

Study of Role of Diagnostic Ultrasound in Tendon Entrapment at Wrist and Hand

Omnia Shaaban Hassan Elshaer*, Said A. Monem, Doaa Ibrahim Hasan, Mahmoud Mohamad Gabal

Department of Radiodiagnosis, Faculty of Medicine, Zagazig University, Egypt

*Corresponding author: Omnia Shaaban Hassan Elshaer, Mobile: (+20) 01094674593, E-mail: oloveh18112012@gmail.com

ABSTRACT

Background: Evaluation of hand tendon injuries can benefit greatly from the use of high-resolution ultrasound as a potential diagnostic technique.

Objective: To study the role of diagnostic ultrasound in tendon entrapment at wrist and hand both in static and dynamic methods.

Patients and methods: A clinical study was conducted on 36 cases. The study included patients with known history of recent or past trauma, had one or more nodules on volar aspect of the proximal one-half of one or more fingers, presented with flexion contracture of fingers, and were attending at Radiodiagnosis Department, Zagazig University Hospitals.

Results: The most affected structure was the tendon (63.9%), with thickened tendon in 44.4% of patients and degenerative changes of tendon in only one patient. Fluid in tendon sheath was presented in 30.6% of patients, there was thickening of pulley of tendon in 22.2% of patients. Ultrasound diagnosis was non-inflammatory and inflammatory conditions, the non-inflammatory was more common. The most common cause of non-inflammatory conditions was Dupuytren's contracture. The palm of hand more affected than dorsum of hand so the flexor tendons more affected than the extensors.

Conclusion: When tendon defects of the hands and fingers are suspected, ultrasonography of the hands should be a standard part of the imaging strategy (trigger finger, tendon related masses tenosynovitis, as well as tendon tears).

Keyword: Ultrasound, Tendon Entrapment, Wrist, Hand.

INTRODUCTION

Sonography can be a helpful diagnostic tool for a variety of musculoskeletal conditions. Expanded clinical uses can be attributed to developments in sonographic technology such as higher resolution probes, power Doppler sonography, extended field-of-view imaging. Ultrasound of the musculoskeletal system can be used for diagnosis, monitoring, and to direct treatment (injections and biopsies). Musculoskeletal ultrasound (MSUS) is a dynamic multi-planar imaging technique. It offers several advantages over other imaging methods, including being safe and well accepted by patients and enabling direct connections between imaging findings and clinical data, both of which contribute to better care for those suffering from musculoskeletal and rheumatic conditions⁽¹⁾.

There are several benefits to using US technology. Patients are often accepting because the procedure is painless, takes only a few minutes, and does not expose them to radiation. From the perspective of the doctor, there are a number of benefits. Contralateral examination is possible, and unlike magnetic resonance imaging, it is not hindered by metal artefacts⁽²⁾. The many benefits of sonography also include its low cost, mobility, noninvasiveness, and the capacity to provide multiplanar imaging. However, its real-time imaging capabilities, which enables dynamic evaluation, is arguably its most significant diagnostic benefit over other methods⁽³⁾.

Disabilities of the hand and wrist due to tendon problems are prevalent and can make even simple actions like going to work difficult. Knowledge of the complicated anatomic structures of the tendons of the hand and wrist, as well as familiarity with related

illnesses, is typically required for imaging to aid in diagnosis⁽⁴⁾.

When it comes to the preoperative evaluation of hand tendon injuries as well as postoperative follow-up, high-resolution ultrasonography is a highly accurate potential diagnostic technique⁽⁵⁾. Real-time dynamic US inspection has many uses in the musculoskeletal (MSK) system. Ultrasound can detect tendon instability, such as anterior extensor carpi ulnaris dislocation⁽⁶⁾.

US performed by the physician provides an excellent opportunity for patient education and to explain the rationale for treatments⁽⁷⁾.

This study objective was to study the role of diagnostic ultrasound in tendon entrapment at wrist and hand both in static and dynamic methods.

SUBJECTS AND METHODS

Our clinical study was conducted on 36 cases referred from the Orthopedic Surgery, Plastic Surgery, and Rheumatology Departments to Radiodiagnosis Department, at Zagazig University Hospitals. The ages of the 36 participants in this study ranged from 11 to 67 years old (17 males and 19 females).

Inclusion criteria:

- Any age and sex.
- History of recent or past trauma
- Patients have one or more nodules on volar aspect of the proximal one-half of one or more fingers,
- Patients present with flexion contracture of fingers

- Patient reports radial side wrist pain that developed gradually and was made worse by grabbing and lifting in a neutrally rotated position.
- Patients suffer from inability to flex or extend the digit smoothly.

Exclusion criteria:

- Acute open trauma.
- Patients experiencing extreme tenderness in the area being examined.

Methods:

All patients were subjected to:

1. **Complete history taking** (mechanism of trauma, site of pain, timing of pain and effect on movement).
2. **Clinical examination** (Clinical examination of the affected hand focusing on: pain, swelling, scar or deformity).
3. **Laboratory investigation.**
4. **Imaging including:**

Ultrasound imaging assessment:

A) Machine:

Real-time ultrasonography was achieved using a (Canon Aplio 500, USA) machine and a high-frequency linear array transducer that could be adjusted from 7.5 to 9 Mega Hertz. Standardized bilateral clinical-focus sonography have been performed on all patients.

Method:

Patients with tendon entrapment were evaluated according to the area of symptoms. Patient symptoms, the affected compartment, and the location of any localised pathology were all under the examination's focus. Frequently, it was easier to identify discrete tendons by following them proximally or distally from joints or anatomical landmark.

Dynamic tests were used to evaluate the patients' tendon mobility after it had been evaluated with superficial ultrasonography (through the active and the passive tendon mobilization). Anisotropic effect makes tendons look hypoechoic, like synovial fluid, leading to a false diagnosis of tenosynovitis if the transducer is not perpendicular to them, especially in the transverse plane.

Ethical consent:

The initiative was authorised by Zagazig University's Academic and Ethical Council. To participate in the trial, each adult patient or caregiver of patient less than 18 years old, signed a written informed permission form. The Helsinki Declaration, the World Medical Association's code of ethics for human studies, directed the conduct of this investigation.

Statistical analysis

For this study, we used IBM SPSS Version 27.0. Numerical information was summarized using minimum and maximum values, as well as means, standard deviations, medians, and ranges. The Shapiro-Wilk test was used to examine the normality of the continuous data. Non-normally distributed data were compared using the Mann-Whitney U test. Fisher's exact test was used to compare categorical variables. P value < 0.05 was considered significant.

RESULTS

The characteristics of the studied patients are shown in table 1. Their age ranged from 11 to 67 years old.

Table (1): Characteristics of patients in the current study

The studied patients (N=36)		
Characteristics	No.	%
Sex		
Male	17	47.2%
Female	19	52.8%
Age (years)		
Mean ±SD	36.19±15.12	
Median (Range)	35.50 (11 – 67)	
Side		
Right	17	47.2%
Left	15	41.7%
Bilateral	4	11.1%

Ultrasound findings in the studied patients:

The most affected structure was the tendon (63.9%), with thickened tendon in 44.4% of patients and degenerative changes of tendon in only one patient. Fluid in tendon sheath presented in 30.6% of patients. There was thickening of pulley of tendon in 22.2% of patients. Synovial thickening was in one case. Disruption of continuity of subcutaneous fascia was in 19.4% of patients and thickening of subcutaneous fascia was in 25% of patients.

There was fracture with abnormal articulation in only one case. Joint effusion was in 8.3% of patients. Nodule was present in 11.1% of patients. The median size of the nodules was 13 mm. All nodules were seen superficial to tendon with hypoechoic echogenicity and well-defined border. On color Doppler study, internal vascularity was seen in one case. With dynamic study, there was no movement of nodules with tendon movement. Cyst was presented in 6 patients. The wall of cyst was thin in 4 cases and thick in 2 cases. The content of cyst was clear fluid in 4 cases and turbid fluid in 2 cases, with internal septations in 2 cases and lobulation in one case (Figure 1).

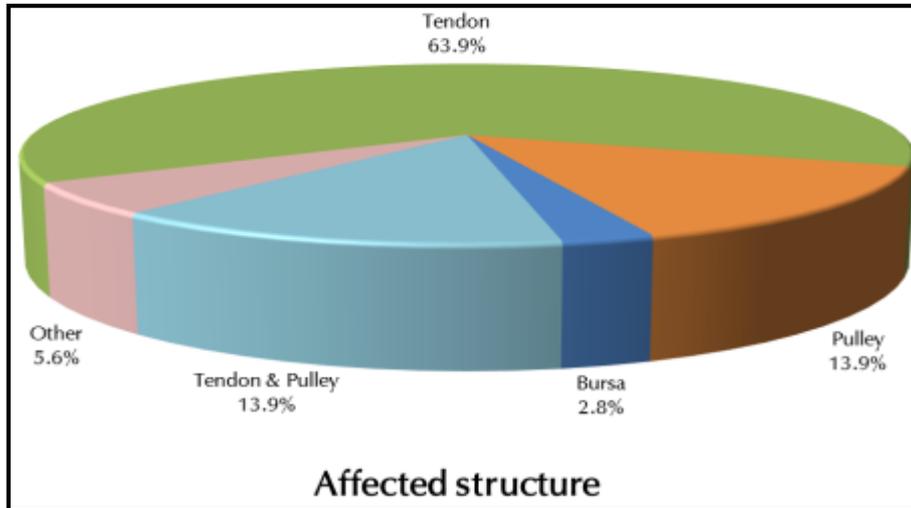


Fig. (1): Pie diagram shows affected structure among the studied patients (N=36)

Ultrasound diagnosis was non-inflammatory and inflammatory conditions, with the non-inflammatory was more common (66.6%). The most common cause of non-inflammatory conditions was Dupuytren's contracture (27.8%). Giant cell tumor was seen only in one patient (Figure 2).

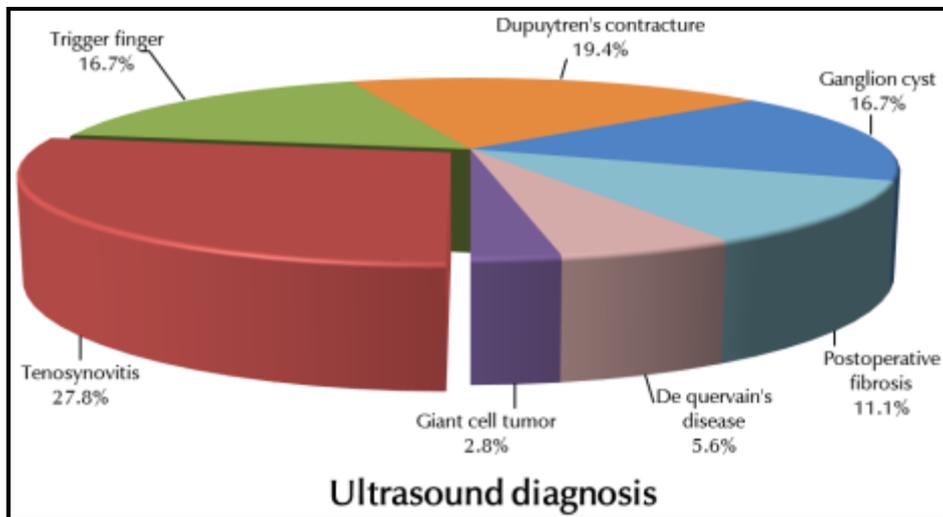


Fig. (2): Pie diagram shows ultrasound diagnosis of the studied patients (N=36)

The difference between non-inflammatory and inflammatory conditions was insignificant regarding sex, age, occupation, and the dominant hand (Table 2).

Table (2): Comparison between inflammatory conditions and non-inflammatory conditions regarding basic characteristics

Basic characteristics	Diagnosis				p-value (Sig.)
	Non-inflammatory (N=26)		Inflammatory (N=10)		
	No.	%	No.	%	
Sex					
Male	12	46.2%	5	50%	1.000
Female	14	53.8%	5	50%	(NS)
Age (years)					
Mean±SD	37.69	±15.89	32.30	±12.84	0.313
Median (Range)	38	(11 – 67)	29	(12 – 52)	(NS)
Occupation					
Forceful	10	38.5%	5	50%	0.679
Less demanding	4	15.4%	2	20%	(NS)
Unemployed	12	46.2%	3	30%	
Dominant hand					
Right hand	22	84.6%	10	100%	0.559
Left hand	4	15.4%	0	0%	(NS)

SD: Standard deviation, NS: Nonsignificant

Clinical presentation in the studied patients:

Inflammatory conditions had significantly more primary trauma and pain and less swelling compared to non-inflammatory conditions (Table 3).

Table (3): Comparison between inflammatory conditions and non-inflammatory conditions regarding clinical presentation and findings

Clinical presentation and findings		Diagnosis				p-value (Sig.)
		Non-inflammatory (N=26)		Inflammatory (N=10)		
		No.	%	No.	%	
History of trauma	Absent	21	80.8%	9	90%	0.655
	Present	5	19.2%	1	10%	(NS)
Etiology of entrapment	Primary	7	26.9%	9	90%	0.002
	Secondary	19	73.1%	1	10%	(NS)
Swelling	Absent	17	65.4%	10	100%	0.039
	Present	9	34.6%	0	0%	(S)
Limited movement	Absent	26	100%	10	100%	1.000
	Present	0	0%	0	0%	
Pain	Absent	23	88.5%	3	30%	0.001
	Present	3	11.5%	7	70%	(S)
Affected hand	Right hand	13	50%	4	40%	0.564
	Left hand	11	42.3%	4	40%	(NS)
	Bilateral	2	7.7%	2	20%	
Affected site	Palm of hand	21	80.8%	8	80%	1.000
	Dorsum of hand	5	19.2%	2	20%	(NS)
Affected tendons	Flexor	21	80.8%	8	80%	1.000
	Extensor	5	19.2%	2	20%	(NS)
Right thumb affection	Absent	20	76.9%	8	80%	1.000
	Present	6	23.1%	2	20%	(NS)
Left thumb affection	Absent	23	88.5%	7	70%	0.317
	Present	3	11.5%	3	30%	(NS)
Right index finger affection	Absent	23	88.5%	10	100%	0.545
	Present	3	11.5%	0	0%	(NS)
Left index finger affection	Absent	26	100%	10	100%	1.000
	Present	0	0%	0	0%	(NS)
Right middle finger affection	Absent	20	76.9%	8	80%	1.000
	Present	6	23.1%	2	20%	(NS)
Left middle finger affection	Absent	21	80.8%	10	100%	0.293
	Present	5	19.2%	0	0%	(NS)
Right ring finger affection	Absent	22	84.6%	9	90%	1.000
	Present	4	15.4%	1	10%	(NS)
Left ring finger affection	Absent	23	88.5%	9	90%	1.000
	Present	3	11.5%	1	10%	(NS)
Right little finger affection	Absent	25	96.2%	9	90%	0.484
	Present	1	3.8%	1	10%	(NS)
Left little finger affection	Absent	25	96.2%	8	80%	0.181
	Present	1	3.8%	2	20%	(NS)

S: Significant; NS: Nonsignificant

Ultrasound findings in the studied conditions:

Inflammatory cases had significantly more thickening of tendon than the non-inflammatory cases (Table 4).

Table (4): Comparison between inflammatory conditions and non-inflammatory conditions regarding ultrasound findings

Ultrasound findings	Diagnosis				p-value (Sig.)
	Non-inflammatory (N=26)		Inflammatory (N=10)		
	No.	%	No.	%	
Affected structure					
Tendon	16	61.5%	7	70%	0.441
Pulley	4	15.4%	1	10%	(NS)
Bursa	0	0%	1	10%	
Tendon & Pulley	4	15.4%	1	10%	
Other	2	7.7%	0	0%	
Thickening of tendon					
Absent	19	73.1%	1	10%	0.002
Present	7	26.9%	9	90%	(S)
Degenerative changes in tendon					
Absent	26	100%	9	90%	0.278
Present	0	0%	1	10%	(NS)
Limited mobility					
Absent	1	3.8%	1	10%	0.484
Present	25	96.2%	9	90%	(NS)
Thickening of pulley of tendon					
Absent	20	76.9%	8	80%	1.000
Present	6	23.1%	2	20%	(NS)
Disruption of continuity of subcutaneous fascia					
Absent	20	76.9%	9	90%	0.645
Present	6	23.1%	1	10%	(NS)
Thickening of subcutaneous fascia					
Absent	18	69.2%	9	90%	0.392
Present	8	30.8%	1	10%	(NS)
Fracture with abnormal articulation					
Absent	25	96.2%	10	100%	1.000
Present	1	3.8%	0	0%	(NS)
Synovial thickening					
Absent	26	100%	9	90%	0.278
Present	0	0%	1	10%	(NS)
Joint effusion					
Absent	24	92.3%	9	90%	1.000
Present	2	7.7%	1	10%	(NS)
Nodule					
Absent	22	84.6%	10	100%	0.559
Present	4	15.4%	0	0%	(NS)
Fluid in tendon sheath					
Absent	25	96.2%	0	0%	<0.001
Present	1	3.8%	10	100%	(HS)
Cyst					
Absent	20	76.9%	10	100%	0.157
Present	6	23.1%	0	0%	(NS)

S: Significant; NS: Nonsignificant

Management of non-inflammatory conditions was mainly surgical and that of inflammatory conditions was mainly conservative. The difference between the 2 groups was significant (Table 5).

Table (5): Comparison between inflammatory conditions and non-inflammatory conditions regarding management

Management	Diagnosis				Chi-square test	p-value (Sig.)
	Non-inflammatory (N=26)		Inflammatory (N=10)			
	No.	%	No.	%		
Conservative	1	3.8%	8	80%	22.338 ^a	<0.001
Surgical	25	96.2%	2	20%		(HS)

HS: Highly significant.

Figures 3-6 present examples of some of the studied cases.

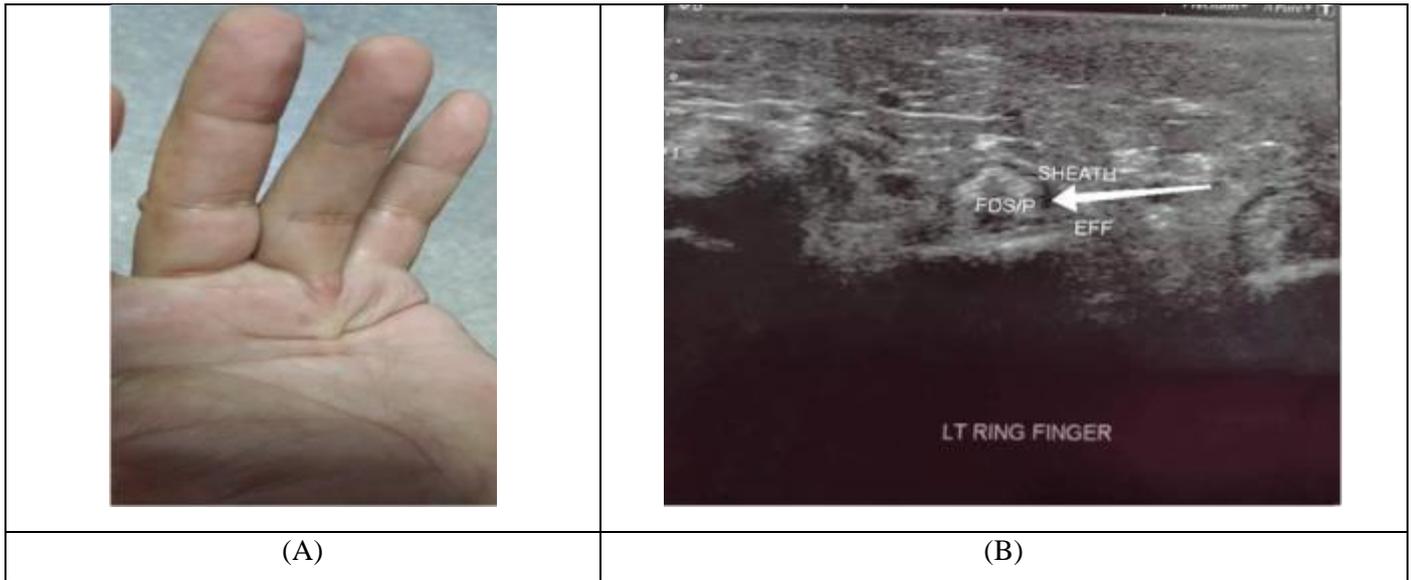


Fig. (3): Male patient, 40 years old with history of stiffness when moving of the left (LT) ring finger with pain at the base of the finger (picture a). MSUS examination reveals, as illustrated in picture b; Sonogram (T.S. view) on the LT ring finger: There is mild effusion around FDS/P tendon opposite the metacarpal head of the LT ring finger: stenosing tenosynovitis.

Management: Physiotherapy with medical treatment.

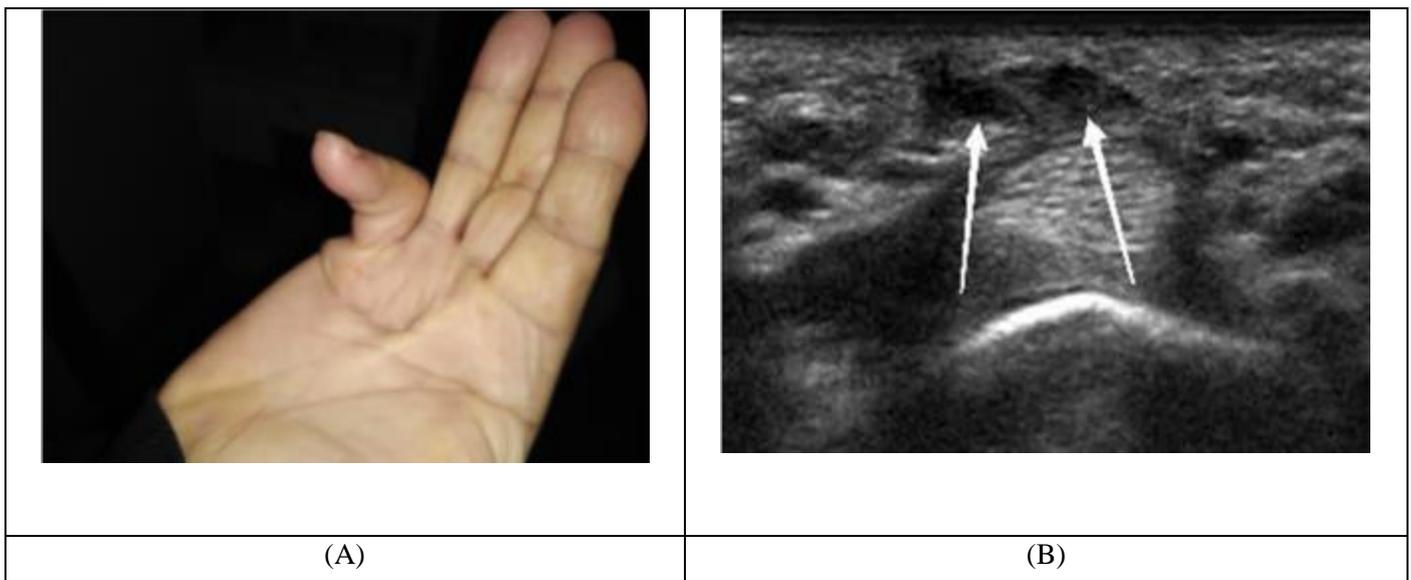


Fig. (4): Female patient, 53 years old with history of flexion deformity of LT little finger (picture a). MSUS examination reveals, as illustrated in picture b; Sonogram (TS view) on the palm of the LT hand: There was hypoechoic nodule (arrowhead) about 10x4 mm seen superficial to the flexor tendon in the superficial fascia with no internal vascularity.

Management: Surgery

Surgical finding: Thickening of palmar aponeurosis with formation of nodule of fibrous tissue.

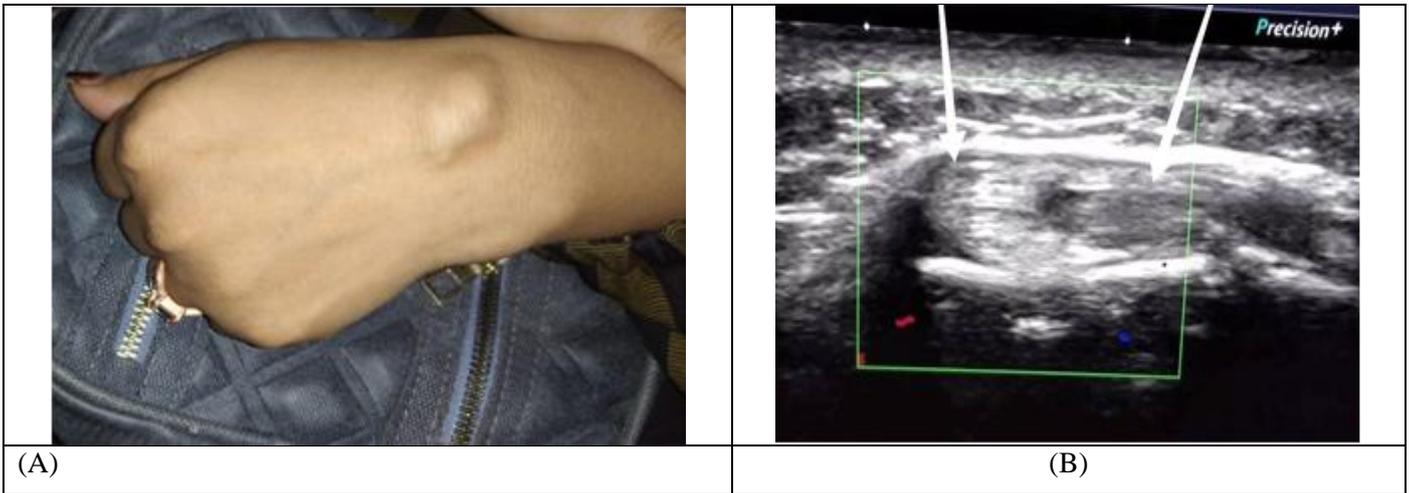


Fig. (5): Female patient, 25 years old with history of swelling on the dorsum of the LT hand that was gradually increased in size with painful extension of the middle finger (picture a). MSUS examination reveals, as illustrated in picture b; Sonogram (L.S. view) on the dorsum of the LT hand: There is well defined lesion measuring about 14x7x14 mm, it has thick wall and turbid fluid and it related to the underlying extensor tendon of the middle finger >>> complicated ganglion cyst.

Management: Surgery.

Surgical finding: There is firm fluctuant mass arise from the sheath of the extensor tendon of the middle finger.

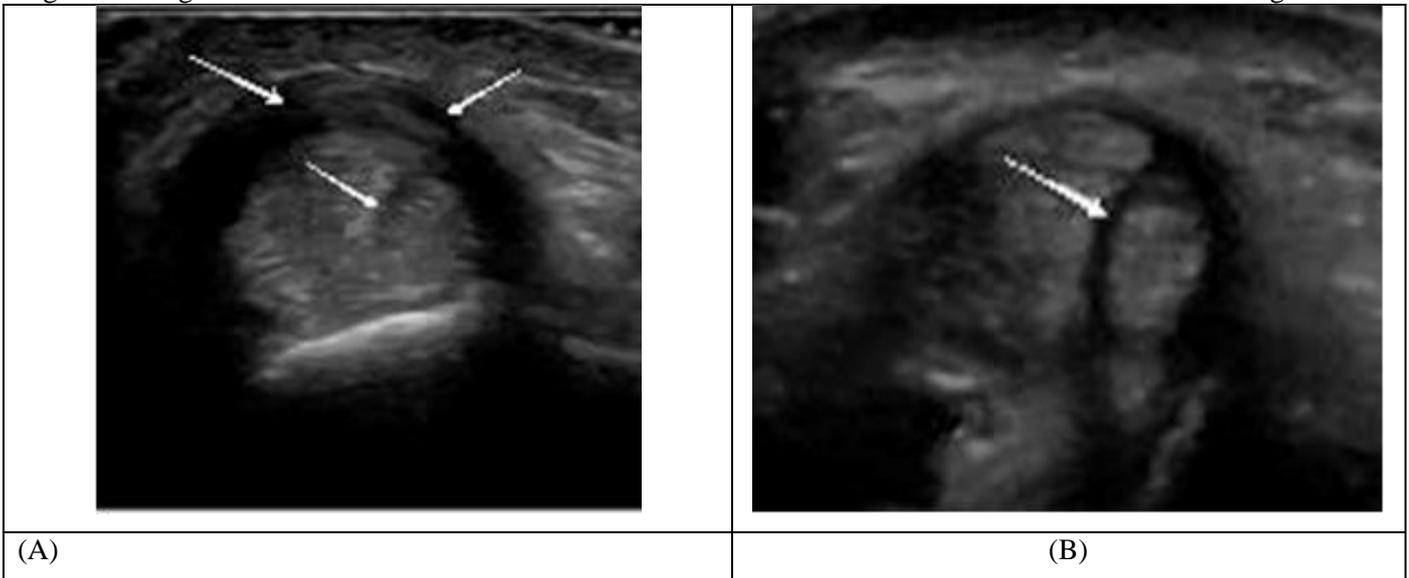


Fig. (6): Female patient 35 years old with history of painful movement of RT thumb. MSUS examination reveals: as illustrated in picture a and b; Sonogram (T.S. view) on RT thumb: In picture a, as a result of the swelling, the EPB and APL tendons have grown in size and the overlying extensor retinaculum has thickened (arrows' tips). In picture b, unlike the APL, where the retina is thin and clear, the EPB's retina remains thicker.

In both US pictures, between the APL and EPB tendon slips, a vertical fibrous septum (arrow in a and b) can be observed dividing the first dorsal compartment into two parts: de Quervain's tenosynovitis.

Management: Surgery.

Surgical finding: Thickened fascia around the first compartment tendon.

DISCUSSION

The accuracy of ultrasonographic (USG) evaluation of hand anatomy has risen dramatically in recent years. Due to the superficial position of most tendons and the advancement in resolution and frequency of modern ultrasound equipment, the spectrum of tendon anomalies can be easily represented with USG⁽¹⁾.

Hand and finger tendon anomalies are extremely frequent, especially among athletes and the elderly. They could be the result of degenerative changes causing pain, inflammation, or a rupture. Pain and dysfunction frequently result from tendon diseases. Overuse and age-related tendon degradation are the leading causes of chronic tendon problems, making them far more common than acute injuries⁽⁶⁾.

Our results showed that tendon entrapment of the hand and wrist were more common among female rather than male patients. This result was similar to that of **Haugen et al.**⁽⁸⁾ whose results showed that the prevalence of tendon entrapment was higher in women (54.2%) than men (45.8%) and **Cooper et al.**⁽⁹⁾ whose results showed that tendon entrapment was higher in women (62.3%) than men (37.7%) with P value < 0.001. It was found that the anatomical differences between the sexes, namely in the form of the trapezoidal surfaces, account for the observed gender difference in CMC joint congruence.

Our study showed that the age of patients ranged from 11 to 67 years old with mean 36.19±15.12. This was similar to study of **Dahaghin et al.**⁽¹⁰⁾ whose result showed that tendon entrapment was present in people aged 25–62 years.

In the present study the percentage of patients with forceful occupation was equal to that unemployed patient, so that in our study there was no relation to occupation. The dominant hand was the right hand in 32 patients (88.9%) and the left hand in 4 patients (11.1%). This was in concordance with the studies done by **Haara et al.**⁽¹¹⁾ and **Fontana et al.**⁽¹²⁾, which found that no significant association was found between the physical workload history and tendon entrapment.

Our results were also in agreement with the study of **Ceceli et al.**⁽¹³⁾ who showed that the hand pain and tenderness, and swelling were most common findings in tendon entrapment cases. On other hand, the study of **Kortekaas et al.**⁽¹⁴⁾ reported that tenderness was found in 63.4% of patients and synovitis (32%).

Our results coordinate with **El-Deek et al.**⁽¹⁵⁾ study, who used USG to evaluate tendon anomalies in the hands and fingers. Tenosynovitis was found in 20 of 20 instances (100 percent), trigger finger in 8 of 10 cases (80 percent), tendon rupture in 10 of 12 cases (83.3 percent), foreign body impaction in 3 of 3 cases (100 percent), simple ganglion in 12 of 12 cases (100 percent), and solid masses in 3 of 3 cases (100 percent).

Tendon tears can be detected with a high degree of sensitivity and specificity using US, as reported by **Hodgson et al.**⁽¹⁶⁾. This agrees with the findings of **Tahmasebi et al.**⁽¹⁷⁾, who found even greater precision (90.2%) and sensitivity (97.9%), when diagnosing a problem with a tendon.

Our study agreed also with **El-Deek et al.**⁽¹⁵⁾ where giant cell tumor of tendon sheath was detected in 12 of 12 instances (100%) of simple ganglions connected to tendon sheathes and in 3 of 3 cases (100%) of solid lesions related to tendon sheathes with intact fibres of the tendon.

In the current study trigger finger was present in (19.4%) of the cases. In the study of **Abdelrahman et al.**⁽⁵⁾ trigger finger sonographic appearance in 33 patients was evaluated using a 7-15 MHz probe. Twenty patients without trigger fingers served as a control group. All patients with trigger fingers were found to have a thickened A1 pulley that was hypoechoic. Increased blood flow to the area. Forty-eight percent of trigger fingers had flexor tendinosis, fifty-five percent had tenosynovitis, and thirty-nine percent had both. There were no cases of tenosynovitis or tendinosis in the control group. They concluded that: Sonography findings unique to trigger fingers include A1 pulley thickening and hyper-vascularization. Tenosynovitis and tendinosis of the distal flexors are two other common diagnoses.

In the current study postoperative fibrosis present in (11.1%), which is in accordance with **Zeidenberg et al.**⁽¹⁸⁾ who reported that after an injury, HRU can tell the difference between a traumatic neuroma, which is caused by fibroblast infiltration, and a ruptured nerve bundle. The uneven, hypoechoic region encircling a lesion and entrapping a scar is called scar entrapment.

In our study, tenosynovitis was diagnosed in 27.8%, which was presented with or without thickening in comparison to contralateral side augmented by dynamic US to rule out partial tear or ruptured tendon and also Doppler revealed increased vascularity. That were in accordance with **Chiang et al.**⁽¹⁹⁾ and **Robinson**⁽²⁰⁾ who said that early tendinopathy was diagnosed if we found tendon thickening.

In the current study de Quervain's disease exhibited 5.6% of our cases. **Robinson**⁽²⁰⁾ studied people with de Quervain disease to see whether he could prove that ultrasonography (US) is beneficial for detecting anatomic changes in the first extensor compartment of the wrist. Thirteen women (ranging in age from 41 to 62) with a clinical diagnosis of de Quervain illness and who required surgery for chronic pain had 15 wrists included.

In our study management of inflammatory conditions was conservative in 8 cases (80%) and surgical in 2 cases (20%). **Golas et al.**⁽²¹⁾ reported that digits that were symptomatic for 3 months or less were more likely to resolve after conservative treatment than those that were symptomatic for more than 3 months.

Stenosing tenosynovitis is more likely to respond to nonoperative therapy when treated before 3 months.

CONCLUSION

When tendon abnormalities (tenosynovitis, trigger finger, tendon tear, tendon associated masses, and foreign body) of the hands and fingers are suspected, ultrasonography of the hands should be a vital part of the imaging routine, because it is a strong, simple, and cheap imaging technology that provides the highest level of diagnostic confidence.

Ultrasound has many benefits, such being non-ionizing, real-time, multi-planar, and invasive-free. It's a quick process that requires little to no prep time for the patient. It's cheap and widely accessible. It can resolve fine spatial details.

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Conflict of interest: The authors state no conflict of interest.

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