 show the relation between pathological findings and types of ligament was affected, 8 patients of anterior talo-fibular ligament had sprain, and three show partial tear and 5 with complete tear. While 3 patients with posterior talo-fibular ligament had ankle sprain. From 8 patients with Calcaneofibular ligament 3 of them had complete tear.

Ligaments sprain was seen in older age group in more than 30 years. Age group less than 30 there were 3 patients has partial tears, 5 patients has complete tears, these relation was statistically not significant, as shown in table №6. For acute presentation 14 of them had ligaments sprain, 7 had partial tear and 10 complete tear whereas chronic presentation had sprain partial tear and complete tear in two, three and four respectively in addition this figure not significant association, as in table №7.

Variables		No.	%
Age	<30 years	13	32.5
	≥ 30 years	27	67.5
Gender	Female	26	65
	Male	14	35
Occupation	Not	12	30
	Worker	28	70

Variables		No.	%
Acute		31	77.5
Chronic		9	22.5
Clinical diagnosis	Positive	8	20
	Negative	32	80
Affected joints	Right	28	70
	Left	12	30
Main causes	Accidents	7	17.5
	Sport's	4	10
	Football	11	27.5
	Stump	18	45
Clinical presentation	Limitation of movement	28	70
	Swelling	37	92.5
	Tingling and numbness	6	15

Ligaments injuries by MRI	No.	%
Anterior talofibular ligaments	16	40%
Posterior talofibular ligaments	7	17.5%
Calcaneo-fibular ligament	8	20%
Deltoid ligament	6	15%
Anterior tibiofibular ligaments	2	5%
Posterior tibiofibular ligaments	1	2.5%

MRI pathological findings	No.	%
Ligaments sprain	16	40
Partial tear	10	25
Complete tear	14	35
Total	40	

**Table №5. The association between types of ligaments injuries and pathological findings.**

Ligaments injuries	Sprain	Partial tear	Complete tear	Total
Anterior talo- fibular ligament	8	3	5	16
Posterior talo-fibular ligament	3	2	2	7
Calcaneo-fibular ligament	3	2	3	8
Deltoid ligament	1	2	3	6
Anterior tibio-fibular ligament	0	1	1	2
Posterior tibio-fibular ligament	1	0	0	1
Total	16	10	14	40

**Table №6. The association between ligament injuries and age of patients.**

MRI findings	< 30 years	30 years≥	p-value
Ligaments sprain	5	9	0.9
Partial tear	3	7	
Complete tear	5	11	
Total	13	27	

**Table №7. The relation between ligament injuries and time of presentation.**

MRI findings	Acute	Chronic	p-value
Ligaments sprain	14	2	0.4
Partial tear	7	3	
Complete tear	10	4	
Total	31	9	

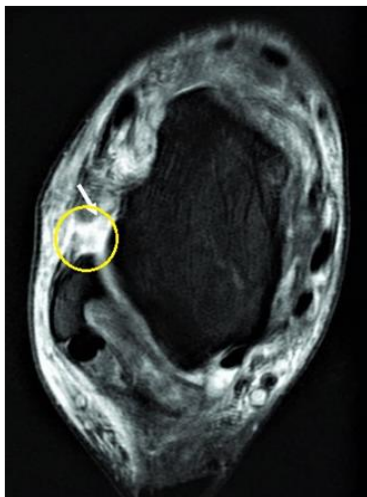


Fig. 1 а (Рис. 1 а)



Fig. 1 б (Рис. 1 б)

**Fig. 1. MRI. Acute lateral ankle ligament injury.**

a – Axial PD image show complete discontinuity of the anterior talofibular ligament (ATFL).

b – Coronal image show complete discontinuity of the calcaneofibular ligament (CFL).

**Рис. 1. МРТ. Острое повреждение латеральных связок голеностопного сустава.**

а – Аксиальная плоскость; изображение, взвешенное по протонной плотности. Полный разрыв передней таранно-малоберцовой связки.

б – Корональная плоскость; полный разрыв пяточно-малоберцовой связки.

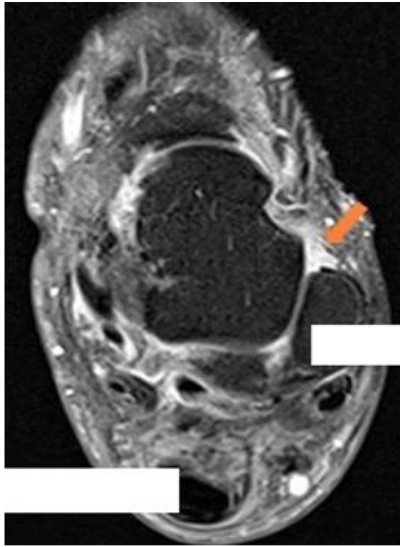


Fig. 2 a (Рис. 2 а)



Fig. 2 b (Рис. 2 б)

**Fig. 2. MRI. Injured ankle ligaments.**

a – Axial view show absent ATFL.

b – Coronal view show injured deep deltoid ligament along.

**Рис. 2. МРТ. Повреждение связок голеностопного сустава.**

а – Аксиальная плоскость; передняя таранно-малоберцовая связка полностью отсутствует.

б – Корональная плоскость; протяженное повреждение дельтовидной связки.



Fig. 3 (Рис. 3)



Fig. 4 (Рис. 4)

**Fig. 3. MRI.**

The anterior talofibular ligament is torn, and is discontinuous at talar insertion.

**Рис. 3. МРТ.**

Передняя таранно-малоберцовая связка разорвана, не прослеживается в месте прикрепления к таранной кости.

**Fig. 4. MRI.**

Axial T2 weighted image show thick anterior talofibular ligament.

**Рис. 4. МРТ.**

Аксиальная плоскость, T2-взвешенное изображение. Утолщение передней таранно-малоберцовой связки.

### Discussion.

MRI images can provide specific higher soft tissues resolution and have ability to illustrating anatomical integral ligament through their pathways. In acute injury of ankle joint MRI show presence of hemorrhage and accumulation of fluid interstitial of joint soft tissues and swelling appear over lateral malleolus. Moreover, image reveal high signal for bone at site of ligaments avulsion. But with recurrent or chronic injuries these signs might be not present, therefore in chronic presentation diagnosis hard [10].

One of MRI limitation it difficult to assess dynamic stability as occur in physical examination and stress view, but it can give high resolution of special morphology of abnormalities obviously [6].

However, the MRI offer beneficial evidence of related pathological signs of functional instability for example chondrals lesion and loose body, which similar to structure un stability secondary to ligaments deficit [9].

Our study of 40 patients with ankle pain the 26 female and 14 male demonstrated age range 20-50 years (mean age  $36.1 \pm 8.4$  year). It is with line of study Harraz et al [11]. In Erbil Nawroz et al whose reveal maximum of the patient fit to the age group 31-40 and 41-50 year with 20 and 14 case, in respective [12].

Regarding the association between MRI finding and age group in the study groups, the ATFL injuries, tenosynovitis, joint effusion, bone contusions and fractures were found more in patients below thirty year [13].

A study by Martin et al, stated that prevalence of ankle sprain is most frequently seen in person age between 14-19 age groups [14]. More over other authors reported the age of 18-49 year are more prevalent for ankle sprains with mean age 25 year [15]. The findings reveal the incidence of ankle sprain were mostly happened among male than female, 32 in male and 18 female. These results not in line with finding of study done by waterman et al. which is stated female over age of thirty with higher incidence of ankle sprain than male of same age [16]. The result agree with other thesis reported female had greater chance of ligaments injuries. The scarce data about these findings and why ankle sprain happened in female than male, the authors suggestive physical damage and emotional stress through sport action which more prone to ankle injuries in compared to male [17]. These consistent with study by El-Liethy and Kamal which enrolled 35 patients male constitute 30% and female constitute 70% with range of age 19-61 years and mean age 36 year, and right side are more

affected than left side 54%, 46% respectively [6]. Furthermore, in spite of these studies findings many reporter appear the age and gender are not risk factor for ankle joint injuries [12].

Our result reported main causes of ankle pain was during stumping 45%, 17.5% accidents, 10% during sport activity and 27.5% during football, it agreement with other study [18]. Nawroz et al recorded the cause of ankle sprains, the greatest patients were because accidents in 40%, 26% by sport, 18% by stumping and 16% by football [12]. El-Liethy and Kamal study, reported that traumatic insult was the most common etiology of ligament injury noticed in 67% of their cases. This is agreed with our study in which most of our cases are presented by traumatic insult (noticed in 18/30 cases representing 60%) while the other patients were non-traumatic [6].

Other findings revealed ligaments injuries by MRI study, 40% anterior talofibular ligaments, 17.5% posterior talofibular ligaments, 20% Calceneofibular ligaments, 15% deltoid ligaments, 5%, anterior tibiofibular ligaments and 2.5% Posterior tibiofibular ligaments were affected. Ligament sprain was seen in 16 patients, partial tear were found in 10 patients and complete tear of ligament present in 14 patients. It agree with previous conducted studies [5, 19]. Mervat Elgohary et al, reported the anterior talofibular ligament are more frequent damage ligaments constitute (37.5%) of the whole ligaments injury followed by Deltoid ligaments (5%). This coincides with different literature assessing ankle ligament [13].

Michela Barini found anterior talofibular ligaments firstly injured by trauma, he stated this ligaments more often damaged in all type of ankle trauma. Calceneofibular ligaments injury might be happened in main inversion strain, although it related with an anterior talofibular ligaments injury. On other hand, posterior talofibular ligaments are infrequently torn apart from case of entirely ankle dislocation [20]. Study by Helms et al, showed the ATFL is frequently torn ligaments in ankle joint. Followed by CFL tear also come after and rarely PTFL ligaments injury happened [21]. Azni study enrolled 43 patients, anterior talus fibular ligaments tear presented in 76% with same percent injury by Calceneofibular ligaments, while deltoid presented in 52% and posterior talo fibular ligaments in less than 50%, most of patients reveal more than one ligament damaged and frequently reported partial tear in 66% [17].

Gross terlinden et al, stated that the ATFL was the extremely common affected ankle ligaments injury in his study noticed in 34% of

his cases. This is agreed with our study which revealed also that the ATFL being the furthermost common damage ligaments, it is follow by PTFL ligaments [22].

Crema et al, quantified that, imagining of an unbroken anterior talofibular ligaments nearly exclude separation of some of the lateral collateral ligament and also listed that Calcaneofibular ligaments and posterior talofibular ligament rupture are not establish in the occurrence of an unbroken anterior talofibular ligaments [22]. This is also agreed with previous conducted studies which reveal that Calcaneofibular ligaments tear and posterior talofibular ligaments tears were continuously related with anterior talofibular ligaments tears [23].

Gross terlinden et al, stated that the deltoid ligaments is the toughest ankle ligaments and slightest to be wounded. He mentioned that 5.7% of his patients showed deltoid ligament tear [24].

Crema et al, stated in his study that ligaments sprain were further commonest than ligaments tear. He mentioned that 63% of all

patients in his study showed different sprained ligaments [22]. In our result ligaments sprain were most common than ligaments tear.

MRI examination clearly demonstrates the soft tissue abnormalities and can also detect bony. MRI has a superior sensitivity and specificity in assessment of ankle numerous ligaments wounds as well as impingement syndromes and bony abnormalities [15].

#### Conclusion.

MRI is vitally significant in diagnosing injuries of ligaments of ankle strain and play an important role in detect lesion of tendon and ligament. MRI can assist with the initial judgment of bad consequence of ankle trauma and avoid the probable complications that might be arise from delay in distinguish of ankle damage and defects. MRI findings are more common in age group over 30s than those who are younger and with acute injuries than those with chronic injuries.

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