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Preoperative ultrasonograghic assessment of lacerated flexor tendons in hand

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Abstract
Background: Flexor tendons injury of the hand is common injury that could be open or close in nature.Injury to the flexor tendons can result in severe functional impairement of hand.Ultrasonograghy examination seen to be inexpensive imaging tool that can be help in the diagnosis of injury and localization of the proximal stump of the injured flexor tendons.
Methods: Ten patients with 14 tendons injuries at the different zone were preoperatively evaluates using real time ultrasound scan between January 2018 to January 2019.Time between injury and ultrasound examination was more than 24hrs.The ultrasound scan findings were compare to the intraoperative finding during surgical exploration of flexor tendons.
Results: Ultrasound accuracy in identified the flexor tendons injuries was seen in 12 tendons out of 14 tendons with 85.7% success rate with 75% success rate in localization of the proximal stump of injured flexor tendons.
Conclusion: Ultrasound examination of the lacerated flexor tendons showed to be reliable and safe method in the diagnosis of the flexor tendons injuries and in localization of lacerated ends.

Keywords: flexor tendons injury, ultrasound

Introduction

Flexor tendons injuries could be occurred anywhere a long the tendon from its origin to its insertion, thus could be occur in mid, distal forearm, wrist, palm, or in digits. Flexor tendons injuries could be occurred at any age but it is most common between 15-30 years with 1:7000 incidence in the industrialized countries. Tendon injury may be open or closed, complete or partial. Partial tendon injury may described painful digital flexion and the degree of limitation of active digital flexion depend on extend of the tendon laceration. Closed rupture of the flexor tendon occurs as result of sudden forceful extension of the digit while the finger is flexed. Closed rupture especially occurs when the player accelerate while other player trickle him and still holding his jersey, that why it called jersey finger flexor Digitorum prefunds avulsion [1, 2, 3, 4, 5].

Ultrasound is an optimal diagnostic method that can be used in many upper extremities conditions. It provided us much information regarding soft tissue and also useful for studying structural movements. However, it is still extremely operator dependent. Diagnostic ultrasound had much advance recently, new probe with ultrahigh frequency with small size probes these together allow images with high quality to be taken for hand and wrist. Advantage of the ultrasound over other form of radiological image like CT scan are it is not coasty, allow dynamic and real time evaluation, and not involve ionization. Also it extremely helpful in young infants were can be imaged without sedation, Also it help to confirm diagnosis in such age groups where the physical examination is difficult [6, 7, 8, 9].

Ultrasound can be able to detect anechoic effusion at the site of tendon rupture and also visualized the torn end of the tendon. Also it helpful in case of proximal tendon retraction. Ultrsound can also detect tendon bowstring which occur after pulley rupture. Ultrsound helpful in differentiation between tendon rupture and adhesion which could be occur after tendon repair [6, 8, 10], In this study we assess of using ultrasound in diagnosis of patient with flexor tendon injuries.

Patients and Methods

Prospective study which was done between January 2018 to January 2019. The study sample was included ten patients presented to us with history of acute flexor tendon injury in the hand. Those patients were subjected to ultrasound examination of their hand to assessed the integrity of flexor tendon.Patients data are shown in table -1-.

Table 1: Patients data. (FDP= flexor digitorum profundus. FDS= flexor digitorum superficialis. FPL= flexor pollicis longus).

Patient No.	gender	age	Hand involvement	Mechanism of injury	Zone of injury	finger
1	male	20	Right	laceration	III	Little/FDS,FDP
2	female	22	Right	Laceration	II	Little/FDS,FDP
3	male	32	Right	Laceration	II	Middle/FDP
4	male	36	Right	laceration	II	Index/FDS,FDP
5	female	17	Left	laceration	I	Middle/FDP,FDS
6	male	19	Right	laceration	II	Thumb/FPL
7	male	24	Right	laceration	II	Ring/FDP
8	male	45	Right	laceration	I	Middle/FDP
9	female	33	Left	laceration	I	Index/FDP
10	male	55	Right	laceration	II	Little/FDP

All patients presented to us have no concomitant injury like fracture or arterial injury, three of our patients had sensory deficit of their fingers which indicated concomitant digital

Nerve injury. Time of presentation of those patients was within 48hrs postinjury and they were evaluated by plastic surgeon clinically with medical record renewed information about mechanism of injury,time of injury, and most likely diagnosis. All patients after evaluation were subjected to ultrasound examination performed by consultant radiologist using volume E6 with 5-12 MH2 real time linear probe after 24hrs of injury. Finger examination were done during active and passive flexion of the involved finger. Both saggital and transverse planes used to identify the flexor tendon Real-time video recording was done in every study. The ultrasound findings was either normal tendon appearance, partial tendon laceration or complete tendon laceration. The final diagnosis is done intraoperatively which was compared with preoperative findings.

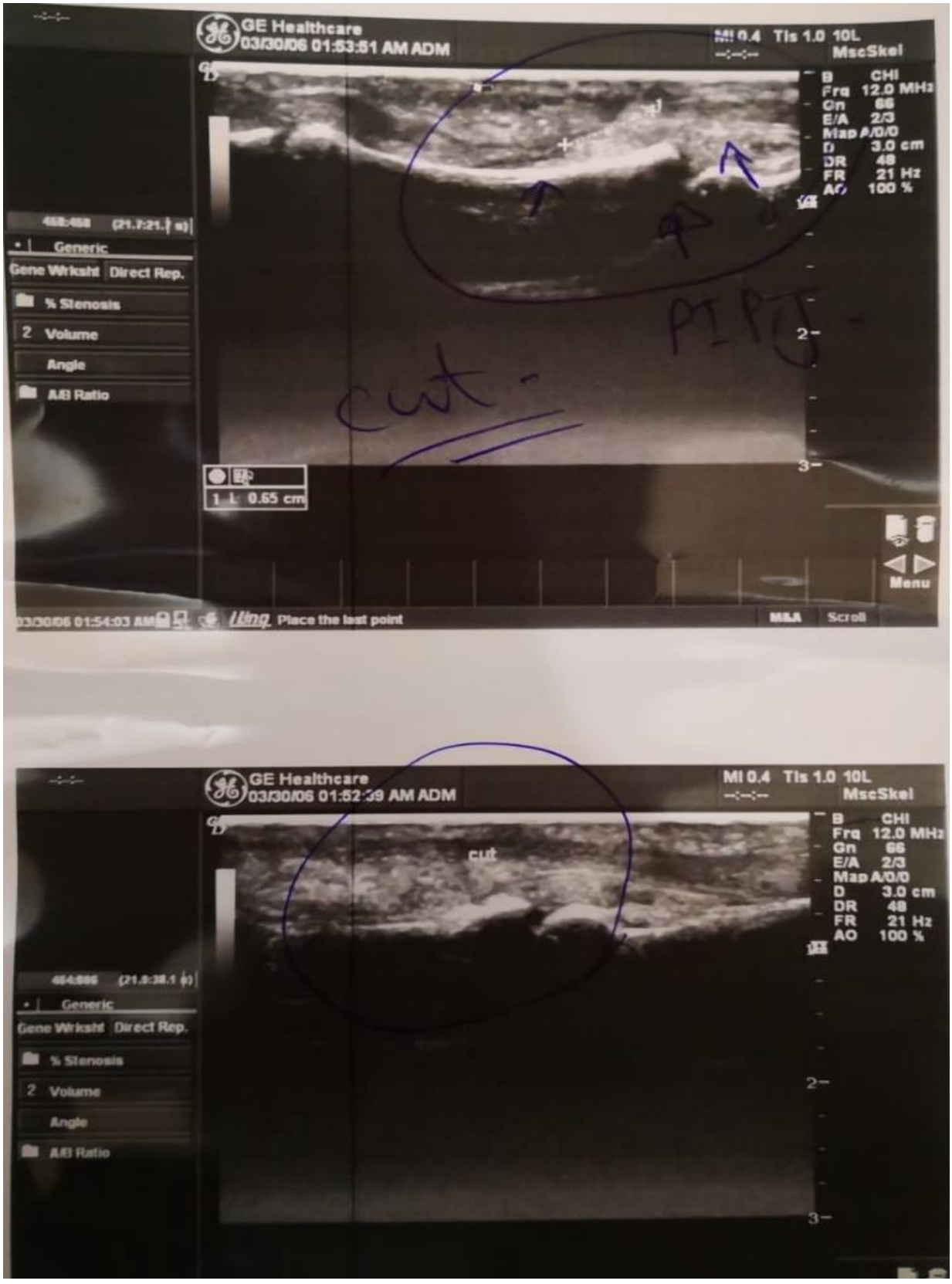

Fig 1: Right ring finger with flexor digitorum profundus Cut (Zone II).

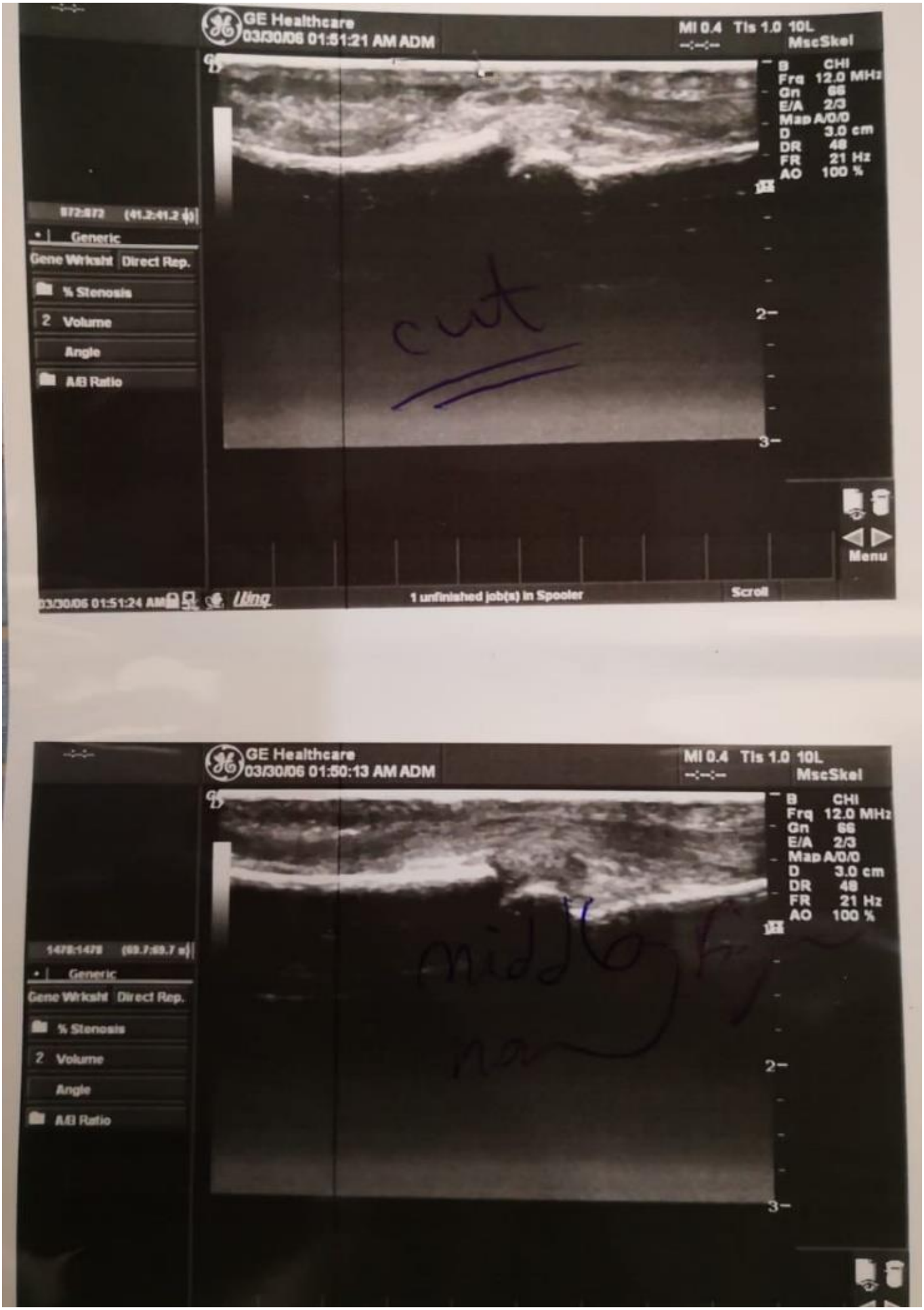

Fig 2: Comparism between Rt ring FDP cut Zone II and RT middle normal FDP.

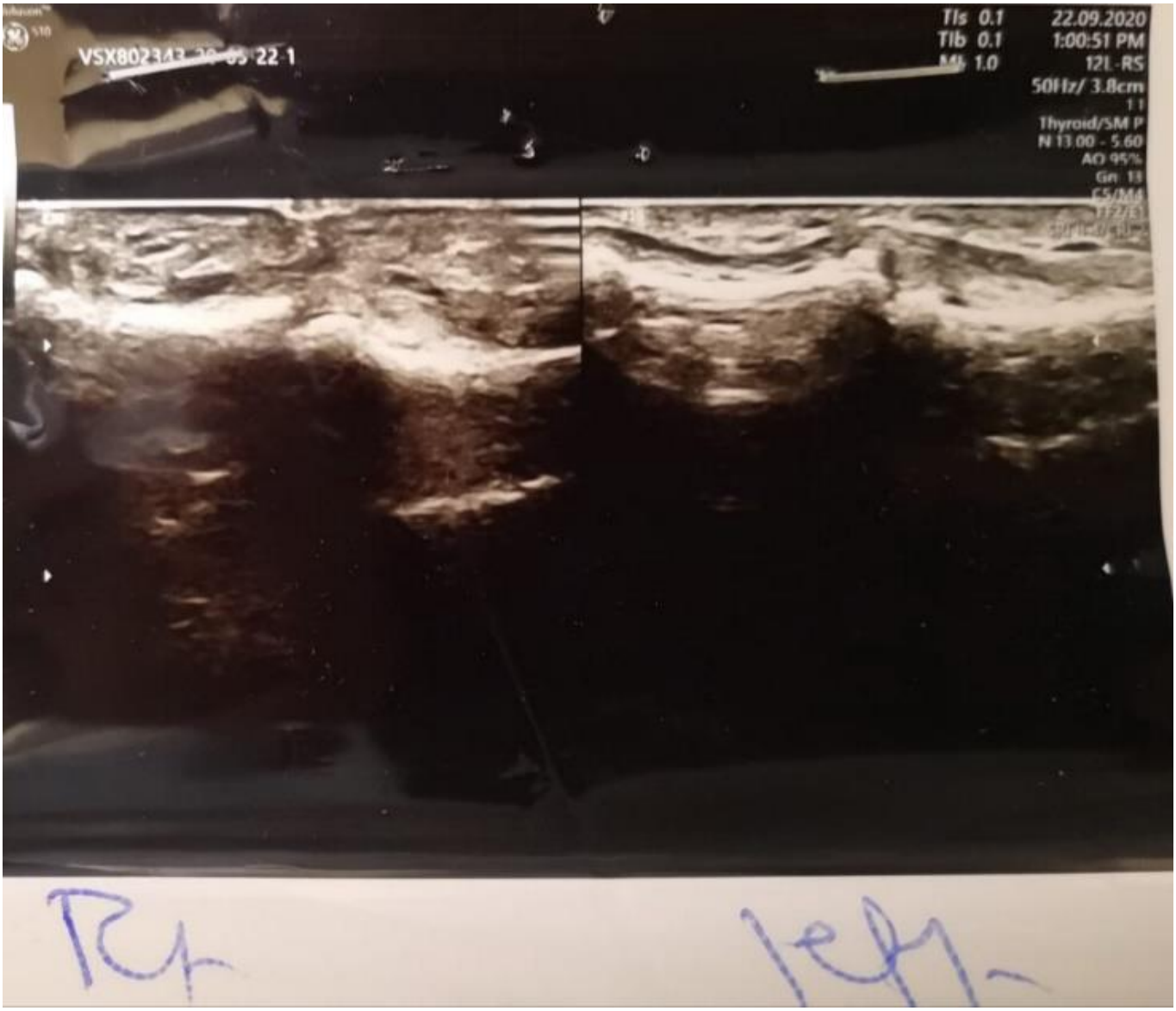

Fig 3: Comparism between Rt little finger Zone II FDP cut and LT normal FDP.

Results

In this study 10 patients presented with history of acute flexor tendon injuries those patients were subjected to ultrasound examination preoperatively. Patients age were ranging between 17-55 years mean 44.5 (7 male versus 3 female). Mechanism of injury were open injury in all of cases. The numbers of injured tendons were 14 tendons in 10 fingers. The fingers which was involved were middle finger in three cases, little finger three cases, index finger two cases, ring finger one case and thumb one case. The diagnosis of complete tendon laceration by ultrasound was made by finding flexor tendon discontinuity with presence of gap at the site laceration together with disruption of the longitudinal fibrillar normal architecture of the tendon, those will replaced by hypoechoic or anechoic focal areas. The gap that occurred between proximal and distal segments of the tendon filled sometime with echogonic fibrinous materials. In order to differentiated between laceration of FDP and FDS the distal inter phalangeal joint is flexed and extend while the proximal inter phalangeal joint is kept in immobile status. If during this, the tendon was notice to move back and froth, this indicated the FDP is intact. If the tendon was noticed and not moved this mean that FDP is cut. FDS usually noticed volar to FDP which should not mobilized when DIP joint is moving. Then the involved finger putting so that the PIP joint keep in flexion and DIP joint in extension and then reverse. When the FDS is intact, should be seen moving and gliding distally over FDP when we extended PIP joint and DIP joint flexed and moving proximally over FDP when DIP joint extended and PIP joint flexed. When we noticed FDS but did not glide with PIP joint manipulation this is indicated FDS is laceated, for FPL same protocol is done but without need to differentiation between deep and superficial tendon. Identifying the exact location of the proximal part of the lacerated tendon was done when the probe is oriented in transverse plane. After finishing of ultrasonic examination and report the result is medically reported, a surgical exploration was done in next day under general anaesthesia and the accuracy of the ultrasound finding was compared with preoperative ultrasound reports. Ultrasound finding was accurate in determining flexor tendon injuries in 12 out of 14 flexor tendon(85.7%).In only 2 cases of tendon laceration ultrasound gave us false-negative intact flexor tendon inpatient [2] who had laceration of the ring finger FDP and FDS in zone III. The proximal stump in those accurately diagnosed flexor tendon injury(12 out of 14) was accurate in

9 out of 12 (75% success rate).All of our patients had intraoperative complete tendon laceration which was also detected by ultrasound scan.

Discussion

One of the most common injuries encountered in the emergency department is the hand injuries. Flexor tendons laceration is the one of the problems that can be faced in hands trauma. Although the diagnosis of the flexor tendons injuries can be mainly relies on accurate history with adequate and well-done physical clinical examination, However, Imaging modalities can be done to confirm the diagnosis. There are many conditions that need ultrasound examination to confirm diagnosis of tendon laceration like conditions when the examination is difficult such occur in children, uncooperative patients and in those cases where there is possibility of partial tendon injury. Other conditions like Jersey or rughy finger which result from avulsion of flexor tendon from its insertion with its bony attachment, this represented one of the diagnosis difficulties for tendon injury with missed diagnosis in 50% of cases as seen by Gaston. In such condition ultrasound examination could be play critical role in the diagnosis of Jersey or rugby finger [11, 12, 13, 14, 15]. In this study we had ten patients with history of flexor tendon injuries at different level and zones whom subjected to ultrasonic examination to Confirmed the present of the tendon injury and also to detect the site of the proximal stump of the lacerated tendon. Preoperative ultrasonic findings was compared with the intra operative findings. All of our ten patients had clinical evidence of tendon laceration (whether FPL,FDS or FDP or combined of them).All ultrasound scan done by same consultant radiologist using GE voluson E6 with real time linear probe 5-12 MH2 for all of those patients were proceed to surgical exploration 24h after ultrasonic examination. The intra operative findings were confirmed the clinical findings in all of our cases, and confirmed ultrasonic findings in 87.7% of cases. All our patients had complete tendon laceration which was noticed both by ultrasonic scan and intra operatively. The proximal stump site was accurate in 75% of cases which was detected by ultrasonic scan as it was confirmed by intra operative findings. In this study we began examination of the tendon over zone III since in this area the tendons are relatively large and not crowded in flexor sheath or in carpal tunnel which help us to indentify the normal longitudinal fibril architecture of the intact tendon. Normal tendon in the hand and wrist are echogenic when compared to muscle with present of tendon rupture it will give the flexor tendon discontinuity with present of gap which lead to loss of normal fibrillar pattern of the normal tendon. Its important from technical point to keep beam of ultrasound in perpendicular direction to the tendon, as a slight oblique direction of the ultrasound beam whether in transverse or longitudinal plane can lead to false hypoechoic area which can be confused with tendon laceration, this known as anisotope phenomenon [12, 13, 16]. When we were seeking foe the proximal tendon stump our search stop at the distal aspect of flexor retinaclium (carpal tunnel) since the crowdness of the structures inside the carpal tunnel area make the beam poorly penetrate the transverse carpal ligament which of course lead to poor quality image that is not conclusive in determined whether we had tendon injury or not. In all of cases in this study a dynamic examination was done which enhanced the diagnostic ability of ultrasonic scan, this usually done by examine the patient hand at rest and during active extension and flexion of the injured finger, at least two orthogonal cross section is obtained. In general dynamic ultrasound examination better performed in saggital plane during active extension and flexion of the involved digit. Ultrasound scan was done in this study after 24h of the injury, it have been demonstrated that the accuracy of the ultrasound scan examination of the flexor tendon injury is less when performed at the same time of the injury because of present of haematoma with its highly echogenic appearance that make visualization of the ruptured tendon is difficult. Also early ultrasound examination immediately after trauma will precluded dynamic examination since present of pain and swelling which limited finger movement. Also ultrasound examination after 7 days may give false Negative (give appearance of intact tendon), since present of fibrosis and adhesion of tendon to the adjacent tendon or to the flexor fibrous sheath [14, 17]. Ultrasound accuracy in the evaluation of the flexor tendon injury was evaluated by Donald H. lee *et al*. [13, 18]. were in their study of 13 injured fingers in ten patients with potentially damage flexor tendon in 10 patient have found that accurate indenti fied tendon by using ultrasound scan was 11 in 13 fingers and 18 of 20 flexor tendons (6 complete flexor tendon laceration, 2 were partially lacerated and in 12 intact tendons).In this study they found that the proximal tendon end location was accurate in 5 out of 6 of complete tendon injury. A cadaveric study was done by Ramic *et al* to evaluate the accuracy of the ultrasound scan in the determining of flexor tendon laceration in 70 out of 81 tendon with 96.2% success rate and with 78% success rate for correct identified the location of the proximal tendon stump while in our study Ultrasound finding was accurate in determining flexor tendon injuries in 12 out of 14 flexor tendon (85.7%) [12]. Gilleard *et al* evaluated using of the ultrasound scan in the diagnosis of closed rupture of flexor tendon and they found that ultrasound examination was significantly higher when it is compared to physical clinical examination(95% versus 79%).Also they found that ultrasound examination accuracy change significantly according to time between injury and ultrasound examination, were the accuracy of ultrasound examination was 100% when examination occurred between 1-7 days after injury, it is 88% accurate at the same day of injury, and when perform after 1 week after injury the accuracy rate will become 85.7%. Of course preoperative ultrasound scan examination of flexor tendon laceration will not eliminated the role of adequate physical examination in identified laceration of flexor tendon injury. However, present of pain, swelling and uncooperative patient especially children will present adequate clinical examination. One of the diagnostic difficulties in the flexor tendon laceration is determining of partially tendon laceration. Surgeon usually proceeding for tendon repair when it involved 50-60% of the tendon in order to avoid complication that associated with partial tendon laceration namely rupture, entrapment and triggering. Ultrsound examination showed to be of valuable tool in the diagnosis of partially lacerated tendon [13, 19]. Preopertive imaging of flexor tendon with using of ultrasound scan help the surgeon to determine the extent of damage and to put plan of the treatment before surgery. Also help the surgeon to identified the exact location of proximal stump of the tendon which help the surgeon to reduce the exploration incision that need to localize the proximal stump also help the surgeon to reduce the retrieving method for proximal stump such as tendon grasping forceps which had potential damage to

tendon with increased adhesion at the site of repair. Also known the exact site of retracted proximal stump of the lacerated tendon will reduce the time of repair [13, 19]. Ultrasound examination of lacerated flexor tendon has significant advantage over computer tomography (CT scan) and Magnetic resonance imaging (MRI), since it less costy and can perform rapidly with no risk of radiation. Also in contrast to ultrasound examination, MRI cannot perform dynamic assessment of flexor tendon in real time as occurred in ultrasound since the patient in MRI examination should be keep in static position. The only disadvantage of ultrasound examination is operator dependence and had relatively poor quality of image [13].

Conclusion

The purpose of this study to determine whether the ultrasound examination can be used for preoperative diagnosis of flexor tendon injury and determine the accuracy of the ultrasound examination in the diagnosis of flexor tendon injury. Also our ultimate decision for surgical exploration of lacerated flexor tendon injury is not affected by ultrasound examination. However, ultrasound examination in this study showed to be inexpensive tool which helpful in diagnosis and evaluating flexor tendon laceration preoperatively together with localization of the proximal stump of the injured flexor tendon.

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