Magnetic Resonance Imaging Role in Evaluation and characterization of Hand and Finger Lesions

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Received: 26 July 2020

Accepted: 22 March 2021

Abstract:

Background: MRI describes the main features of the encountered different pathological lesions of the hand and fingers, as well as specifies the signal characteristics and location, which help to differentiate them. In general, a specific diagnosis may be achieved by taking into account the location of the lesion within the hand or wrist and its signal characteristics. Aim: The aim of the study is to evaluate the role of MRI in diagnosis of various hand and finger pathologies using different sequences. Methods: This is a prospective observational study of patients who suffers from hand or fingers swelling or trauma. The patients were investigated by MRI. Results: The study included 30 patients with hand or finger lesions who were evaluated by MRI and enrolled from Benha University hospitals. Conclusion: Magnetic resonance imaging is the preferable method of choice for evaluating various hand and finger lesions in traumatic and non-traumatic condition if conventional radiography isn't enough.

Key words Magnetic Resonance Imaging (MRI), Hand, Finger, Traumatic, Non-traumatic.

List of Abbreviations:

MRI: Magnetic resonance imaging.

Introduction:

Modern magnetic resonance imaging (MRI) techniques and high-quality surface coils can provide exquisite anatomic detail of the small extremities such as the hands and feet. Recent advances in gradient hardware, coil design and pulse sequences

allow very small field-of-view imaging at high resolution. As imaging quality continues to improve, the value of MRI of the hand becomes more apparent in the evaluation and management of these entities (1, 2).

Wrist and hand tumors are common conditions as hand tumors account for 12.8% of all soft tissue tumors. The frequencies of these lesions are in favor of benign against malignant. MRI plays an important role in characterization of these masses. Besides, they provide information about the site, size, extent, and relation with surrounding structures (3, 4).

Magnetic Resonance Imaging describes the main features of the encountered soft tissue masses of the hand and fingers, as well as specifies the signal characteristics and location, which help to differentiate them. In general, a specific diagnosis may be achieved by taking into account the location of the lesion within the hand or wrist and its signal characteristics (5).

Hence, MRI continues to be the optimal imaging technique for detailed assessment of the hand and fingers. With ever evolving MRI sequences and improved understanding of the imaging anatomy of smaller structures there is a high level of expectation for accurate diagnosis (6).

Patients and Methods

This is a prospective observational study started from 01/09/2019 to 01/02/2020

Patients:

The study included 30 patients with hand or finger lesions who were enrolled from Benha University hospitals.

Inclusion criteria:

- Patients with hand or finger swelling, mass, pain or limitation of function

Exclusion criteria:

- Ferromagnetic or electronically operated active devices like automatic cardioverter defibrillators or cardiac pacemakers.
- Cochlear implants.

All patients will be subjected to the following:

- History taking.
- Thorough clinical examination.
- Exclusion of contraindications to MRI.

Imaging technique:

Patient positioning needs particular attention to avoid motion artifact and image degradation. In most patients, a satisfactory position can be achieved when the patient

scanned supine, with the arm by the side and the dorsum of the hand parallel to the coronal plane of the magnet. Alternatives such as prone position with arm above the head can also be used, especially in larger patients and children. A dedicated wrist coil is advised, and to achieve high resolution a small field of view (FOV) in the order of 8–12 cm, with a matrix of at least 256 by 512 and slice thickness of 1.5–3 mm. A number of pulse sequences and image planes can be used as the routine examination for a mass would include coronal or sagittal T1 and T2 weighted sequences with axial short tau inversion recovery (STIR) and T1 weighted images. The hand could be supported with pads or bolsters to reduce motion.

Ethical Considerations:

- A written consent was taken from all participants in this research.
- The study was approved by Ethical Committee of the Faculty of Medicine, Benha University.

Adequate provisions to maintain privacy of participants and confidentially of data are as follow:

A code number for each patient will be used, symbols to the name and address that will be kept in a special file.

- Patients' names were hidden during the research
- The results of the research was only used in scientific aim.

Results ;

The study included 30 patients. Their age ranged from 5 years to 77 year with average 32.07 years old +/- 14.6 SD (Table 1).

The frequency and the percentage of affection of right and left hand were 50% as 15 patients for each side. The main presenting conditions were in 4 categories as following traumatic, soft tissue lesions, degenerative and inflammatory. The traumatic lesions were in form of fractures, TFCC injury, tendon tear/sprain and contusion (Fig. 1) (Table 2).

I- Scaphoid fractures:

The most frequent lesion was scaphoid fracture as nine cases were presented by scaphoid waist fracture as 30% of the presented cases and 50% of all traumatic conditions. Evidence of male predominance as seven of the nine cases are male (77.8%). Three of these cases were complicated by AVN of the proximal part of the scaphoid bone in form of collapse or fragmentation of the proximal pole which represent 33.3% of all scaphoid fracture and 10% of all conditions. The main age of all patients with scaphoid fracture is 33.1 years old +/-17 SD while it tends to be high in patients

complicated by scaphoid AVN as it is around 44.7 years old (Fig. 2) (Table 3).

II- TFCC injury:

TFCC was affected in 6 cases (20% of all cases), 5 of them were its ulnar attachment (83.3% of the TFCC cases) and 1 of them at its radial attachment (16.7% of the TFCC cases). All the cases were complaining of related trauma in the previous month before the exam. The mean age of the presented cases was 36.5 years old +/- 14.6 SD (Fig. 3).

III- Other traumatic injury:

Three of the all cases were traumatic ligament injury (16.7%) including three cases of scapholunate injury as two cases of complete tear (60%) while one of just scapholunate ligament sprain. On the other hand, 2 cases were in form of traumatic tendon injury affecting the flexor tendons of the 3rd and 4th fingers. The mean age of the presented cases was 30.2 years old +/- 16.67 SD. Bone marrow contusion/edema was presented solitary in one case and associated with other all traumatic conditions.

IV- Ganglion cysts:

In all presented patients, 6 cases were reporting have ganglion cysts (20% of all cases) which represent 66.67 of all reported benign lesions in the study. They had a mean age of 33.5 years ± 15.9 SD. Their size ranged from 3.7 to 20mm with average 10.2mm ± 5.67SD. Three cases (50%) were related to trauma while in the others there wasn't any history of obvious trauma. Their size ranged from 3.7 to 20mm with average 10.2mm ± 5.67SD. Two cases of the associated with trauma was reported with TFCC injury and the third one was associated with scaphoid fracture. Three cases (50%) were dorsal and the rest were volar.

V- Neoplastic masses:

Four cases of neoplastic masses were reported (13.3 of all cases), all these cases were benign in nature. One of the cases was in form of giant cell tumor (3.3% of all cases). Two cases of the benign were enchondroma seen at the long bones of hand (one at the 3rd metacarpal bone and the second one in the proximal phalanges of 4th finger). Both were reported in age group (21-30 years old) (Fig. 4). The giant cell tumor was reported in 35years old patient being deep lobulated soft tissue mass at the ventral aspect of the index opposite to middle phalanx. This mass encased the intact flexor tendon abutting the adjacent bone, bulging at the lateral aspect of the finger. It elicits low at T1 & T2 and high at STIR.

VI- Others:

Three cases in form of AVN of the lunate (10 % of all cases) with mean age around 41.7 years old. One third of the reported cases were post traumatic (33.3%). On the other hand, two cases of tendinopathy of extensor carpiulnaris were reported (6.7%). One inflammatory case was detected in form of carpoulnar bursitis.

Table (1): Percent of patients per each group.

Age Groups	Nu of patients	Percent
0-10 Y	1	3.3%
11-20 Y	6	20%
21-30 Y	11	36.7%
31-40 Y	5	16.7%
41-50 Y	3	10%
more than 51 Y	4	13.3%

Table (2): Classification of the lesions according to their location.

Location	Percentage
I- Bone	50%
II- Tendonieus	20%
III- Intra-articular	16.7%
IV- Subcutaneous	3.3%
V- Juxta-articular	10%

Table (3): Comparison between scaphoid fracture with or without osteonecrosis.

Pathological lesion	Nu. of patients	%	Mean age (year)
All scaphoid fracture	9	30%	33.1
Scaphoid fracture only	6	20%	27.3
Scaphoid fracture with AVN	3	10%	44.7

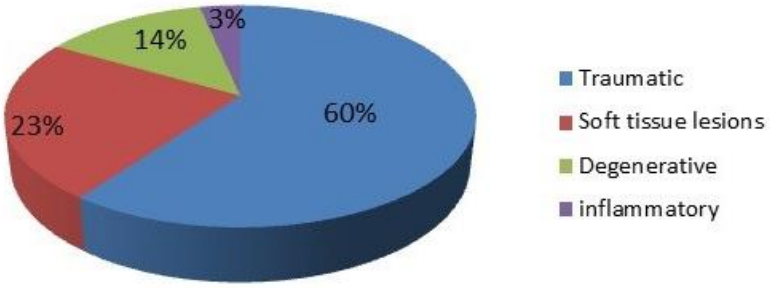

Fig (1): Percent of the presenting category of cases

Fig (2): Coronal T1-weighted image showing loss of signal marrow intensity within the proximal pole of the scaphoid after a fracture (arrow), indicative of posttraumatic necrosis.

Fig (3): Coronal gradient-echo image showing ulnar positive variance, a large defect in the central portion of the triangular fibrocartilage complex (arrows).

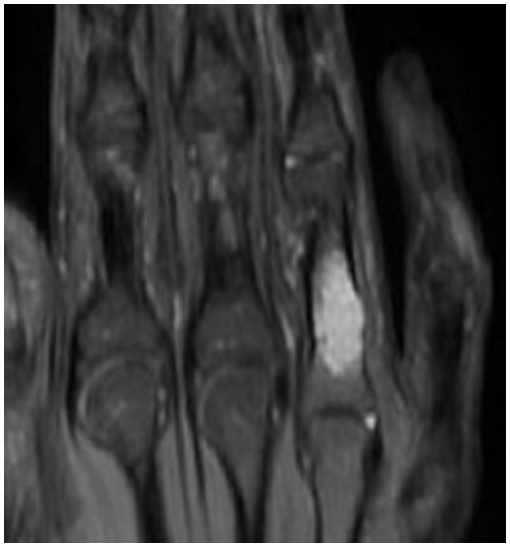

Fig (4): Coronal proton-density showing focal expansile intramedullary bony lesion with endosteal scalloping and mild cortical thinning with no periosteal reaction or extraosseous soft tissue components representing enchondroma.

Discussion:

The usefulness of MRI as a non-invasive method in evaluating various hand and wrist lesions is being able to produce high resolution images of the hand osseous and soft tissue structures. Over the past few years, the improvement of dedicated surface coils and higher strength magnets was an addition to the quality of MRI (7).

In our study, 30% of all presented cases were scaphoid fracture. According to Van Onselen et al., the scaphoid fracture accounts for 61% all carpal fractures (8). Early diagnosis of carpal fractures is essential to determine the applicable treatment and to reduce the undesirable sequences of including fracture progression, non-union, osteonecrosis, and secondary degenerative arthritis. The remaining carpal fractures account for 11% to 42% of carpal fractures, with the triquetrum and hamate being the in the lead (9). It is known that the most appropriate study in the early evaluation of the acute suspected scaphoid fracture is radiography in postero-anterior, lateral, semi-pronated oblique, and PA with ulnar deviation views (10). A published metanalysis revealed that 16% of initial radiographs are missed raising the need to series as a reference standard (11). Although serial radiographs may end up in revealing a scaphoid fracture, other studies have shown that MRI has the upper hand than others in

initial detection (12). A meta-analysis by Yin et al. of forty-one different studies, with a cumulative total of 1826 patients, showed a pooled sensitivity and specificity are 96% and 99%, respectively, for MRI (13).

Early MRI has also been proven to be more cost-effective in the United States and in other countries (14, 15). Moreover, early MRI is very efficient in detecting associated lesions or alternate diagnoses when a scaphoid fracture is not present, such as identifying other carpal fractures, distal radius fractures, osseous contusions, and soft tissue injuries (16). As in our study one of the cases was reported with TFCC injury and another case was reported with ganglion cyst.

In our study 33.3% of scaphoid cases were complicated by osteonecrosis. The fracture of the proximal pole has a worse prognosis than the distal part related to the retrograde to the retrograde blood supply. AVN in non-union scaphoid fracture is affected by the location of the fracture with a 30% rate of osteonecrosis when the fracture involves the middle one third and a 100% rate of osteonecrosis when the fracture involves the proximal one fifth. Many consider MRI is the best imaging modality for assessing osteonecrosis of the proximal pole of the scaphoid (17, 18). On the other hand, some consider MRI having a limited role in following the resolution of scaphoid or occult fractures. It is showed that scaphoid fractures continued to show an abnormal MRI signal even after clinical evidence of progression to union making the CT is the preferable imaging modality for visualization of trabecular development of a healing scaphoid or an occult fractures (19).

In our study, TFCC injury was reported in 20% of all cases. Tear is defined as fluid signal intensity extending through the disc or ligament on fluid sensitive sequences, including proton density, T2-weighted or gradient echoes sequences. The main age in our study was 36.5 +/- 14.6 which is rather similar to study published by Boer BC et al., as it was 38 +/- 15 years (20). Differentiating between the traumatic and degenerative tears is rather difficult but it can be correlated with specific criteria including ulnar positive variant, diffuse thinning of the triangular fibrocartilage, site of tear closer to the radial attachment. A meta-analysis of eleven studies combining the pooled results of 410 patients using the utility of 0.5 to 1.5-T MRI for the detection of triangular fibrocartilage tears revealed a sensitivity, specificity, and accuracy of 83%, 80%, and 81%, respectively, compared with arthroscopy if we ignored the invasiveness

of this technique (21). The advantage of stronger 3.0-T magnets has improved the detection of triangular fibrocartilage complex tears, with a reported sensitivity and specificity approaching 86% and 100%, respectively (22).

In our study, three cases of carpal ligament injury were reported. All of them involved the scapholunate ligament. MRI is considered as a reliable modality for the diagnosis of intrinsic carpal ligament tears in compare to wrist arthroscopy. Hobby et al. performed a meta-analysis of studies examining the use of 0.5 to 1.5-TMRI for the detection of intrinsic ligament tears. Six studies on scapholunate ligament tear detection with 159 pooled patients showed a sensitivity, specificity, and accuracy of 70%, 90%, and 85%, respectively, for MRI. The introduction of 3.0-T MRI has improved the sensitivity for the detection of scapholunate tears to 89% (22). If the diagnosis remains unclear, MR arthrography may help diagnose subtle lunotriquetral or scapholunate ligament tears by showing abnormal communication of contrast agent between the radiocarpal and midcarpal compartments (23).

Many osseous masses and soft tissues masses may involve the upper extremity. Most of these soft tissue mass lesions are benign. In soft tissue lesions of the hand, plain radiography has limited utility but can demonstrate calcification, bony destruction and is able to diagnose some pseudo lesions such as arthropathies (24).

In our study, 10 cases were reported with hand mass or cyst and MRI was conducted for each one of them. All presented lesions were benign. The most commonly encountered lesions were ganglia (20% of all lesions). These results differs from the work of de La Kethulle de Ryhove et al., who reported that 9.8% the cases in their study had malignant lesions which may be attributed by the limited number of cases (25).

In the present work, ganglia were the most common hand mass (20%). Approximately 70% of soft tissue ganglia occur around the wrist. 50-70% of the soft tissue lesions about the wrist are ganglia which are usually small, 2 to 3 cm in greatest dimension, without joint space communication. These results were rather similar to ours where all ganglia were around the wrist joint and they varied in size from 3.7mm to 2cm along their longest dimension. The efficacy of MRI and ultrasonography in diagnosing the presence of dorsal occult ganglion cysts is similar; however, MRI offers an objective,

reproducible display of anatomic relationships (26).

This study reported two cases of enchondroma being hyperintense on T2-weighted MR images due to the high water content of the extracellular matrix and mostly have a lobulated appearance on T1-weighted images. Melamud et al., that reported that MRI had upper hand in the evaluation osseous lesions over ultrasonography (27).

Limitations in our study included the small sample size which is not enough for powerful conclusion with only one case of giant cell tumor, lipoma and carpoulnar bursitis included.

In summary, MRI has the ability to provide detailed soft tissue characterization and is preferred in most of hand lesions.

Early MRI following negative radiographs if clinically suspected scaphoid fracture allows for an accurate diagnosis while minimizing direct and indirect costs. MRI is also the best imaging modality to evaluate for proximal pole osteonecrosis in a scaphoid non-union. The main advantage of MRI over CT is that rather than decreasing any ionizing radiation, but also more importantly, it provide alternate diagnoses (e.g., other fractures, osseous contusions, soft tissue injuries) when no scaphoid fracture is present.

The most common soft tissue lesion encountered in the hand is ganglion cyst with accurate characterization regarding size, size and shape using MRI.

In conclusion, MRI is the preferable method

:e for evaluating various hand and finger lesions in traumatic and non-traumatic condition if conventional radiography isn't enough.

References:

1- Malone, J. C., Preston, K. S., Garner, H. W., Bestic, J. M., Wessell, D. E., & Peterson, J. J. (2016). MRI of the hand and fingers. *Applied Radiology*, 45(2), 9-21.

2- Peterson, J. J., Bancroft, L. W., & Kransdorf, M. J. (2004). Principles of bone and soft tissue imaging. *Hand clinics*, 20(2), 147-166.

3- Agarwal, A., Prakash, M., Gupta, P., Tripathy, S., Kakkar, N., Srinivasan, R., & Khandelwal, N. (2015). Soft tissue masses of hand: a radio-pathological correlation. *Radiology research and practice*, 2015.

4- Morey, V. M., Garg, B., & Kotwal, P. P. (2016). Glomus tumours of the hand: review of literature. *Journal of clinical orthopaedics and trauma*, 7(4), 286-291.

5- Teh, J., & Whiteley, G. (2007). MRI of soft tissue masses of the hand and wrist. *The British journal of radiology*, 80(949), 47-63.

6- Plonczak, A. M., Niruttan, K., & Jain, A. (2019). Should we be imaging soft tissue masses of the hand and wrist?. *Journal of Plastic,*

Reconstructive & Aesthetic Surgery, 72(2), 335-354.

7- Dewan, A. K., Chhabra, A. B., Khanna, A. J., Anderson, M. W., & Brunton, L. M. (2013). Magnetic resonance imaging of the hand and wrist: techniques and spectrum of disease: AAOS exhibit selection. *JBJS*, 95(10), e68.

8- Van Onselen, E. B. H., Karim, R. B., Hage, J. J., & Ritt, M. J. P. F. (2003). Prevalence and distribution of hand fractures. *Journal of Hand Surgery*, *28*(5), 491-495.

9- Murthy, N. S. (2013). The role of magnetic resonance imaging in scaphoid fractures. *The Journal of Hand Surgery*, *38*(10), 2047-2054.

10-Newberg, A., Dalinka, M. K., Alazraki, N., Berquist, T. H., Daffner, R. H., DeSmet, A. A., ... & Pavlov, H. (2000). Acute hand and wrist trauma. American College of Radiology. ACR Appropriateness Criteria. *Radiology*, *215*, 375.

11-Hunter, J. C., Escobedo, E. M., Wilson, A. J., Hanel, D. P., Zink-Brody, G. C., & Mann, F. A. (1997). MR imaging of clinically suspected scaphoid fractures. *AJR. American journal of roentgenology*, *168*(5), 1287-1293.

12-Adey, L., Souer, J. S., Lozano-Calderon, S., Palmer, W., Lee, S. G., & Ring, D. (2007). Computed tomography of suspected scaphoid fractures. *The Journal of hand surgery*, *32*(1), 61-66.

13-Yin, Z. G., Zhang, J. B., Kan, S. L., & Wang, X. G. (2010). Diagnosing suspected scaphoid fractures: a systematic review and meta-analysis. *Clinical Orthopaedics and Related Research®*, *468*(3), 723-734.

14-Dorsay, T. A., Major, N. M., & Helms, C. A. (2001). Cost-effectiveness of immediate MR imaging versus traditional follow-up for revealing radiographically occult scaphoid fractures. *American Journal of Roentgenology*, *177*(6), 1257-1263.

15-Brooks, S., Cicuttini, F. M., Lim, S., Taylor, D., Stuckey, S. L., & Wluka, A. E. (2005). Cost effectiveness of adding magnetic resonance imaging to the usual management of suspected scaphoid fractures. *British journal of sports medicine*, *39*(2), 75-79.

16-Tibrewal, S., Jayakumar, P., Vaidya, S., & Ang, S. C. (2012). Role of MRI in the diagnosis and management of patients with clinical scaphoid fracture. *International orthopaedics*, *36*(1), 107-110.

17-Fox, M. G., Gaskin, C. M., Chhabra, A. B., & Anderson, M. W. (2010). Assessment of scaphoid viability with MRI: a reassessment of findings on unenhanced MR images. *American Journal of Roentgenology*, *195*(4), W281-W286.

18-Schmitt, R., Christopoulos, G., Wagner, M., Krimmer, H., Fodor, S., Van Schoonhoven, J., & Prommersberger, K. J. (2011). Avascular necrosis (AVN) of the proximal fragment in scaphoid nonunion: is intravenous contrast agent necessary in MRI?. *European journal of radiology*, *77*(2), 222-227.

19-Hackney, L. A., & Dodds, S. D. (2011). Assessment of scaphoid fracture healing. *Current reviews in musculoskeletal medicine*, *4*(1), 16-22.

20-Boer, B. C., Vestering, M., van Raak, S. M., van Kooten, E. O., Huis, R., & Vochteloo, A. J. H. (2018). MR arthrography is slightly more accurate than conventional MRI in detecting TFCC lesions of the wrist. *European Journal of Orthopaedic Surgery & Traumatology*, *28*(8), 1549-1553.

21-Hobby, J. L., Tom, B. D., Bearcroft, P. W., & Dixon, A. K. (2001). Magnetic resonance imaging

of the wrist: diagnostic performance statistics. *Clinical radiology*, *56*(1), 50-57.

22-Magee, T. (2009). Comparison of 3-T MRI and arthroscopy of intrinsic wrist ligament and TFCC tears. *American journal of roentgenology*, *192*(1), 80-85.

23-Brown, R. R., Fliszar, E., Cotten, A., Trudell, D., & Resnick, D. (1998). Extrinsic and intrinsic ligaments of the wrist: normal and pathologic anatomy at MR arthrography with three-compartment enhancement. *Radiographics*, *18*(3), 667-674.

24-Tandon, A. A., & Lee, C. H. (2014, March). Radiological approach to focal hand lesions. European Congress of Radiology-ECR 2014.

25-De La Kethulle de Ryhove, D., De Beuckeleer, L., & De Schepper, A. (2000). L'imagerie par résonance magnétique des tumeurs des tissus mous de la main et du poignet [Magnetic resonance imaging of soft tissue tumors of the hand and wrist]. *Journal de radiologie*, *81*(5), 493–507.

26-Anderson, S. E., Steinbach, L. S., Stauffer, E., & Voegelin, E. (2006). MRI for differentiating ganglion and synovitis in the chronic painful wrist. *American Journal of Roentgenology*, *186*(3), 812-818.

27-Melamud, K., Drapé, J. L., Hayashi, D., Roemer, F. W., Zentner, J., & Guermazi, A. (2014). Diagnostic imaging of benign and malignant osseous tumors of the fingers. *Radiographics*, *34*(7), 1954-1967.

To cite this article: Medhat M. Reffat, Ahmed E. Shalan, Ahmed M. Montasr. Magnetic Resonance Imaging Role in Evaluation and characterization of Hand and Finger Lesions. BMFJ 2021; 38(1): 254-265. DOI: 10.21608/bmfj.2021.37316.1297