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MRI value in Characterization of Tendon and Ligament Lesions of the Fingers

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ABSTRACT

Background: MR imaging is a powerful method for characterization of swellings arising from the tendon sheath especially giant cell tumors and ganglion cyst of the tendon sheath. A trigger finger is a common condition and is either blockage or triggering of the finger from flexion to extension.

Objective: To evaluate the diagnostic performance of MRI in non-traumatic finger tendon and ligament-related lesions to allow a more focused assessment of the soft tissue structures of this region.

Patients and methods: This study was performed in Radiology Department, Menoufia University Hospitals, during the period from August 2018 to April 2020. This study included 44 patients; 25 males, 19 females with an age range from 13 years to 58 years (mean age 35 years). In terms of clinical presentation, 73% of cases presented by swelling and cases presented by pain were 27%.

Results: Primary diagnosis by MRI revealed 50% of cases were giant cell tumors, 25% were ganglion cysts and the remainder were hemangiomas, MRI detection of characterization represented by 100%, the results then compared with pathology and laboratory results with accuracy of MRI in the detection of tissue characterization is 93.3%, MRI evidence of non-traumatic tenosynovitis constituted about 75% of all cases of tenosynovitis. On the other hand, only 25% of cases had a radiological diagnosis of trigger finger.

Conclusions: MRI is a great assessment of the tendon and ligaments tear whether partial or complete, any associated marrow edema or bony fragment avulsion, and the extent of retraction in cases of a complete tear.

Keywords: Finger, Ganglion, Tendon sheath Giant cell tumor, Hemangioma, Ligament, Magnetic Resonance Imaging, Tendon.

INTRODUCTION

Recent studies have demonstrated the significant impact of MR on treatment approaches. MR studies changed the clinical diagnosis in 55%, modified the treatment plan in 45%, and improved the physicians' understanding of the disease process in 67% of cases [(1)]. MRI also plays important role in the characterization of soft tissue messes arising from the tendon sheath. Giant cell tumor is the most common neoplasm & the second most common soft tissue space-occupying lesion of the hand constituting 12% of these lesions [(2)]. On MR, haemosiderin leads to low T1 & T2 signals. The low T2 signal is useful as it is rarely seen in other soft tissue tumors of the hand although other lesions like fibroma of the tendon sheath can show similar findings. Sometimes intra-lesional heterogenicity with a low signal rim is seen due to hemorrhage or necrosis. Usually, slight inhomogeneous post-gadolinium enhancement is seen [(3)].

Fibroma of the tendon sheath is a rare benign tumor of the tendon sheath which may be confused with GCTTS [(4)]. The MRI appearance is variable but usually, the presence of fibrous tissue results in low signal on both T1 and T2 weighted images with no or little enhancement [(4)].

Malignant tumors of the hand and wrist are uncommon. Their initial behavior may be similar to that of a benign lesion and hence may be missed with a disastrous consequence for the patient [(5)]. Some sarcomas such as synovial sarcoma (10 % of all soft tissue tumors) are more frequent, particularly the subset epitheloid sarcoma occurring in the hand in 43% of cases. On MR it appears as a heterogeneous multilocular mass with internal septations. It has a homogenous bright T2 & low-to-intermediate T1 signal but it is not a fluid signal. Fluid-fluid levels are due to hemorrhage [(2)].

Cystic lesions are the most common lesions with mass effects arising in the hand and wrist, accounting for 50–70% of all soft tissue tumors of the hand and wrist. The terminology of cystic lesions is very confusing. The terms synovial cyst and ganglion cyst are often used interchangeably. A tendon sheath cyst consists of a special ganglion cyst subtype located on the course of a tendon sheath. The etiology of tendon sheath ganglia is still unclear [(6)]. MRI demonstrates the exact location and extent of the cystic lesions and their relationship to the joint and surrounding structures. Cystic lesions are usually well-circumscribed but may be lobulated or multicystic with internal septa. The diagnosis of a typical cyst is usually straight forward by analysis of the signal intensities of the lesion. They are typically hypo- or isointense to muscle on T1-WI, and homogeneously hyperintense on T2-WI. After gadolinium contrast medium administration, subtle rim enhancement of the peripheral fibrovascular tissue in the cyst wall is seen [(6)]. Therefore, this study aimed to evaluate the diagnostic performance of MRI in non-traumatic finger tendon and ligament-related lesions to

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allow a more focused assessment of the soft tissue structures of this region.

PATIENT AND METHODS

This study was performed in Radiology Department, Menoufia University Hospitals, during the period from August 2018 to April 2020. This study included 44 patients; 25 males, 19 females with an age range from 13 years to 58 years (mean age 35 years). In terms of clinical presentation, 73% of cases presented by swelling and cases presented by pain were 27%.

Inclusion criteria:

Patients presenting with pain, swelling, or limitation of function with or without a history of trauma.

Exclusion criteria:

Known patients of rheumatoid arthritis with finger pain and/or limitation of movement. Simple post-traumatic fractures without suspected soft tissue injuries, whenever multiple fingers are involved with the same pathology, the most involved finger will be chosen as representative of the case, bilateral lesions of the same nature will be considered as one case, history of related operations or internal fixations, cardiac pacemaker and critically located FB.

All patients were subjected to the following:
History taking, Clinical examination:

(General examination for systemic disease and Local examination of the fingers), **Technique of MRI study of the fingers as follows: (**MRI was performed using **1.5-T MR scanner closed magnet (Excelart, Vantage, TOSHIBA Medical Systems)** at the radiology department of Menoufia University Hospitals, preparation of the patients: The patients were asked about any contraindications for MR imaging examination as a cardiac pacemaker, artificial valves or aneurysm clips.

The patients were informed about the nature and duration of the examination (ranged from 15 to 30 minutes) and were instructed to remove any metallic objects and not move, patient position: patients were scanned in the prone position with the arm above their head in the so-called "Superman" position, the wrist was immobilized in a neutral position utilizing molded holder. The radio carpal joint was used as a landmark, surface coil: Circular coil was used (C 200) placed over the hand and was wrapped and fixed by rubber bands, the imaging planes for axial, coronal, and sagittal acquisitions were prescribed concerning the finger rather than the hand, an adjacent finger was included within the FOV to allow internal comparison, administration of MRI intravenous contrast medium (gadolinium) was used in selected patients with a history of swelling and whenever we had a surgical and pathological final diagnosis, it was considered the gold standard of the results.

When only MRI was correlated, MRI was considered the gold standard. **Protocol of MR imaging:** The imaging protocol and its parameters (table 1) consisted of the following pulses: **(**A scout 3 planes T1 weighted images (T1WI) were taken for localization of the subsequent slices, axial T1 and T2 weighted images, coronal T1, T2, and gradient weighted images, coronal STIR (Short time Inversion Recovery) weighted images sagittal T2 weighted images and In cases that required intravenous gadolinium, axial, sagittal and coronal fat-saturated T1-weighted sequences were obtained after administration of the contrast).

Table (1): MR imaging parameters used in the study

Pulse sequences	T1WI	T2WI	STIR
TR	400-600 msec	2000-4000 msec	2000 msec
TE	15-25 msec	70-100 msec	48 sec
Slice thickness	2.5 mm	2.5 mm	2.5 mm
Interslice gap	2-3 mm	2-3 mm	2-3 mm
Matrix size	256 x 256 pixels	256 x 256 pixels	256 x 256 pixels
FOV	12 cm	12 cm	12 cm
Time of examination	2-3 minutes	2-3 minutes	5 minutes

Systematic Approach to MRI Interpretation:

(The bones are evaluated for the presence of fracture, osteomyelitis, osteonecrosis, or neoplasm, the joints are evaluated for the presence of effusion, synovial proliferation, erosions, osteophytes, and articular cartilage abnormalities, next, the tendons and ligaments are analyzed with special emphasis on the flexor mechanism, extensor mechanism, collateral ligaments, volar plates, and sagittal bands and finally, the surrounding soft tissues are evaluated for the presence of neoplasms, fluid collections, and neurovascular abnormalities).

Sample Size:

The study was done on 50 patients who have a clinical suspicion of tendon or ligament lesion of the fingers either in the form of a history of trauma, swelling, or painful finger.

Ethical consent:

Approval of the study was obtained from Menoufia University academic and ethical committee. Every patient signed informed written consent for the acceptance of the operation. This work has been carried out following The Code of Ethics of the World Medical Association

(Declaration of Helsinki) for studies involving humans.

Statistical Analysis

Our data were tabulated and analyzed statistically using MICROSOFT EXCEL 2017 and SPSS v. 22 (SPSS Inc., Chicago, IL, USA. Statistical analysis was done using descriptive and analytical tests. Descriptive includes percentage (%), mean and standard deviation. Analytical includes Chi-square ($\chi 2$). considering P-value < 0.05 statistically significant.

RESULTS

This study included 44 patients; 25 males, 19 females with an age range from 13 years to 58 years (mean age 35 years), In our study, revealed 73% of cases presented by swelling and cases presented by pain were 27%. While primary diagnosis by MRI revealed 50% of cases were giant cell tumors, 25% were ganglion cysts and the remainder were hemangiomas **(Table 1).**

Table (1): The number & percentage of the patients according to their clinical presentation in the studied cases:

Etiology	Frequency	Percentage
Swelling	32	73%
Painful finger	12	27%
Total	44	100%
Swelling by MRI		
Giant cell tumor	16	50%
Hemangioma	8	25%
Ganglion cyst	8	25%
Total	32	100%

In our study, ganglion cyst represented by (25%, 6.6%), giant cell tumors (50 %, 46.8%), and (25%, 26.6%) hemangioma in MRI and pathology respectively **(Table 2).**

Table (2): Comparison between MRI and pathology:

	MRI		Pathology		X^2	*P-value*
	No	%	No	%		
Ganglion cyst	8	25	8	26.6	**1.33**	**0.461**
Giant cell tumor	16	50	14	46.8		
Hemangioma	8	25	8	26.6		
Total	32	100	30	100		

In our study, MRI detection of characterization represented by 100%, the results then compared with pathology and laboratory results with accuracy of MRI in the detection of tissue characterization is 93.3% **(Table 3).**

Table (3): Correlation of swellings by MRI with pathology:

	Correct	Incorrect	Total
Number	28	2	30
Percentage	93.3%	6.7%	100%

In our study, Characteristic female predominance was noted in cases diagnosed with GCTTS with 87.5% of cases were females. Affected cases with GCTTS were Characteristically in the 3rd to 5th decades, almost 50% of cases were in the 4th decade. One case was presented by recurrent soft tissue mass at the site of previously excised GCT representing 12.5% of cases with GCT in our study. While affected cases with GCTTS showed Characteristic affection of the flexor tendons. Also, MRI was accurate in the diagnosis of 14 cases of giant cell tumor out of 16 cases with accuracy in diagnosing giant cell tumors was 87.5% **(Table 4).**

Table (4): The maximum, minimum, mean & standard deviation (SD) of the size of GCT:

	Median	Range	Mean+/-SD
size of GCT	**290**	**156.75-960**	**366.09±242.8**

In our study, MRI assessment of the size of the GCT masses showed that the greatest dimension ranged from 28mm to 16mm **(Table 5).**

Table (5): The location of GCT as proven by MRI:

	PIP		Proximal phalanx		Total	
	No	%	No	%	No	%
Thumb	0	0%	4	25%	4	25%
Index	4	25%	0	0%	4	25%
Middle	2	12.5%	0	0%	2	12.5%
Ring	4	25%	0	0%	4	25%
Little	2	12.5%	0	0%	2	12.5%
Total	12	75%	4	25%	16	100%

In our study, all fingers were affected by GCTTS with higher occurrence in the thumb, index, and middle fingers. Characteristic location at the proximal portion of the finger; namely the proximal phalanx and the PIP **(Table 6).**

Table (6): Demographics, recurrence, tendon affection, and pathological results of giant cell tumor cases:

		Number	Percentage
Demographics of giant cell tumor cases	**Male**	2	12.5%
	Female	14	87.5%
	Total	16	100%
Age distribution of giant cell tumor cases	**3rd decade (20-30)**	4	25%
	4th decade (30-40)	8	50%
	5th decade (40-50)	4	25%
	Total	16	100%
cases with giant cell tumor according to recurrence	**Primary diagnosis**	14	87.5%
	recurrent	2	12.5%
	Total	16	100%
Affected tendons in the studied cases with giant cell tumor	**Flexor tendons**	16	100%
	Extensor tendons	0	0%
	Total	16	100%
Pathological diagnosis in giant cell tumor cases	**Correct**	14	87.5%
	Incorrect	2	12.5%
	Total	16	100%

In our study, Patients diagnosed with trigger fingers among the study population revealed 4 patients with tendinosis and A1 pulley thickening affecting the flexor pollicis longus of the thumb and 2 cases with tenosynovitis of the middle finger **(Table 7).**

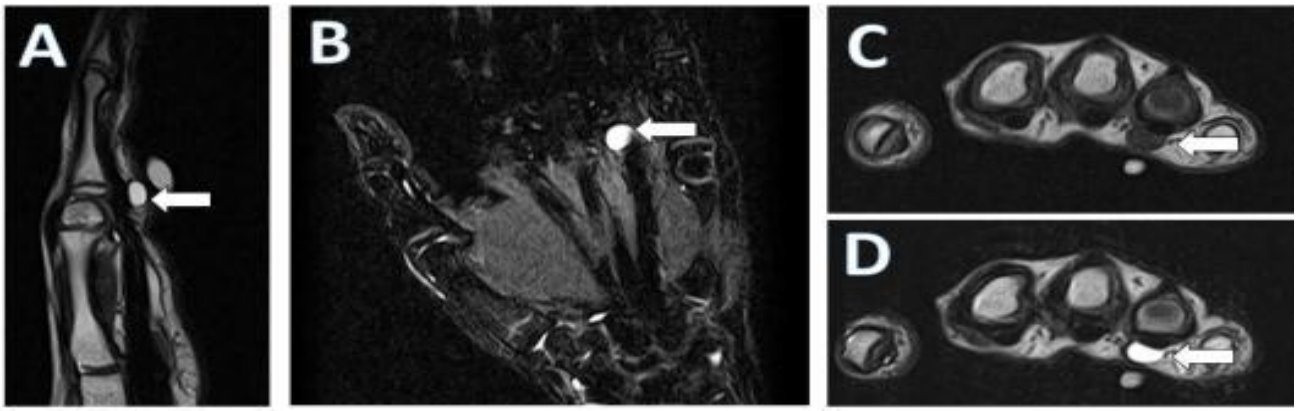
Table (7): Characterization of the painful finger by MRI:

Finding	No	%
Tendinosis with A1 pulley thickening	8	66.6%
Tenosynovitis	4	33.3%
Total	12	100%

In our study, MRI evidence of non-traumatic tenosynovitis constituted about 75% of all cases of tenosynovitis. On the other hand, only 25% of cases had a radiological diagnosis of trigger finger **(Table 8).**

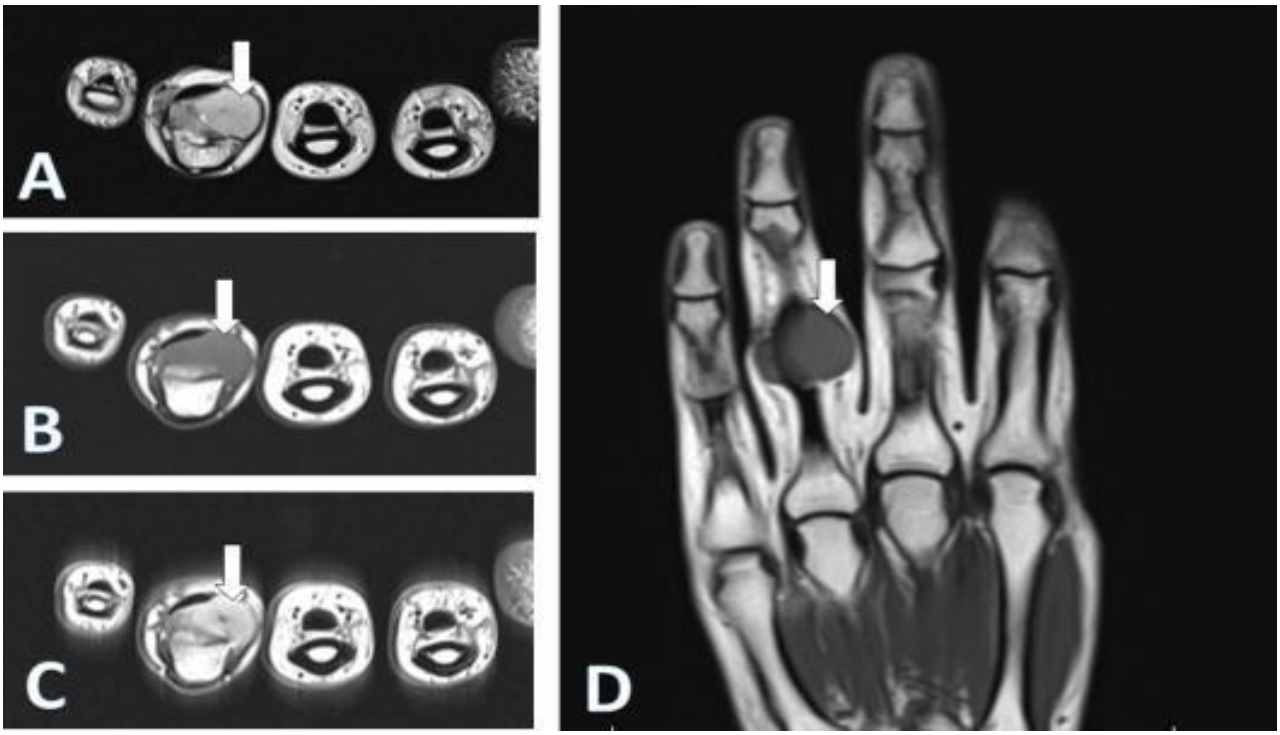
Table (8): etiological analysis of cases that showed tenosynovitis by MRI:

History of trauma	No	%
Isolated	12	75%
With trigger finger	4	25%
Total	16	100%



Case 1: Female patient 13 years old, complaining of painless swelling of the ventral aspect of the ring finger of the right hand.

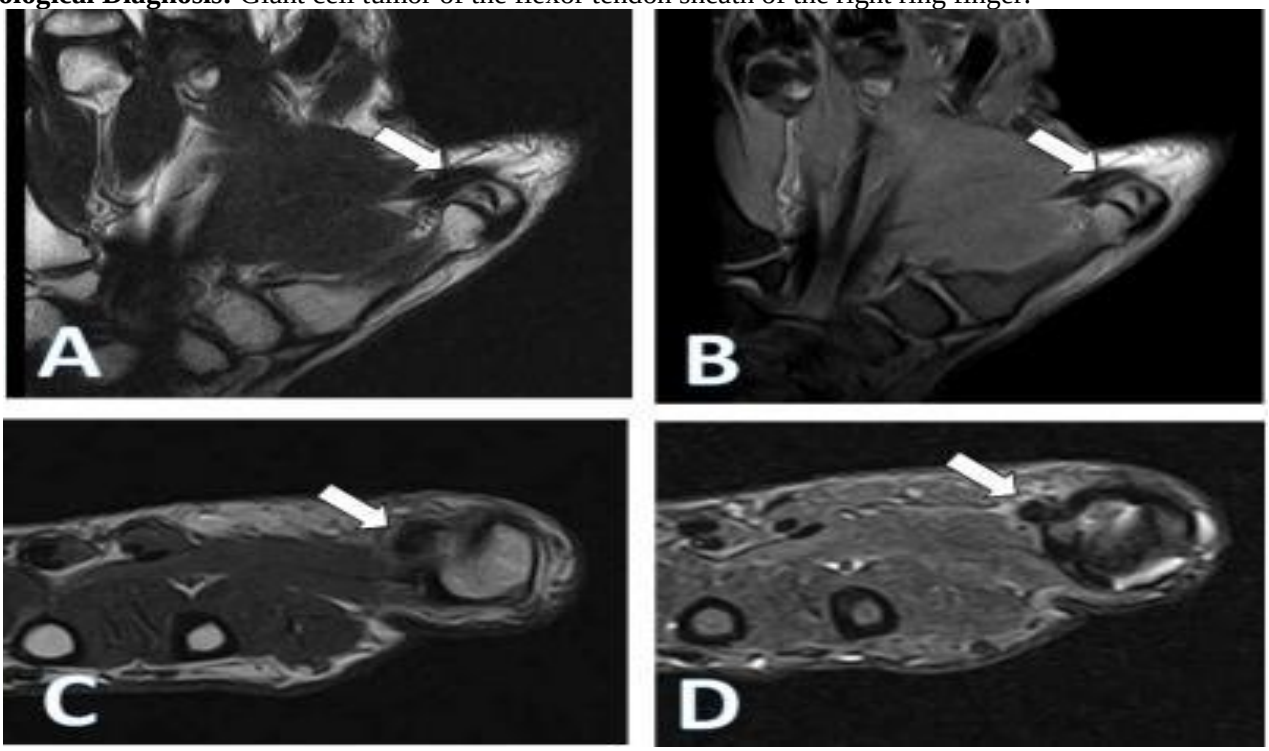
Sagittal T2WI (a), coronal STIR (b), axial T1WI (c), and axial T2WI (d) weighted imaging of the right ring finger showing thin-walled cystic structure abutting the ventral aspect of the flexor tendon of the ring finger appearing hypointense in T1WI and hyperintense in T2WI (white arrow) with no mural nodules. Ganglion cyst of the flexor tendon sheath of the right ring finger.



Case 2: History: Female patient 25 years old, complaining of painless slowly growing mass at the ventral aspect of the ring finger.

MRI findings: Axial T2WI (a), pre-contrast axial T1WI (b), post-contrast axial T1WI (c), coronal T1WI weighted imaging of the right ring finger at the ventral aspect of the proximal interphalangeal joint (PIP) deep to the related flexor digitorum tendon (white arrow) measuring about 18x14mm appearing hypointense in T1WI and isointense in T2WI with homogenous post-contrast enhancement.

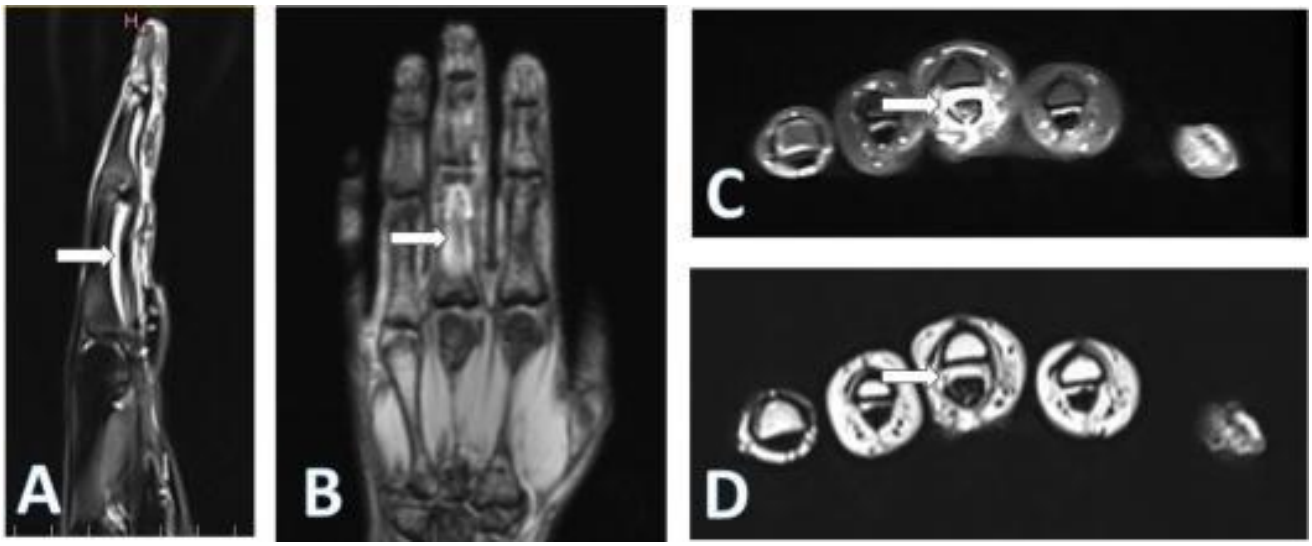
Radiological Diagnosis: Giant cell tumor of the flexor tendon sheath of the right ring finger.



Case 3: History: Female patient 55 years old, complaining of trigger finger of the right thumb with no history of trauma.

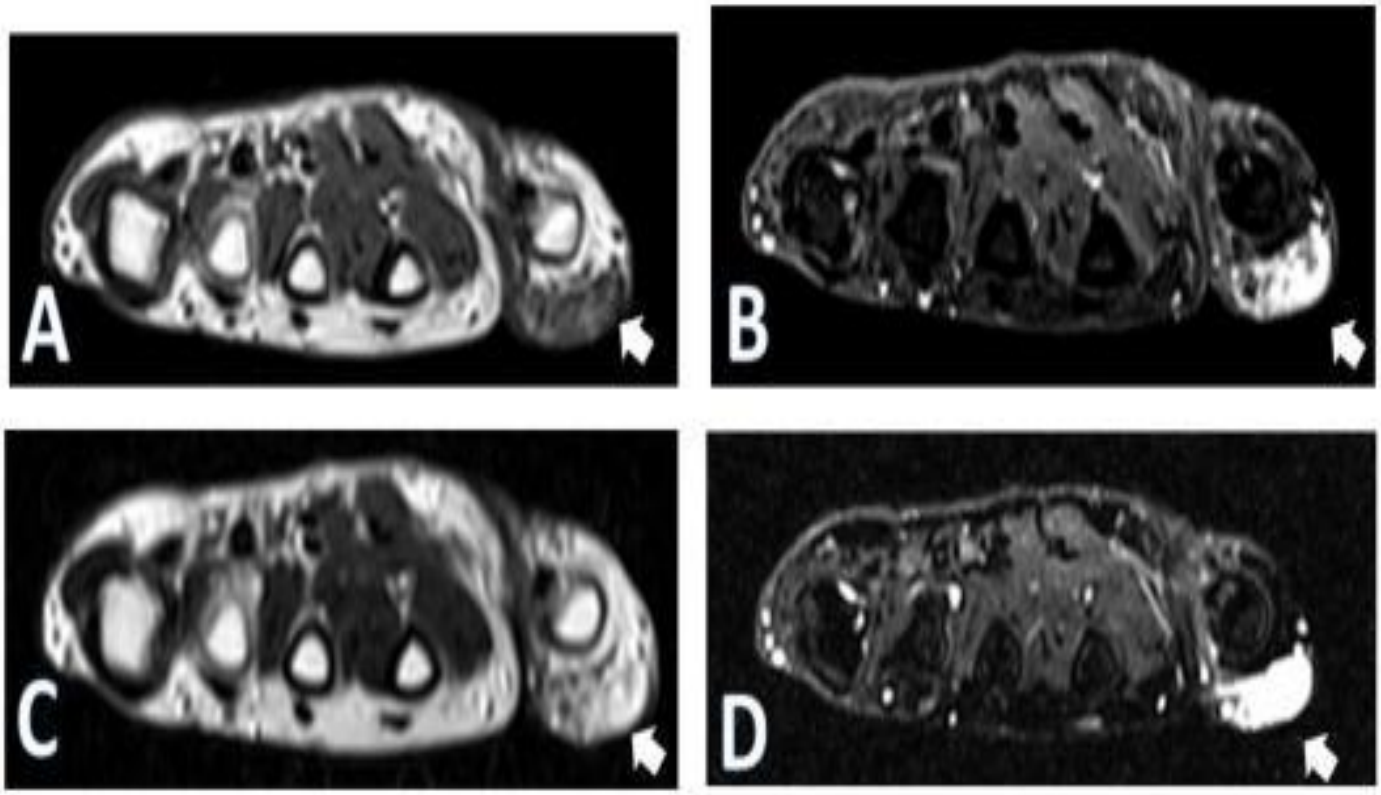
MRI findings: Coronal T2WI (a), axial T2WI (b), axial STIR (c), and coronal PD (d)weighted imaging of the right thumb at the level of the metacarpophalangeal (MCP) joint showed abnormally rounded thickened flexor tendon of the thumb (white arrow) showing abnormal intrasubstance signal with thickening of the related overlying pully.

Radiological Diagnosis: Inflammatory process of the flexor tendon of the thumb and its pully.



Case 4: History: Female patient 32 years old, complaining of swelling and pain on flexion of the left middle finger.
MRI findings: sagittal T2WI (a), coronal T2WI (b), axial PD fat-saturated (c), and axial T2WI (d) weighted imaging of the left middle finger showed fluid signal intensity surrounding the flexor tendons of the middle finger (white arrow) at the level of the proximal two phalanges with no areas of tendon interruption.

Radiological Diagnosis: Tenosynovitis of the flexor tendons of the left middle finger.
Final Diagnosis: Tenosynovitis of the flexor tendons of the left middle finger.



Case 5: History: Female patient 56 years old, complaining of slowly progressive painless swelling related to the extensor aspect of the thumb.
MRI findings: Axial T1WI (a), axial post-contrast fat-saturated T1WI (b) and axial T2WI (c), axial STIR (d) weighted imaging of the right thumb at the level of the proximal phalanx shows a well-defined lobulated soft tissue intensity measuring about 17x16mm abutting the dorsal aspect of the extensors of the thumb (white arrow) appearing hypointense in T1WI, hyperintense in T2WI with scattered intralesional hypointense foci and avid post-contrast enhancement.
Radiological Diagnosis: Thumb hemangioma.

Final Diagnosis: Thumb hemangioma.

DISCUSSION

Forty-four patients participated in this study, with an age ranging from 13-58 years (mean age 35years old), suffering from either traumatic finger lesions or non-traumatic etiology of different presentations including pain, swelling, or limitation of function. All cases were subjected to MRI examination, In the present study, fourteen cases were presented by swellings, we found that giant cell tumors represented 50 % of these swellings, 25% hemangioma, and 25% were ganglion cyst. This means that, in our study, GCT is the most common mass affecting the finger tendons and also the most common soft tissue neoplasm affecting the finger tendons. This partially agreed with the study of **Garcia and Bianchi** [(2)] that had detected that GCTTS is the most common neoplasm of the finger tendons, but the second most common soft tissue space-occupying lesion of the fingers constituting 12% of these lesions. This also disagreed with the study of **Malone *et al.*** [(7)] that had detected tenosynovial giant cell tumor or giant cell tumor of tendon sheath is commonly seen in the hand and fingers, only, second to ganglia.

In this study, MRI was able to detect the location and the extension of the swelling either subcutaneous, encasing the tendon sheath, or passing along the tendon sheath. This also agreed with the study of **Malone *et al.*** [(7)] that had detected that MR imaging provides multi-planar capability allowing precise localization of hand lesions in all planes. Soft tissue lesions are ideally suited for MRI evaluation as this modality can precisely localize lesions and delineate their association with surrounding structures. In the current study, the ganglia were unilocular and typically displayed low T1, high T2, and strongly high STIR signal intensities as previously reported by **Garcia and Bianchi** [(2)]**.**

In the present study, we found that soft tissue characterization by MRI was 100% and by comparison with pathology and laboratory results we found that the accuracy of MRI in the characterization of soft tissue was 93.3%%. In this study, we found that MRI was accurate in the diagnosis of a ganglion cyst and giant cell tumor. This present study showed that MRI was accurate in the diagnosis of 14 cases of giant cell tumor out of 16 cases with accuracy in diagnosing giant cell tumors was 87.5%. This agreed with the study of **Bassetti *et al.*** [(8)] which showed that MR imaging is a valuable tool for preoperative diagnosis, surgical planning, and postoperative follow-up of GCTTS. However, the final diagnosis requires pathological evaluation. It represents 12% of soft tissue lesions of the hand and wrist [(2)]**.**

This present study showed Characteristic female predominance in cases diagnosed with GCTTS reaching about 87.5% of cases. Also, affected cases with GCTTS were Characteristically in 3rd to 5th decades (age range from 25 to 42 years old), almost 50% of cases were in the 4th decade. This agreed with the study of **Farid *et al.*** [(9)] **and Fotiadis *et al.*** [(10)] that showed that GCTTS or localized nodular pigmented tenosynovitis is a benign soft tissue tumor that can present at any age but is most common in the 3rd-6th decades. There is a slight female preponderance. In this study, one case was presented by recurrent soft tissue mass at the site of previously excised GCT representing 12.5% of diagnosed cases with GCT. This agreed with the study of **Graffin *et al.*** [(11)] that showed that giant cell tumors of tendon sheath have an unpredictable biologic behavior with up to 56% local recurrence.

In this study, an MRI assessment of the size of the GCT masses showed that the greatest dimension ranged from 28mm to 16mm. This agreed with the study of **Stevanovic and Sharpe** [(12)] that showed that the mass is approximately 2 to 4cm in the greatest dimension. It usually presents with a slow growing nodular soft tissue mass related to the tendon sheath or joint capsule [(13)]. In this study, all fingers were affected by GCTTS with higher occurrence in the thumb, index, and middle fingers. Characteristic location at the proximal portion of the finger; namely the proximal phalanx and the PIP. Also, affected cases with GCTTS showed Characteristic affection of the flexor tendons (volar affection of the fingers) reaching up to 100%. This agreed with the study of **Teh and Whiteley** [(14)] that reported that GCTTS usually affects the volar aspects of the first three digits, much less commonly affecting the wrist.

In our study, the lesions displayed intermediate T1, inhomogeneous dark T2, and high STIR signal intensities. The lesions had inhomogeneous enhancement in the post gadolinium study. These results coincide with **Flors *et al.*** [(15)] who reported that hemosiderin-laden tissue exerts a paramagnetic effect that shortens T1 and T2 relaxation times resulting in low/intermediate signal intensity on both T1 and T2-weighted FSE sequences. Hemosiderin and dense collagen are responsible for the low signal intensity areas often seen on all pulse sequences**.** None of the cases with GCTTS in our study showed joint or tendon sheath effusion. These results coincide with **Flors *et al.*** [(15)] who reported that Joint or tendon sheath effusion is uncommon with giant cell tumors of the tendon sheath. Considering the previous characteristic clinical presentation, age prevalence, peculiar location, and MR signal intensity pattern of giant cell tumor of the tendon sheath of the hand, the high accuracy (87.5%) of MRI in the detection of such tumor in the current study can be easily explained.

In our study, hemangiomas were encountered within the subcutaneous fat layer encasing the underlying flexor or extensor tendons. They appeared as characteristically multilobulated masses of high T2 signal intensity showing fluid-fluid levels within and dark signal phleboli. In T1-weighted images, they were mildly hyperintense to the muscles with peripherally located areas of fat signal intensity (high signal areas suppressed in STIR WIs). In the post-contrast study,

they showed mild central enhancement. These results matched with the findings of **Flors *et al.*** [15] who described similar signal intensities and patterns of enhancement of such lesions. **Robinson & Learch** [16] stated that lesions composed entirely of serpentine vascular channels and fat on MRI are pathognomonic for hemangioma.

In this study, it was shown that 66.6% of the cases represented by painful joint due to blocking of the MCP from flexion to extension (trigger finger) were due to Tendinosis with A1 pulley thickening. This agreed with the study of **Chang *et al.*** [17] that reported that MRI can demonstrate findings of thickening and inflammation of the A1 pulley in cases of trigger finger. In this study, it was shown that 33.3% of the cases represented by painful joint (trigger finger) were due to tenosynovitis. It showed low to intermediate signal on T1-weighting. On T2-weighting and STIR images, they displayed inhomogeneous high signal intensity with intermediate signal areas around the dark signal tendons. This agreed with the study of **Plotkin *et al.*** [18] that reported that tenosynovitis manifests on MR imaging as fluid within the tendon sheath, with or without tendon sheath thickening. Low-signal intensity within the sheath indicates fibrosis, which has a poorer clinical prognosis and is usually seen in chronic tenosynovitis.

CONCLUSION

In conclusion, MRI is a complementary technique to obtain a correct pre-surgical diagnosis. It is of utmost importance to possess an in-depth knowledge of finger radiological anatomy in detail, as well as the appearance of the different pathologic entities on MRI and MRI is useful for evaluating a variety of lesions of the finger. Although soft-tissue lesion characterization is not always possible, MR is the best imaging modality for lesion characterization. By systematically using clinical history, lesion location, findings on radiographs, and MR imaging features, the radiologist can differentiate between determinate and indeterminate lesions. If a lesion cannot be characterized as a benign entity, the lesion should be reported as indeterminate and considered for biopsy to exclude malignancy.

RECOMMENDATIONS

Larger studies using MRI should be performed to allow better exposure to various causes especially neoplastic cases with high lightening of each cause and follow-up of cases.

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