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The Role of Ultrasound in the Preoperative Evaluation of Flexor Tendon Injuries of the Hand

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Abstract

Tendons abnormalities of the hand and the fingers are common disorders, particularly among athletes and in the elderly and are a common cause of pain and loss of function. The quality of ultrasonographic (USG) assessment of anatomical structures in the hand has highly improved over the last decade. The development of high resolution with the highest possible frequency of modern ultrasound equipment and the superficial location of most tendons allows the spectrum of tendon abnormalities to be easily depicted with USG. The role of USG in the assessment of tendon disorders is steadily increasing due to its low cost, fast, widespread availability, and non-invasiveness together with the possibility that it offers a dynamic assessment. The primary purpose of this study was to investigate the overall accuracy of preoperative ultrasound of hand flexor tendons performed by radiologists in the emergency setting. We also sought to investigate whether or not bedside tendon ultrasonography can be used in addition to physical examination to expedite the diagnosis and discharge planning in patients with suspected tendon injuries. This study was conducted at the Radiodiagnosis section of the Emergency Department. It included 34 patients with age ranging from 16 to 55 years (mean ± SD = 32.0 ± 13) complaining from pain or loss of flexion of the hands and the fingers, referred for assessment of tendons. There were 58.8% male and 41.2% female patients. The results of ultrasound as well as physical examination, were then separately compared to operative findings. The age of the study group ranged from 16 to 55 years (mean ± SD = 32.0 ± 13). The male patients represented the majority of our cases. We noted that there was no predilection for the side injured. Only 4 patients with previously repaired torn flexor tendons were examined suspected of re-ruptured tendons following re-injury. In this study, the US demonstrated a sensitivity, specificity, and accuracy of 100%, 95%, and 97%, respectively. Physical examination had a sensitivity, specificity, and accuracy of 100%, 76%, and 85%, respectively. Average time to bedside ultrasound was 46.3 minutes compared with 138.6 minutes for wound irrigation and exploration or surgery consultation. USG of hands should be a fundamental part of the imaging protocol when tendons abnormalities of the hands and the fingers (tenosynovitis, trigger finger, tendon tear and foreign body) are suspected, as it achieves the highest level of diagnostic confidence as it is powerful, easy, and inexpensive imaging tool.

Keywords: Musculoskeletal Ultrasound; Hand and Wrist Injuries; Tendon Lacerations; Flexors; Imaging Studies

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Introduction

The hand is the most commonly injured part of the body. It is estimated that 10% of all presentations to Emergency Departments are the result of hand injuries Unfortunately tendon injury may be overlooked on routine clinical examination as there is no clinical test that can reliably detect partial lacerations. The consequences of missed tendon injury can be devastating for the patient. If a fixed deformity of the finger develops as a result of misdiagnosis, the patient's ability to work and perform normal activities of daily living may be compromised [1].

Assessment of hand injury is a difficult task in the Emergency Department. The anatomy of the hand is very complex and the relationship of anatomy to function is still not entirely understood wounds are difficult to examine as the ooze of blood often obscures the field of view. A patient's inability to move a joint may be due to pain or fear and not due to an anatomical abnormality [2].

The Emergency Physician must decide which injuries warrant further exploration in the operating theatre and which injuries can be managed within the Emergency Department. The decision must be made under the pressure of time and with an awareness of the limited availability of emergency-list operating time in most public hospitals comparatively recent advances in ultrasound technology have made detailed examination of finger tendons possible. Partial tendon and complete tendon lacerations can be detected [3].

Aim

The primary purpose of this study was to investigate the overall accuracy of preoperative ultrasound of hand flexor tendons performed by radiologists in the emergency setting. We also sought to investigate whether or not bedside tendon ultrasonography can be used in addition to physical examination to expedite the diagnosis and discharge planning in patients with suspected tendon injuries.

Patients and Methods

This study was conducted at the Radiodiagnosis section of the Emergency Department. It included 34 patients with age ranging from 16 to 55 years (mean ± SD = 32.0 ± 13) complaining from pain or loss

of flexion of the hands and the fingers, referred for assessment of flexor tendons. There were 58.8% male and 41.2% female patients.

Patients were subjected to full clinical history including the patient's name, age, sex, complaint (hand and finger pain or swelling), and associated symptoms. Clinical examination was made by the referring physician.

Technique

USG examinations were performed with TOSHIBA (Xario 200) using superficial linear transducer 7.5 MHZ. During superficial USG examination of the hand and fingers, the patient was examined while sitting upright, the patient puts the hand in supinated position. We move the transducer axially from proximal to distal. The palm is divided into three spaces by two septa passing from the palmar aponeurosis to the thumb and little finger metacarpals. The lateral space contains thenar muscles, the medial contains hypothenar muscles, and the central contains long flexor tendons, lumbricals, the superficial and deep palmar arches, and median nerve.

For the examination of the flexor tendons of the fingers, namely the flexor digitorum superficialis and flexor digitorum profundus, we move the transducer to the fingers. Axial and longitudinal plane images should be obtained over this tendon. Finally, the surgical finding was reviewed with the US scan findings.

Ethical statement: The study was approved by the scientific and ethical committee of the hospital. Written and verbal consents were obtained from all patients.

Statistical Analysis

Data were statistically described in terms of mean ± standard deviation (± SD), and range, or frequencies (number of cases) and percentages when appropriate. All statistical calculations were done using computer program SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) Release 15 for Microsoft Windows (2006). Chi squared was used for statistical correlation and Significance is defined as $P < 0.05$.

Results

This study included 34 patients, with an age range from 16 to 55 years (mean ± SD, 32 ± 13.0). They presented with loss of finger flexion raising the suspicion of flexor tendon tears. This diagnosis was confirmed later on by surgical correlation and postoperative follow-up. Based on direct wound exploration, 4 patients had partial tendon injuries, 9 patients had complete tendon injury, and 21 patients had no evidence of tendon injury noted. Over all, USG correctly diagnosed the extent of tendon injury in 33 of the 34 total cases (sensitivity, 100%; specificity, 95%). In comparison, physical examination accurately diagnosed 29 of the 34 total cases (sensitivity, 100%; specificity, 76%) (Table 1).

On average, time to diagnosis and disposition based on ultrasound findings was 46.3 minutes. In contrast, overall time to wound exploration or surgical consultation was 138.6 minutes. Of all patients enrolled, none had incomplete data collected or were lost to follow-up (Table 2).

Our study demonstrated that US could clearly differentiate partial and complete flexor tendon lacerations in patients who either presented to the ED following a recent trauma or those who sustained a re-injury to a previously repaired hand flexor tendon.

Discussion

Ultrasonography is a relatively inexpensive, non-invasive tool that allows rapid, real-time imaging of the musculoskeletal system with sensitivities and specificities approaching 100%. It can be used at the bedside to augment the physical examination findings and provide useful data that can be used to expedite diagnosis and disposition [4].

This prospective study demonstrates that ultrasound was able to accurately identify the extent of tendon injury in 97% of the patients evaluated (33 of 34 patients). In contrast, physical examination was only able to correctly identify the extent of tendon disruption in 86% of enrolled patients ($P = 0.221$).

Of the 34 patients evaluated, one case was misdiagnosed with a partial tendon disruption on bedside ultrasound. The patient ultimately did not demonstrate any tendon injury on bedside wound irrigation and exploration. The false-positive ultrasound interpretation was felt to be due to anisotropy. When scanning tendons in a longitudinal plane, the tendon fibers will appear bright white and hyperechoic when the transducer is placed parallel to the course of the fibers. If the ultrasound beam is angled obliquely against the tendon fibers, a hypoechoic artifact may be noted. This hypoechoic artifact can lead to a false-positive interpretation of the ultrasound images. Anisotropy can lead to misinterpretation of sonographic findings by inexperienced users [5].

In evaluating our data, it was interesting to discover the low overall accuracy and specificity of the physical examination in the diagnosis of extremity tendon lacerations. Physical examination of the hand in a cooperative and fully functional patient can often miss partial tendon injuries because range of motion can be preserved with up to 90% tendon injury. If practitioners were to rely on physical examination findings alone, many patients may be misdiagnosed and suffer from significant tendon disruptions that manifest deficits later down the road [6,7].

Table 1: Performance of ultrasound evaluation of tendon lacerations as compared with physical examination findings. Significance is defined as $P < 0.05$.

		Surgical findings		Sensitivity	Specificity	Accuracy	P value
		No injury	Injury				
Ultrasound	**No injury**	20	0	100%	95%	97%	
	Injury	1	13				0.221
Physical examination	**No injury**	16	0	100%	76%	85%	
	Injury	5	13				

Table 2: Average time to diagnosis by ultrasound and average time till confirmation of findings by surgical exploration. Significance is defined as $P < 0.05$.

	Mean (min)	Median (min)	Number	P-value
Time to Ultrasound	46.3	28	34	<0.0005
Time to Surgical Exploration	138.6	106	34	

Conversely, false-positive diagnoses are also not without risk. In the ED, it is not uncommon to care for patients who cannot fully participate in their physical examination. Lack of effort, intoxication, altered mental status, neurological injury, or presence of an associated fracture or foreign body can make their physical examination findings unreliable [8,9].

For suspected partial tendon injuries, ultrasound has been used successfully to look for signs of partial damage as swelling or discontinuation of the tendon [10].

Using ultrasound, partial tendon lacerations that may have been missed on physical examination can be diagnosed accurately in the acute phase. Early diagnosis and treatment of these partial tendon lacerations can prevent complete rupture and the need for future surgical repair [11,12] (Figure 1).

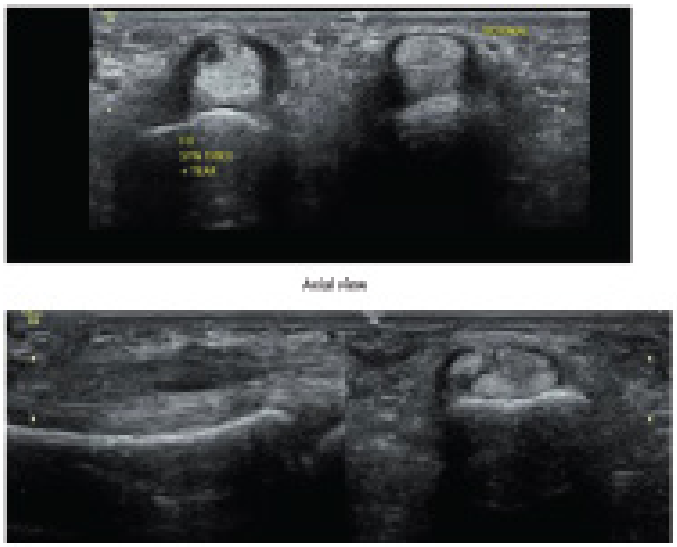

Figure 1: 45 years old female patient presented with pain at ring finger with movement, there is intrasubstance hypoechoic area seen in flexor tendon of ring finger at proximal phalanx associated with thickened synovium denoting a partial tendon tear.

Data from the ultrasound not only enhanced time to diagnosis and disposition but also provided helpful information that was used to aid in tendon repair. In a few cases, ultrasound evaluation of the injury site helped delineate the location of the ends of the disrupted tendon, therefore minimizing the amount of local tissue damage sustained from blind exploration attempts during the repair [2,13,14].

Jacob D, et al. (2007) reviewed the contribution of ultrasound in tendon lesions of the wrist and hand and concluded that plain radiography in addition to ultrasound should be the first line tool in the diagnosis of both traumatic and non-traumatic tendon lesions [15]. Wang PT, et al. (1999) used ultrasonic assistance in the diagnosis of flexor tendon injuries and showed that US was used to make correct preoperative determinations in six of the eight patients they studied [11]. They concluded that US was useful in evaluating equivocal flexor tendon injuries.

In a study of 98 investigations, Read JW, et al. (1996) analysed a wide-range of injuries and a positive predictive value of 100% was reported for tendon ruptures, tendonitis, and foreign bodies [4].

Lee DH, et al. 2000 described an accuracy of 90% in diagnosing flexor tendon lacerations before exploration (18 out of 20) in a study cohort of 10 patients and found good correlation between the observations on US and those at operation [7,12].

Al-Hourani K, et al. 2018 and before him Corduff N, et al. (1994) reviewed the role of ultrasound in patients with tendon re-rupture post repair [7,16]. Al-Hourani K, et al. (2018) demonstrated 100% PPV and 100% NPV for identifying all patients who had a post repair complete tendon rupture when correlating with operative finding [7].

While Corduff N, et al. (1994) claimed that US evaluation was more accurate than the Strickland formula in assessing the state of the repaired tendon and proposed a new method of grading the results of tendon repairs based on ultrasonographic findings [16].

Study Limitations

Radiologists need to gain suitable amounts of experience before correctly and reliably performing and interpreting an ultrasound examination. They have to be well aware of the tendon ultrasonographic images and potential pitfalls in sonographic diagnosis of tendon lacerations.

The main disadvantage of US imaging is that it depends on the experience and knowledge of the operator. This can affect the quality and consistency of the images taken and the report given.

This study only included patients with a questionable clinical examination that were candidates for surgical exploration to evaluate for tendon injury.

The results of the study are not applicable to those with completely normal physical examination (no painful or decreased range of motion), or those with obvious tendon tears.

It is supposable that the results from our study may not be generalizable to practice settings with less sophisticated ultrasound equipment. Subtle tendon injuries may be missed if high-frequency transducers are not available or if lateral and axial resolution is not optimized.

Conclusion

Bedside ultrasound is more sensitive and specific than physical examination for detecting tendon lacerations, and takes less time to perform than traditional wound exploration techniques or MRI. It can be reliable for the evaluation of tendon injuries in patients with questionable clinical findings and obviates the need for a mere diagnostic surgical exploration and decreases morbidity in patients and disease burden on health care systems.

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