Original Research Article

MRI supplemented with Diffusion Weighted Image in characterization of soft tissue masses of the wrist and hand

Abstract:

Background: The wrist joint is considered to be a condyloid synovial joint of the distal upper limb that connects and serves as a transition point between the forearm and hand. Hand and wrist soft tissue masses comprise a special subset of soft tissue masses. MRI imaging has an important role in characterization of soft tissue tumors, yet, it lacks specificity for differentiation between benign and malignant lesions. Diffusion-weighted imaging (DWI) is a non-invasive method for investigation of tumor histological content and used for differentiation between benign and malignant masses.

Aims: This study aimed at assessment of the role of MR diffusion Weighted imaging (DWI) in the evaluation of soft tissue masses of the wrist and hand.

Patients and Methods: This study conducted on 30 patients with soft tissue masses of the wrist and hand. They were referred from Orthopedic and Physiotherapy Departments to MRI unit in Radio-diagnosis Department, Tanta University Hospital. The study was conducted from November 2018 to November 2019. MRI with DWI was conducted for each one of them and results were correlated with histopathological examination.

Results: There is a significant difference in the mean ADC value between benign and malignant soft tissue tumors. Increased apparent diffusion coefficient (ADC) values represent an increase in extracellular water or loss of cell membrane integrity whereas decreased ADC values reflect decrease in extracellular water content or increase in cell number or size.

Conclusions: this study proved the role of MRI and supplementary Diffusion weighted image (DWI) with numerical ADC values in characterization of soft tissue masses of the wrist and hand.

Keywords: MRI, Diffusion Weighted Image soft tissue masses, wrist, hand

Introduction:

The majority of soft tissue mass lesions of the wrist are benign. The most common lesions in practice are ganglia. Diagnosis of these masses may be achieved by their anatomical location and their characteristics [(1)].

Imaging cannot only confirm the presence of these soft tissue masses but can also provide essential information necessary for diagnosis, local staging, and biopsy planning [(2,3)].

Plain films and Computed Tomography (CT) can detect calcification and allow assessment of adjacent bony structures but unlike Magnetic Resonance Imaging (MRI) don't offer more in the way of tissue characterization[(1)].

Ultrasonography (US) is extremely useful in localizing lesions and determining if it cystic or solid [(4,5).]. It's shown to be sensitive in the detection of synovitis and bone erosions in both small and large joints. US has several advantages including cost, immediate availability in the clinics and the ability to scan multiple joints at one time but still tissue characterization is limited[(6)].

MRI has become the technique of choice for detecting and characterizing soft-tissue masses. It improves soft-tissue contrast and multiple–image plane capabilities and has provided significant advantages for lesion intrinsic characterization, and local staging [(7,8)] Vascular structures can also be easily identified and evaluated without the need for intravenous (IV) contrast agents, and neurovascular involvement is more easily defined.

Although lesions are more easily detected with MRI, its ability to differentiate benign from malignant lesions remains more controversial. Recent studies have shown that MRI can diagnose approximately 50% of histologically confirmed cases using imaging and available clinical information [(9)].

Diffusion Weighted Imaging (DWI) has been used for assessment of tumors [(10)], so it can differentiate benign and malignant soft-tissue tumors because malignant tumors have greater cellularity and more restricted diffusion than benign tumors [(11)].

Patient and Methods:

Study Population: This study will be conducted on 30 patients with soft tissue masses of the wrist and hand. They were referred from orthopedic and physiotherapy departments to MRI unit in Radio-diagnosis department, Tanta University Hospital.

The study was conducted from November 2018 to November 2019.

Inclusion criteria:

1. Patient with soft tissue swelling of the hand and wrist diagnosed either by clinical or other radiological modalities.
2. Both sexes were included.

Exclusion criteria:

1. Patients with bony lesions.
2. Patients who are contraindicated to perform MRI such as: Patient with (intraocular metallic foreign body, cardiac pacemakers, non-compatible MRI aneurysm clips) and claustrophobic patients.
3. Patients who are contraindicated to take contrast media such as: (Previous severe allergic/anaphylactic reaction to Gadolinium based contrast agent, Patients with severe renal disease (Glomerular filtration rate (GFR)<30mL/min/1.73m,2), Patients who are, or might be pregnant.

Statistical Analysis

All data were collected, tabulated and statistically analyzed using SPSS 22.0 for windows (SPSS Inc., Chicago, IL, USA) & MedCalc 13 for windows (MedCalc Software bvba, Ostend, Belgium).

Results:

From 30 soft tissue mass lesion, only 3 masses were malignant (10.00%) and 27 masses were benign (90.00%) **Table (1).**

Table (1): The percentage of benign and malignant soft tissue masses in in our study.

Benign or Malignant		
	N	%
Benign	27	90.00
Malignant	3	10.00
Total	30	100.00

Comparison was done between the result of MRI only and MRI with DWI and correlated with biopsy for all patients to show the role of DWI in differentiation between benign and malignant more than MRI only without DWI as described in **Table (2).**

Table (2): Comparison between MRI, MRI with DWI and biopsy

	Benign		Malignant	
	N	%	N	%
MRI	29	96.67	1	3.33
MRI with DWI	25	83.33	5	16.67
Biopsy	27	90.00	3	10.00

In our study the mean ADC value of benign and malignant soft tissue tumors was 1.802 + 0. 686 $x10^{-3}$ mm^2/s and 0.643 + 0.112 $x10^{-3}$ mm^2/s (mean + SD), respectively. There is a significant difference in the mean ADC value between benign and malignant soft tissue tumors (P < 0.008) **Table (3)**.

Table (3): Comparison between the benign and malignant according to ADC (×10-3 mm/sec)

Benign or Malignant	ADC map (mm2/sec)			T-Test	
	Mean	±	SD	T	P-value
Benign	1.802	±	0.686	2.871	0.008*
Malignant	0.643	±	0.112		

The cut-off ADC value was ≤0.77 masses with ADC value <0.77 were malignant & masses >0.77 were benign. With ADC vale (<0.77) with sensitivity of 100.0% specificity of 96.0%, positive predictive value of 75.0%, negative predictive value of 100.0% with diagnostic accuracy of 98.7% as described in **Table(4).**

Table (4): ROC curve between Benign and Malignant

ROC curve between Benign and Malignant						
	Cutoff	Sens.	Spec.	PPV	NPV	Accuracy
ADC map (mm2/sec)	≤0.77	100.0	96.0	75.0	100.0	98.7%

Case 1: A fifty sex year's old male patient presented with swelling of volar aspect of right wrist of long duration (2 years) (Figure 1)

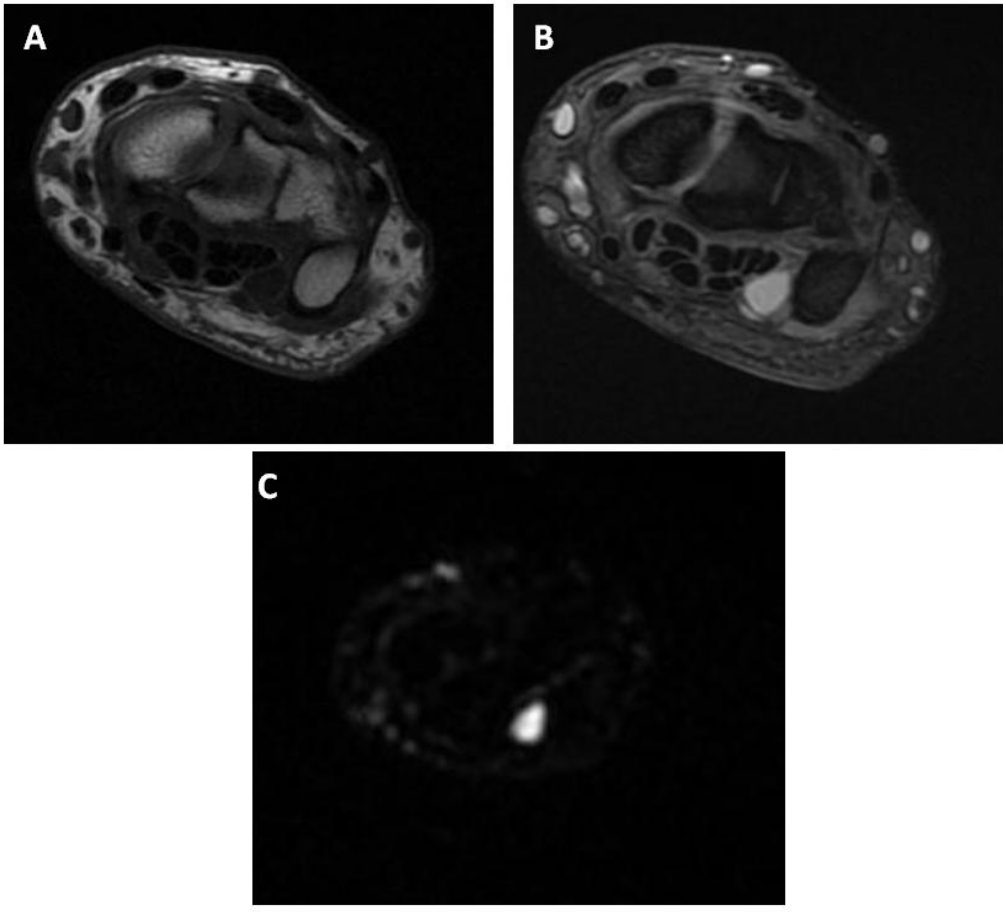

Figure 1: Axial T1 (A) and T2 (B), sagittal T2 (C), ADC showing well defined cystic lesion at the volar aspect of the wrist joint seen superficial to ulnar aspect of flexor retinaculum medial to carpal tunnel and deep to ulnar nerve just proximal to hook of hamate.

Case 2: A twenty-nine years old female patient presented with painful swelling of the right hand of acute onset and progressive course associated with hotness and redness since two month (Figure 2).

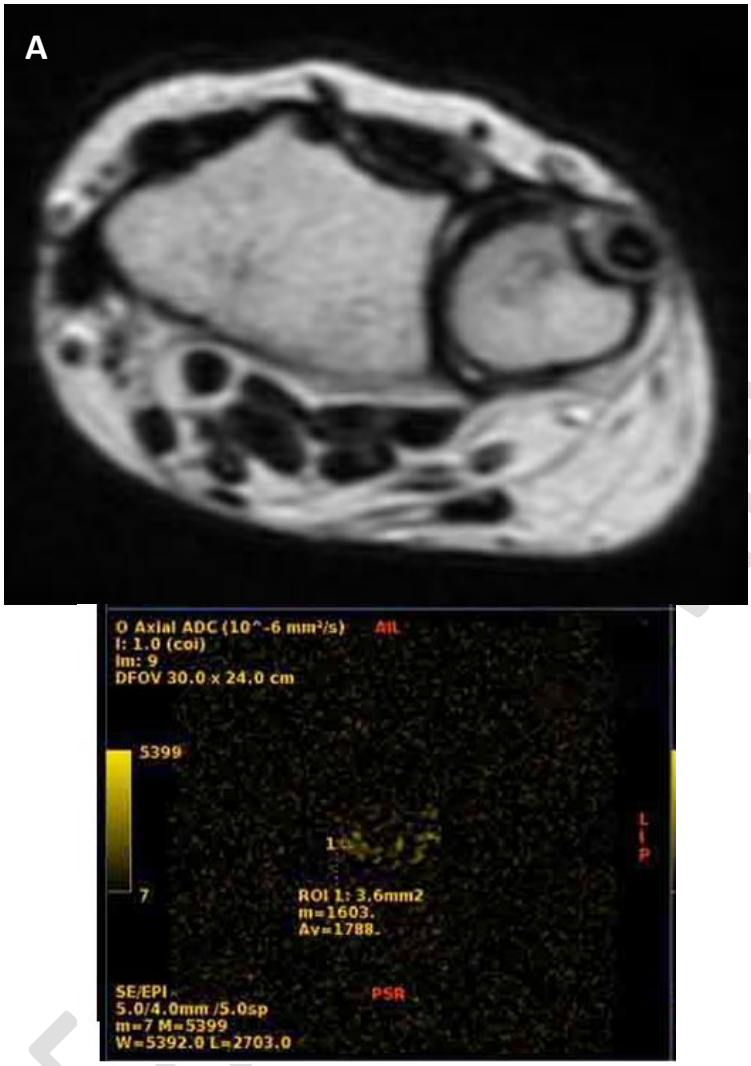

Figure 2: (A) axial T2 (B), ADC of the right hand showing Thickening of the synovial sheath of extensor carpi ulnaris (ECU) tendon (VI extensor compartment).

Case 3: A twenty-sex years old female patient presented with painful swelling of the palm of the right hand since one month after a history of trauma associated with limitation of hand movement (Figure 3).

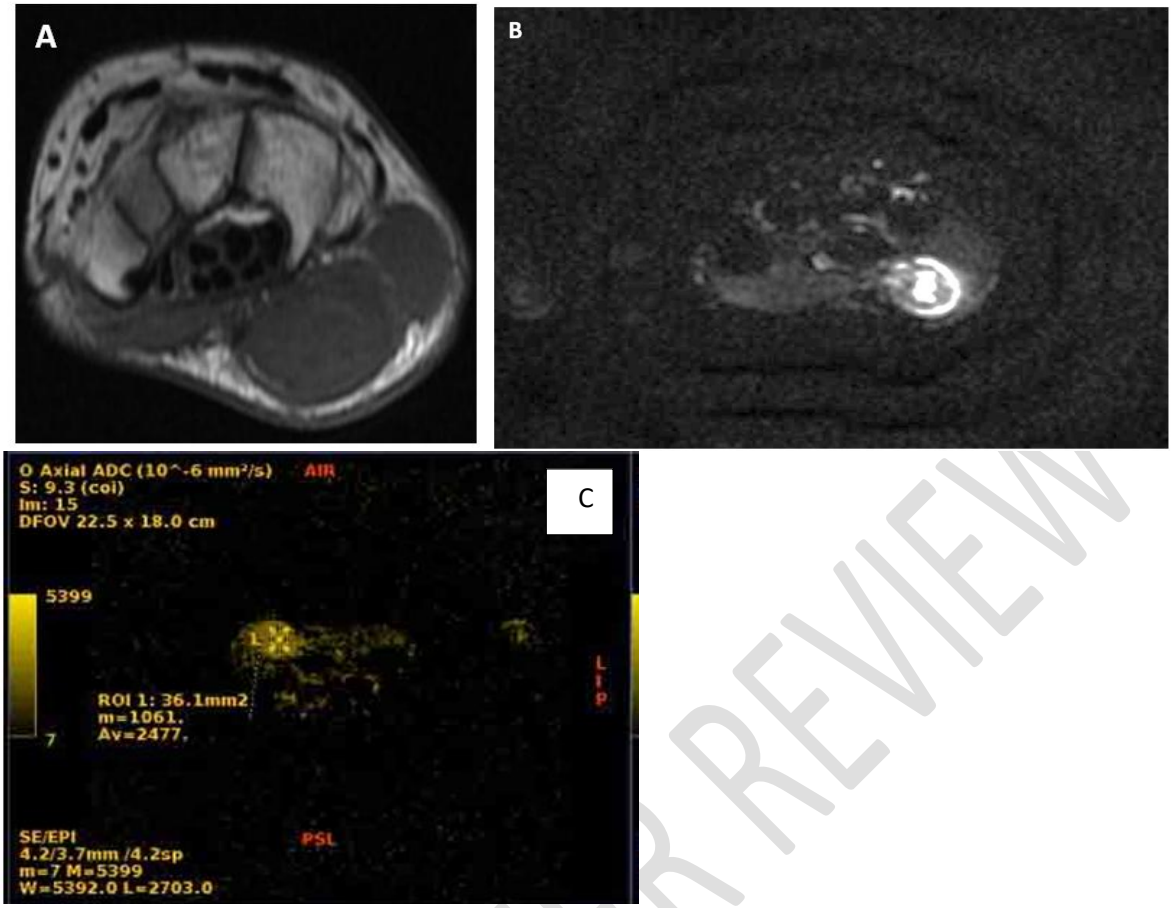

Figure 3: (A) Axial T1, (B) axial DWI, (C) ADC showing well defined subcutenous soft tissue lesion seen at hypothenar eminence of the right hand.

Discussion and Conclusion:

In our study, From 30 soft tissue mass lesion, only 3 masses were malignant (10.00%) and 27 masses were benign (90.00%) These results coincide with work of **Susan, et al., 2021**[12] who reported that benign and malignant lesions represented (97.6%) and (2.4%), respectively.

In our study, DWA was done for all cases most of the mass lesion show restricted diffusion (23 patients)76.67%.and ADC was measured for all cases, the mean ADC value of benign and malignant soft tissue tumors was 1.802 + 0. 686 $x10^{-3}$ mm^2/s and 0.643 + 0.112 $x10^{-3}$ mm^2/s (mean + SD), respectively There is a significant difference in the mean ADC value between benign and malignant soft tissue tumors ($P < 0.008$) which is relatively agreed with the study of **Nassif et al., 2017** [13] the revealed that the ADC value of benign tumors was ranged between 2.21&2.58x10-3mm2 /sec and it was significantly higher than that of malignant soft tissue tumors which ranged between o.90&1.82x10- 3mm2 /sec, where the mean ADC value of all benign soft tissue tumors was 2.21+0.27x10- 3mm2 /sec, while the mean ADC value all malignant soft tissue tumors was 0.90+0.32x 10- 3 mm2 /sec with statistically significant difference ($p<0.001$).

Also, **Razek et al. 2012** [14] reported that malignant tumors tend to exhibit a lower mean ADC value than benign soft-tissue tumors. Our results also matched with **Zou et al. 2016** [15] who reported that the mean ADC value in patients with malignant soft-tissue tumor decreased significantly in comparison with the ADC values obtained in patients with benign soft-tissue tumor ($P <0.001$). Mean ADC value of benign soft tissue tumors was 1.37x10-3mm2 /sec, while mean ADC value of malignant soft tissue tumors was 0.8x10- 3mm2/sec.

In our study we obtained 100%sensitivity and 96.7% specificity and diagnostic accuracy of 98.7%, that matched with the study of **Nassif et al., 2017**[12] that obtained threshold

value1.14x10-3mm2 /sec with 94.4%sensitivity and 91.7% specificity and diagnostic accuracy of 97.9%,.This was higher than the result of **Nagata et al. 2008** [16] who found the sensitivity and specificity of 76.3%and 76.7% respectively, However, these results are matched with those of **Razek et al. 2012** [14] who found sensitivity of 94%, specificity of 88% and an overall accuracy of 91%.

Ethical Approval:

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

Consent

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

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