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Ultrasonography Role for Evaluation of Hand Tendon Injuries

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ABSTRACT

Background: Most tendons injuries are open injuries to the flexor or extensor tendons, but less frequent injuries. Ultrasound (US) and MRI used as a diagnostic tool for tendon injuries.

Objective: This study aimed to investigate the overall accuracy of the bedside tendon ultrasonography, which can be used to the diagnosis and discharge planning in patients with suspected hand tendon injuries.

Patients and methods: A cross sectional study included 24 patients diagnosed with a hand tendon injuries either preoperative or postoperative and carried out in the Department of Radiodiagnosis at Zagazig University Hospitals. Preoperative ultrasound was performed to the affected tendon to perform multisectional scans without flexion or extension of the wrists in all cases. The unaffected hand and fingers were also examined in the same fashion as the affected fingers for comparison.

Results: There was significant increase in number of patients presented with injury preoperatively who didn't present with nerve injury. There was significant change in number of patients presented with either single or multiple tendon injuries. There was significant increase in frequency in patient without foreign body. There were two patients with ultrasonographic features of tendon injury had no tendon injury proven by surgery with sensitivity of 91.7 %. There was significant increase in number of patients presented with tendon injury**.** US can detect tendon injury with 100% sensitivity, 91.7% positive predictive value and 91.7% accuracy.

Conclusion: Ultrasound is a useful diagnostic tool for modality of predicting and diagnosis of a tendon rupture in hand injuries.

Keywords: Nerve injury, Tendon Injuries, Ultrasonographic features, Ultrasonography.

INTRODUCTION

Tendon injuries are the second most common injuries in the hand after fractures [(1)]. Most injuries are direct injuries to the tendons, but less frequent indirect traumas may cause damage to the tendon, tendon sheath, and pulley system. The recognition of a tendon rupture is usually based on the physical examination and history. An acute loss of motion, a patient's report of hearing a popping sound during the injury and the final position of the finger generally demonstrates a tendon rupture. However, imaging is necessary for diagnosis, especially in complicated cases [(2)].

Tendon ruptures are uncommon but may cause severe initial pain and lead to permanent disability if untreated. Tendon ruptures can usually be diagnosed by clinical assessment. X-rays and ultrasound are used to establish or confirm the diagnosis. Patients aged over 60 years are more prone to tendon damage and therefore tendon rupture. Younger people can also be at increased risk associated with sporting activities [(3)].

US can also be used to detect iatrogenic tendon lesions in the postoperative period. Extensor tendon injuries are commonly encountered after fixation of distal radius fractures with palmar locking plates. Tenosynovitis and partial/complete tendon rupture in the extensor compartment are commonly encountered complications after an operation [(4)]. Tenosynovitis can be diagnosed easily with the presence of an effusion or thickening of the synovium around the tendons [(5)].

The main objective of tendon surgery is to restore satisfactory function of the tendon. Indications and surgical techniques vary, and the ultrasound (US) appearance of an operated tendon depends on many factors, which must be known to the US operator before the examination is carried out [(6)].

Healing of the tendon stumps in case of simple end-to-end suture leads to focal thickening called "tendon callus". In these cases, a thinned tendon is highly suggestive of re-rupture [(7)]**.** Diagnosis of re-rupture of the tendon can be difficult depending on the location of the lesion; time elapsed from surgery and surgical technique [(8)].

The purpose of this study was to investigate the overall accuracy of the bedside tendon ultrasonography, which can be used to the diagnosis and discharge planning in patients with suspected hand tendon injuries.

PATIENTS AND METHODS

A cross sectional study included 24 patients diagnosed with a hand tendon injuries either preoperative or postoperative and carried out in the Department of Radiodiagnosis at Zagazig University Hospitals.

Inclusion criteria: Patients who had a history of acute hand tendon injury. Patients who had residual symptoms of pain, swelling, or instability after conservative treatment including rest, analgesia, hand guard, and physiotherapy for at least 6 weeks. Patients who had positive clinical findings suggestive of hand tendon injuries. Postoperative tendon repair complicated with re-rupture.

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Exclusion criteria: Patients with recent or old rheumatologic, orthopedic hand disorder, arthritis, tendinitis or infections.

Clinical assessment:

All patients were subjected to the following:

1- History taking that includes age, gender, occupation, phone number and hand affected. History of the present condition: the onset of the disease duration, course, progression, relieving factors, aggravating factors and medications received. Any previous treatments and their types whether surgical or medical, any previous imaging procedures were recorded.

2- Proper musculoskeletal examination of injured hand tendons including signs of tendon injury.

3- Diagnosis of associated nerve injury, which include signs and symptoms (pain, numbness, sensation of tightness)

4- Ultrasound Examination:

- An ultrasound SIEMENS machine with high-frequency linear transducer (7-15 MHz) with a thick layer of coupling gel. Participants were asked to rest their hand on the trolley or on their lap in a comfortable position.
- In a sitting or supine position, the affected hand and fingers were fully exposed, and the probe was moved longitudinally and transversely along the affected tendon to perform multisectional scans without flexion or extension of the wrists in all cases. The unaffected hand and fingers were also examined in the same fashion as the affected fingers for comparison. The finger was then moved passively to observe the gliding motion of the tendons. Optimal technique involved adjusting the gain, depth and focus to produce the best image. It was also necessary to modify the angle of the probe to avoid the anisotropy artifact.
- US examination had showed whether the tendons (of an immobile finger) are intact or ruptured. Further, in case of a rupture, determining the exact location of the proximal stump can precisely navigate the onward surgery as well. At rest, the tendons were evaluated for evidence of tears, rupture and postoperative complications. With complete rupture, the distance between the two ends or stumps of the ruptured tendons was measured.

Ultrasound findings: US examinations has showed the following features: the tendon (thickness, width, contours, continuity), structure (homogeneity, echogenicity), mobility of the tendon and peritendinous tissues.

Intratendinous and peritendinous color Doppler US: Right after surgery: No vascularization is visible at color Doppler US. One month intratendinous vascularization can be seen and at 3 months intratendinous hypervascularization, and at 6 months: Stabilization and regression; pathological scarring may occur after this moment. Changes in peritendinous vascularization are not sufficiently codified [8].

For the evaluation of the tendon rupture:

Preoperative ultrasound was performed, analyzed the presence of five sonographic features: (1) Discontinuity of the tendon. (2) Decreased echogenicity of the tendon compared to normal tendon. (3) Retraction of the ruptured tendon ends. (4) Fluid collection within the tendon sheath. (5) Motion of the tendon on a dynamic study.

Ethical approval:

The study was approved by the Ethical Committee of Zagazig Faculty of Medicine. An informed consent was obtained from all patients in this research. Every patient received an explanation for the purpose of the study. All given data were used for the current medical research only. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

Data analysis was performed using the software SPSS (Statistical Package for the Social Sciences) version 20. Quantitative variables were described using their median and range. Qualitative data were presented as frequency and percentage and were compared by Fisher's exact test. The level statistical significance was set at 5% ($P<0.05$). Highly significant difference was present if $p\leq0.001$.

RESULTS

The present study showed that age ranged from 2 to 49 years and median was 8.5 years. Males constituted larger percentage of patients **(Figure 1)**.

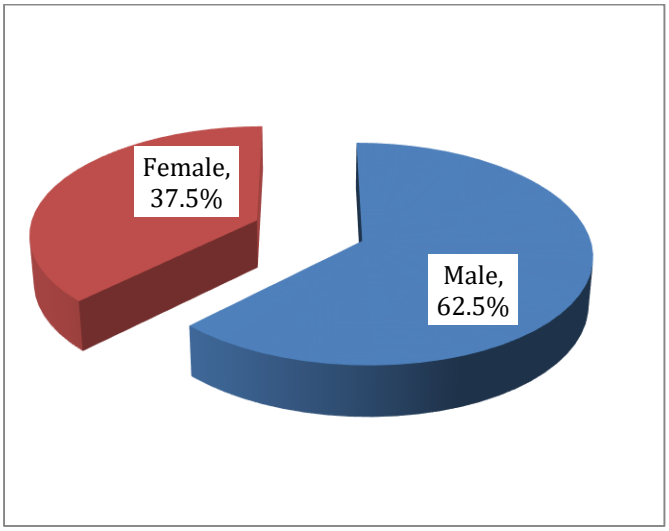

Figure (1): Pie chart showing distribution of the studied patients according to the gender

There was significant increase in number of patients presented with injury preoperatively than postoperatively **(Table 1)**.

Table (1): Distribution of the studied patients according to the time of presentation

Time	N=24	%	One sample p value
Preoperative Postoperative	19 5	79.2 20.8	0.007*

*: Statistically significant

There was a significant number of patients who did not present with nerve injury **(Figure 2)**.

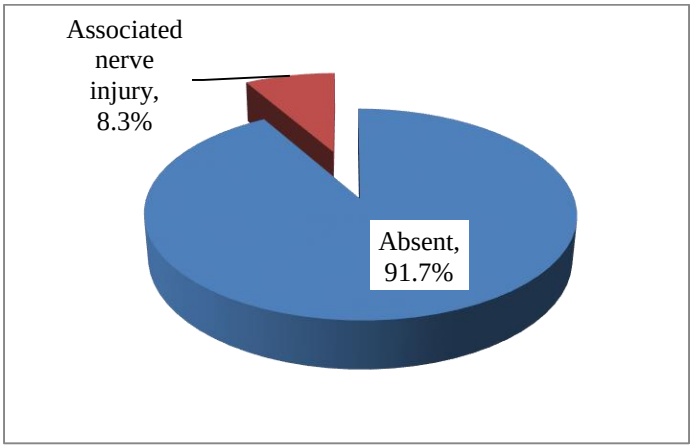

Figure (2): Distribution of the studied patients according to the associated nerve injury

There was significant change in number of patients presented with either single or multiple tendon injuries. Larger percentage of patients had multiple tendon injuries **(Table 2)**.

Table (2): Distribution of the studied patients according to the tendon rupture

Rupture	N=42	%	p
Complete **Partial**	**35** **7**	**83.3** **16.7**	**<0.001****

**: Statistically highly significant

There was significant increase in frequency in patient without foreign body in tendon **(Table 3)**.

Table (3): Distribution of the studied patients according to foreign body in the tendon

Foreign body in tendon	N=24	%	p
Absent **Present**	20 4	83.3 16.7	0.002*

*: Statistically significant

There was significant increase in frequency of patients with flexor surface than in the extensor surface **(Table 4)**.

Table (4): Distribution of the studied patients according to the affected tendon

Tendon	N=42	%	p
Flexor **Extensor**	**36** **6**	**85.7** **14.3**	**<0.001****

**: Statistically highly significant

There were two patients with ultrasonographic features of tendon injury had no tendon injury proven by surgery with sensitivity of 91.7 %. There was significant increase in number of patients presented with tendon injury **(Figure 3)**.

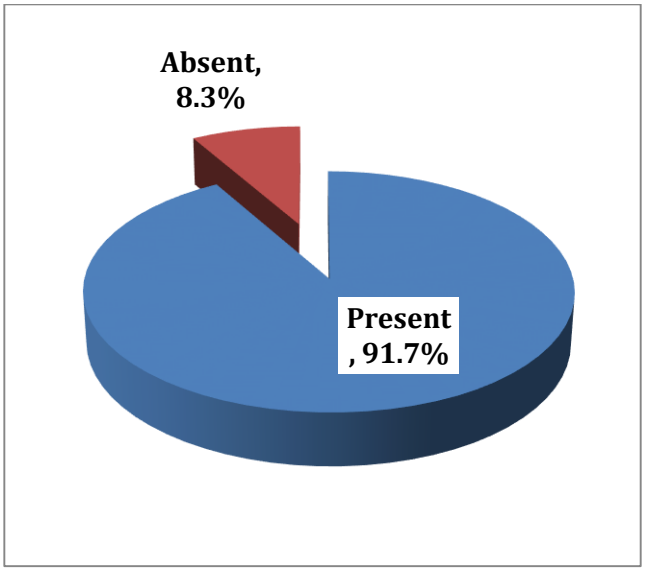

Figure (3): Distribution of the studied patients according to presence of tendon injury proven by surgery

US could detect tendon injury with 100% sensitivity, 91.7% positive predictive value (PPV) and 91.7% accuracy **(Table 5)**.

Table (5): Performance of US in diagnosis of tendon injury as proven by surgery

Sensitivity	Positive predictive value	Accuracy
100%	**91.7 %**	**91.7%**

DISCUSSION

The wrist and hand are the most important functional parts of the body in the daily life activities and are prone to traumatic injuries. Although these injuries are not life-threatening, the accepted treatment strategy for traumatic injuries is immediate reconstruction of all injured tissue structures [(9)].

Most of tendons injuries are open injuries to the flexor or extensor tendons, but less frequent injuries [(1)]. Ultrasound is an excellent imaging modality as it is relatively safe, inexpensive and portable [(10)]. The sonographer may be able to scan directly over the site of pain and can compare the appearance of structures in the injured hand with those in the non-injured hand [(11)].

This study was conducted on 24 patients with tendon injuries to assess the ultrasound role in diagnosis and management of hand tendon injuries.

Our study showed predominance of male gender (15 male and 9 females). Also there was 85.7% of the studied cases had flexor tendon injury and 14.3 % had extensor tendon injury. There was no selection criterion of our study regarding the type of injured tendon. This

results are in agreement with **Hall** [12] who studied 30 patients with hand tendon injury, with male predominance (17 male and 13 females), 50% of them with extensor surface injuries and 36% with flexor surface injuries and 9.1% of fingertip injuries.

In a study of **Lee *et al.*** [9] they studied 24 patients, they consisted of 10 men (42%) and 14 women (58%). The mean age was 47.0 years old (range; 14–73 years old). Limited range of motion in the injured fingers was the most common reason for sonographic evaluation in 18 patients. Other reasons were pain, swelling and deformity of the injured finger. All patients were clinically diagnosed with a full-thickness tear of the affected tendon on sonography and confirmed the same findings during surgery.

Sonographic findings of complete ruptures reveal complete interruption of tendon fiber continuity. Close to injury, the tendon is hyperechoic and thickened, with a loss of the fibrillar echo texture [13].

In another study, **Lee *et al.*** [14] evaluated thirteen injured digits in ten patients using real-time ultrasonography and reported that sonography accurately identified the status of the flexor tendon in 18 of 20 cases (90%).

In our study, the most affected tendon was the flexor pollicis longus of the thumb. The extensor pollicis longus tendon is a highly vulnerable structure due to its superficial location at the dorsum of the wrist [15]. Spontaneous rupture of the extensor pollicis longus tendon may be preceded by distal intersection syndrome [16]. Therefore, the extensor pollicis longus tendon might display the high frequency seen in pseudomass formation because of its superficial location and its specific course crossing over the extensor carpi radialis tendon [9]. In contrast, **Lee *et al.*** [9] found that among 24 patients in their study, the commonly affected tendon was the extensor pollicis longus tendon with the thumb. For cases of extensor tendon injury scanned by high-frequency ultrasound can aid to confirm the diagnosis, with dynamic imaging providing added value compared with static [17].

In our study 19 cases were preoperative (79.2%) and 5 cases were postoperative (20.8%). Only two cases of associated nerve injury (median nerve) were detected (8.3%). Two patients with ultrasonographic features of tendon injury had no tendon injury proven by surgery with percentage (8.3 %). one case is postoperative complete tendon tear of flexor pollicis longus (FPL) (false positive may be due to small gap 2 mm, adhesions or callus formation), another case is preoperative partial thickness tendon tear of fourth finger with small amount of fluid collection.

In a study of **De Maeseneer *et al.*** [18] they reported that ultrasound correctly identified all five cases of extensor pollicis longus tendon tears. The normal tendon was replaced by a tubular hypoechoic or slightly heterogeneous area at the proximal carpal level. As shown intraoperatively, that area corresponded to a synovial sheath distended by fluid, hemorrhage, or scar tissue. Also, **Santiago *et al.*** [19] revealed the sonographic findings of tears of the extensor pollicis longus tendon confirmed by CT, MRI, and surgical findings. They revealed that a gap between the ruptured tendon stumps, seen as a hypoechoic string, consisted of degenerative tissue with inflammatory changes and histiocytic and lymphocyte infiltration in the three cases with pathology reports.

The value of US in post-traumatic nerve tears is twofold: confirmation of the clinical and electromyographic diagnosis and assessment of the level of injury. In complete tears, there is an irregular hypoechoic area interposed between the nerve ends due to inflammatory changes [20]. Because the nerves in the fingers are close to the tendons, a cut may damage them as well so numbness occur on one or both sides of the finger [21].

In four cases of the present study foreign body was detected (16.7%). Ultrasonography allows detection of a variety of soft-tissue foreign bodies along with evaluation of their associated soft-tissue complications. Detection is important because retained foreign bodies may lead to serious infectious and inflammatory complications [22].

There were some limitations in our study. The concept of the ultrasound is an operator-dependent technique and this was usually compromised by the frequent practice under supervision of experienced seniors and second look examination if there was a need for this, and the last one is the lack of long term follow up examinations for most of repaired lesions.

CONCLUSION

Ultrasound is a useful diagnostic tool for modality for predicting and diagnosis of a tendon rupture in hand injuries.

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