Elbow joint tendon and ligament lesions; diagnosis using multiple imaging modalities

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Abstract: Elbow pain is a big problem because the joint is surrounded by numerous ligaments, muscles and neuro-vascular structures. The choice of the imaging modality depends on the clinical presentation and suspected pathology. Fifty patients were studied at Al-azhar University hospital (Damietta). All of the patients were symptomatic and presented by pain and limitation of movement at the affected elbow joint with history of trauma in acute onset patients. They were examined clinically at Orthopedic and Rheumatology Departments and referred to Diagnostic Radiology department for further radiological evaluation. Plain radiography, ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI) were complementary modalities to reach the correct diagnosis. The aim of this study was to reach the proper diagnosis for elbow joint pain using the clinical background and the different imaging modalities.
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Key word: Elbow joint , tendons , ligaments , ulnar collateral ligament , radial collateral ligament.

1. Introduction

The understanding of elbow pathology is becoming easier with the advanced and improvement of diagnostic imaging techniques which help in providing more accurate diagnoses and, therefore, better patient care. (Sofka and Potter:2002)

Elbow joint is surrounded by numerous ligaments, tendons and muscles. The wide range of mechanical forces which act on this complicated joint makes it susceptible to a variety of injuries, which may be due to acute trauma or chronic overuse. (Husarik et al: 2009)

The elbow is a composed of three articulations contained within a common joint cavity: proximal radio-ulnar joint, capitellum with the head of the radius and trochlea with trochlear notch of the ulna in a hinge fashion. Flexion and extension occur at the humero-ulnar articulation, whilst pronation and supination occur at the radio-ulnar articulation. (Cohen and Hastings : 1997)

The anterior and posterior portions of the joint capsule are relatively thin, the medial and lateral portions are thickened to form the medial collateral ligament which consists of anterior, posterior and transverse bands and lateral collateral ligament which consists of radial collateral ligament , annular ligament , lateral ulnar collateral ligament and accessory lateral collateral ligament. (Han et al: 2009).

The muscles around the elbow divided into: anterior compartment (biceps and brachialis muscles), posterior compartment (triceps and anconeus muscles), medial compartment(pronator teres and the flexors of the hand and wrist ,, flexor carpi radialis, flexor digitorum superficialis, flexor carpi ulnaris, flexor digitorum profundus, and flexor pollicis longus(common flexor tendon) and lateral compartment (supinator, brachioradialis and the extensor muscles of the wrist and hand, extensor carpi radialis longus, extensor carpi radialis brevis, extensor digitorum, extensor digiti minimi, and extensor carpi ulnaris muscles, (common extensor tendon), the lateral compartment is best evaluated on axial and sagittal MRI images (Grana et al: 2007) .

2. Patient and Methods

2.1. Patients:

This study was performed at Al-azhar University hospital (Damietta) at the period from January 2008 to June 2009. The study involved 50 patients; 35 males and 15 females (fig . 1) . Their ages ranged from 8 to 65 years (fig.2) . The clinical presentation was summarized at (fig . 3) . The patients referred from emergency room and orthopedic department to radiology department for further evaluation.

2.2. Methods:

All patients were subjected to the following:

A - Full clinical history including the personal history, present history and past history.

B - General and local examinations were done by the orthopedist and rheumatologist.

C - Laboratory investigation in 35 patients including CBC, ESR, rheumatoid factor and serum uric acid.

D - Imaging: which include the following:

1 - Plain radiography was done for all patients: Most evaluations of the elbow begin with radiographs because of their screening value and relatively low cost. Early arthropathy, fracture, calcification, inflammation, joint space abnormality and fat plane changes were easily evaluated in plain radiography. Antero-posterior (AP) and Lateral radiographs were essential in the basic evaluation of disease. Oblique radiographs or additional views, such as the radial head view were done in 10 patients.
2 - Ultrasonography (U/S) was done for all patients; U/S was useful in evaluating a variety of structures. Medium- frequency (7.5 MHz) or high-frequency (10 MHz) linear array transducers was provide high-resolution images of the peri-articular soft tissues, common extensor & common flexor tendons, collateral ligaments, nerves, joint effusion and bursitis were clearly evaluated. Many U/S approaches were used (Anterior approach, Posterior approach, Postero-lateral approach and Postero-medial approach) according to the clinical presentation and suspected pathology. The Doppler ultrasound was used in evaluation of early inflammatory changes by detection of increased flow in the affected area .
3 - Multidetector computed tomography (MDCT); was done for 15 patients using 16 – MSCT scanner.
4 - The scanning was include the distal part of the humerus and the proximal portions of the radius & ulna with total distance approximately 80 mm.

2.3 Scanning parameters:
Rotation speed 0.5 slice/rotation
Table speed 13.75 mm / rotation
Beam pitch 1.375:1
Slice thickness = 2.5 mm
Image spacing = 2.5 mm
Sagittal & coronal reconstructions were obtained.

2.4. Contrast was given in three patients.

4 -Magnetic resonance imaging (MRI); was done for 30 patients Dedicated circumferential elbow surface coils, small field of view (10 to 12 cm), and high-field-strength magnets (1.5 T.) provide optimal image quality. Image planes include axial, sagittal, and coronal; oblique and reformatted thin-section gradient-echo images are optional. The axial image plane was useful to assess neurovascular, tendon, and muscle anatomy. The sagittal plane was useful as a second plane for biceps and triceps tears or to define the extent of a lesion identified on axial images while the coronal plane was useful for evaluating articular surfaces, common extensor, flexor tendons & collateral ligaments.

Intravenous gadolinium contrast agent was given for 5 patients with a suspected elbow mass lesion or infection. (MR) arthrography was performed in one patient, under a-septic technique 10 ml of a 1:100 mixture of contrast agent and saline was injected into the joint cavity.
E - Surgical repair was done for sex patients at orthopedic department (three patients were partial tear at the common extensor tendon, two patients were tear with retraction at the biceps tendon and one patient was medial collateral ligament tear).
F - Post-traumatic and post-operative physiotherapy was done for thirty patients at rheumatology and physical medicine & rehabilitation department.

3. Results

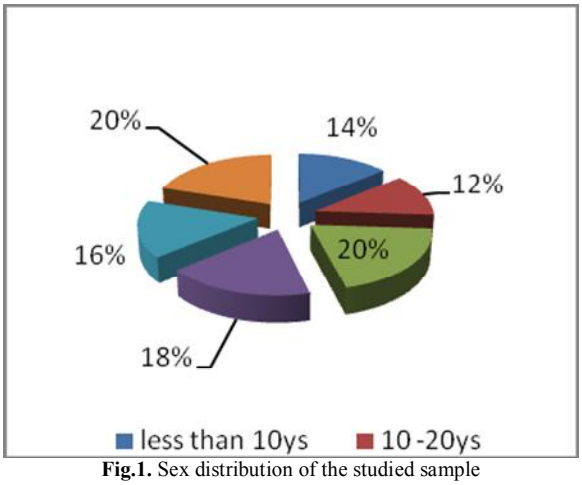


Fig.1. Sex distribution of the studied sample

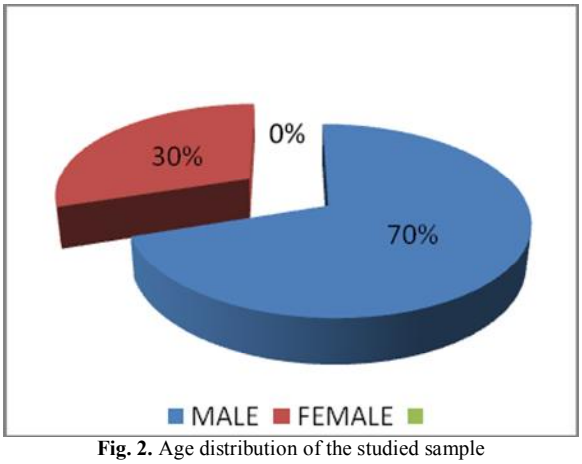


Fig. 2. Age distribution of the studied sample

Table 1. Analysis of the clinical presentation.

Clinical Presentation	Frequency	Percent	Valid Percent	Cumulative Percent
Pain and limitation of movements	8	16.0	16.0	16.0
Pain and swelling	8	16.0	16.0	32.0
Pain and trauma	11	22.0	22.0	54.0
Pain and multiple joints affection	10	20.0	20.0	74.0
Pain and numbness	8	16.0	16.0	90.0
Pain and fever	4	8.0	8.0	98.0
Pain and previous operation	1	2.0	2.0	100.0
Total	50	100.0	100.0	

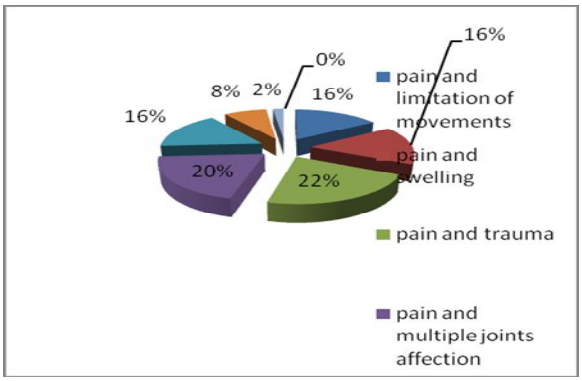


Fig. 3. Clinical presentation of the studied sample

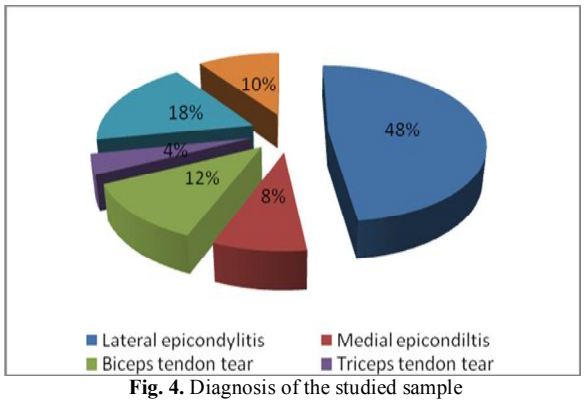


Fig. 4. Diagnosis of the studied sample

Table 2. Analysis of the diagnosis

Diagnosis	Frequency	Percent	Valid Percent	Cumulative Percent
Lateral epicondylitis	24	48.0	48.0	48.0
Medial epicondylitis	4	8.0	8.0	56.0
Biceps tendon	6	12.0	12.0	68.0
Triceps tendon	2	4.0	4.0	72.0
MCL	9	18.0	18.0	90.0
LCL	5	10.0	10.0	100.0
Total	50	100.0	100.0	

Table 3. Age and clinical presentation relation

	Clinical Presentation							
	Pain and limitation of movements	Pain and swelling	Pain and trauma	Pain with multiple joints affection	Pain and numbness	Pain and fever	Pain and previous operation	Total
Age under 10	0	2	2	1	1	1	0	7
10- 20	0	2	0	3	1	0	0	6
20-30	2	3	0	2	0	2	1	10
30-40	2	0	5	0	2	0	0	9
40-50	2	0	1	3	2	0	0	8
50-60	2	1	3	1	2	1	0	10
Total	8	8	11	10	8	4	1	50

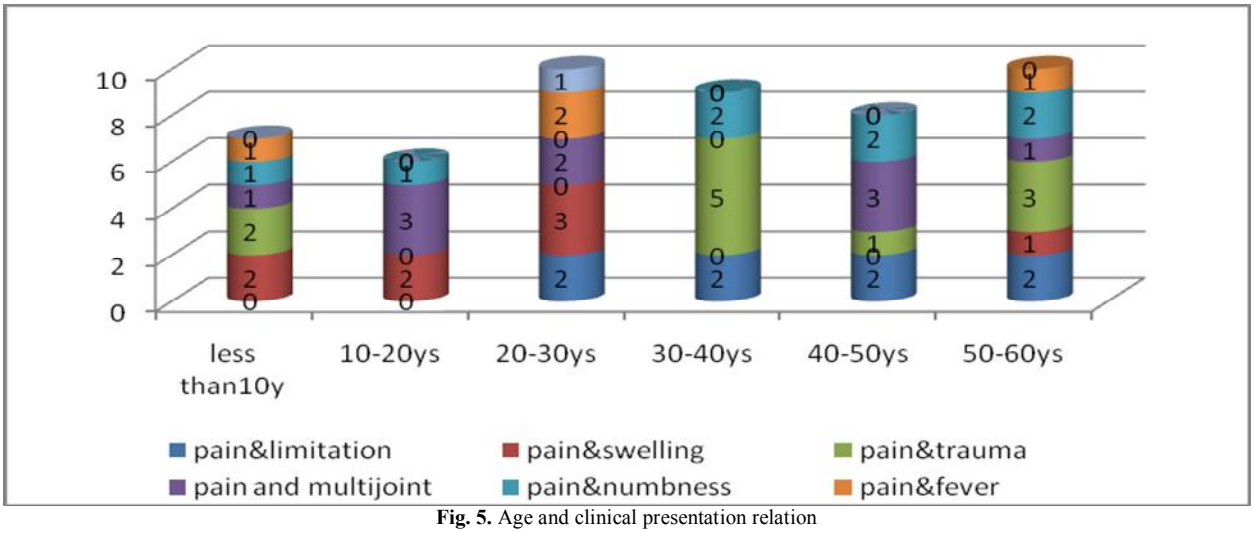


Fig. 5. Age and clinical presentation relation

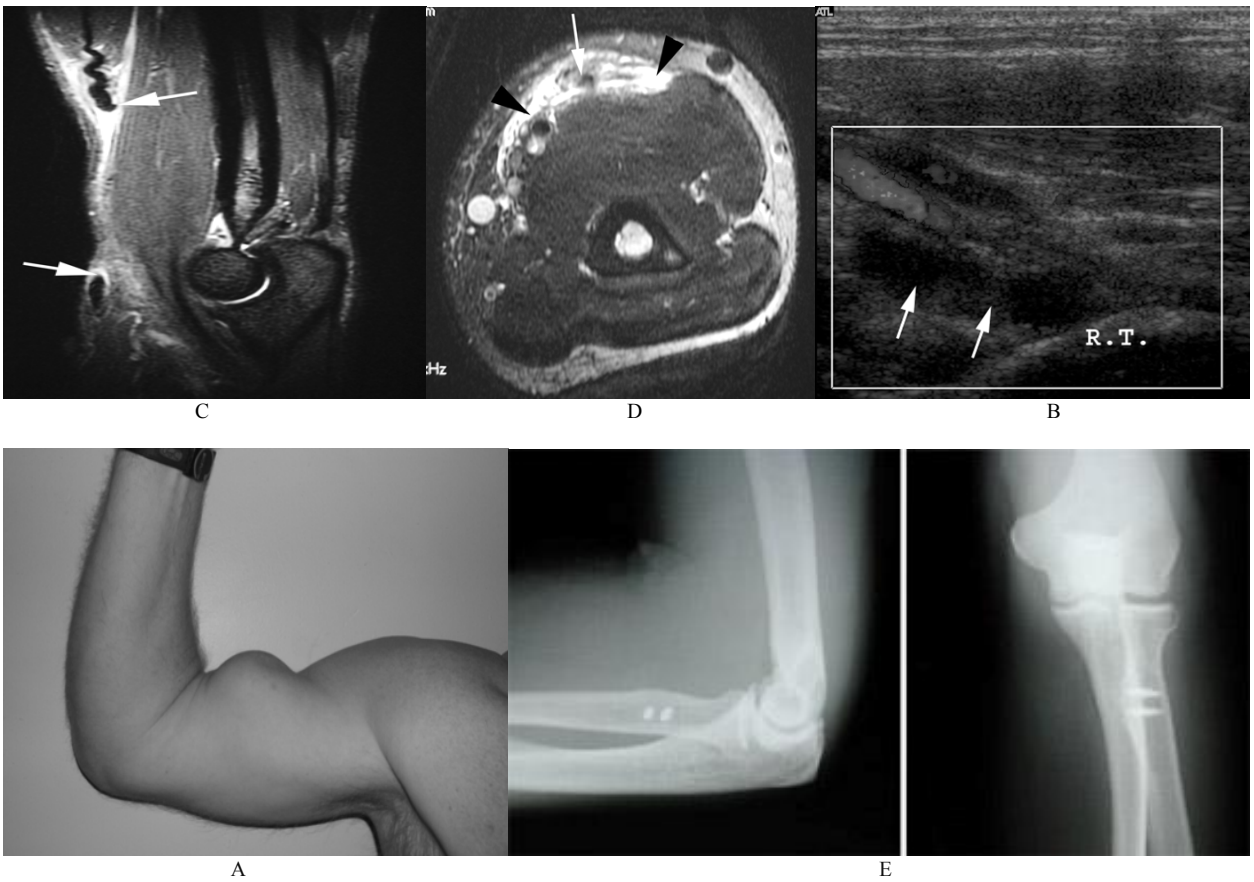


Figure 6. Biceps tendon tear: A - The "Popeye" sign. There is retraction of the biceps muscle belly indicating biceps tendon rupture. B - longitudinal ultrasound show rupture of the distal biceps tendon with collection in –place , Doppler show the position of the brachial vessels. RT radial tuberosity. C - Sagittal short tau inversion recovery image show rupture of the distal biceps tendon with retraction of the tendon ends (arrows). D - Axial T_2 fat saturated image demonstrating the proximal retracted tendon end (white arrow) with high signal edema and hemorrhage (arrow heads) at the musculotendinous junction. E - Antero-posterior and lateral views for the elbow show metal implants (suture anchors) which used to fix the biceps tendon to the bone.

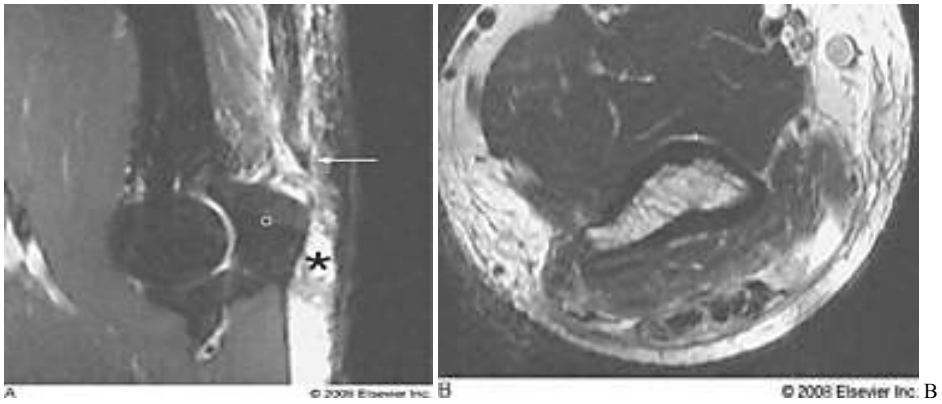


Figure 7. Complete triceps tendon rupture; A - Sagittal fat suppressed T2-weighted image show complete disruption of the triceps tendon (**arrow**). B - Axial fast spin echo T2-weighted image show complete disruption of the triceps tendon i(**arrow**). There is associated olecranon bursitis (asterisk). O – olecranon

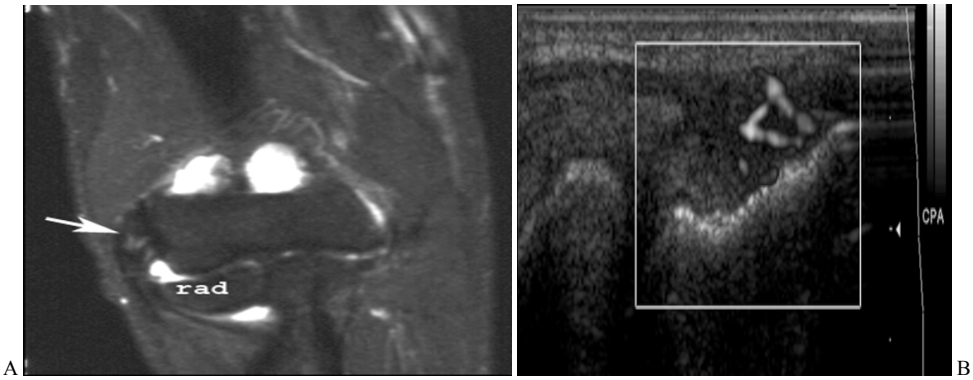


Figure 8. Lateral epicondylitis: A- Longitudinal Doppler ultrasound show increased flow within the common extensor origin indicating lateral epicondylitis. B - Coronal short tau inversion recovery image show high signal intensity within the common extensor origin (arrow) consistent with lateral epicondylitis.

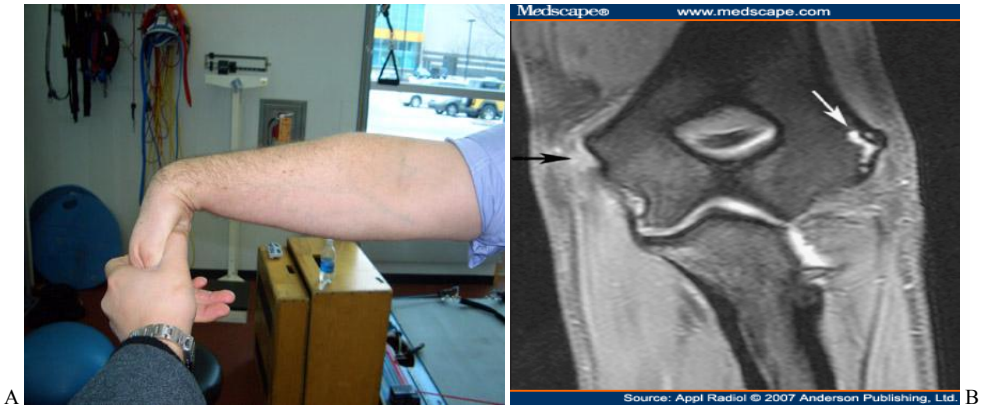
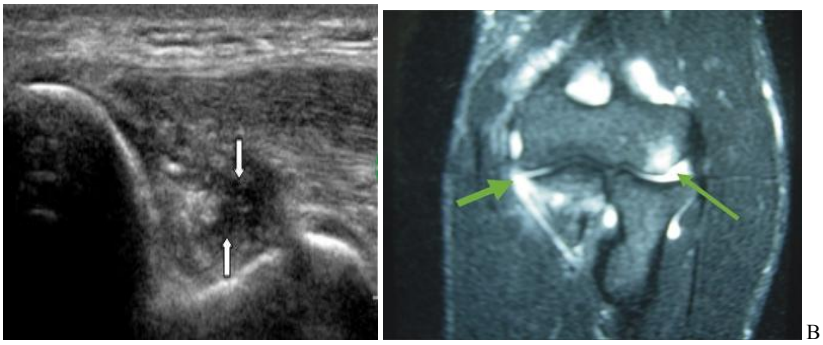


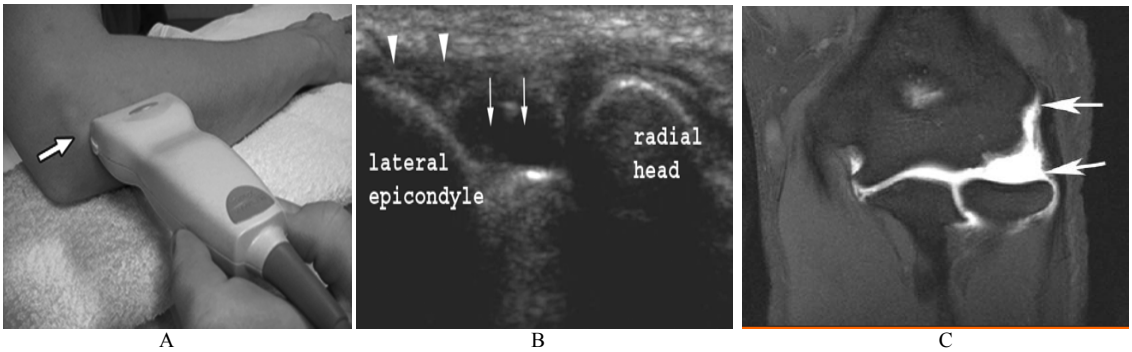
Figure 9. Medial epicondylitis: A- Clinical test for medial epicondylitis , Resisted forearm pronation and palmar flexion elicits pain at the medial epicondyle . B - MRI coronal gradient echo images show full thickness tear of the common flexor tendon origin (black arrow) with retraction and surrounding hyperintensity denoting associated hemorrhage .

Figure 10. MCL tear , Coronal T2 MRI of the elbow demonstrating midsubstance UCL tear (yellow arrow).



A B

Figure 11. MCL tear , A – longitudinal ultrasound show MCL tear with collection . B – coronal T2 MRI of the elbow show medial collateral ligament injury (large arrow) , capitellar bone contusion (small arrow), and joint effusion.



A B C

Figure 12. LCL tear : A - Photograph shows positioning of the patient and placement of sonographic transducer in longitudinal plane during examination of proximal LCL. Arrow indicates end of lateral epicondyle. B - Longitudinal ultrasound show absence of the (LCL) lateral collateral ligament (arrows) indicating a tear. The common extensor origin is intact (arrowheads). C - coronal MR arthrogram show absence of the radial collateral ligament indicated by abnormal lateral extension of the contrast with widening of the lateral joint space.

4. Discussion

The distal biceps tendon is the most commonly injured tendon in the elbow. Ruptures of the biceps tendon account for only 3% of biceps injuries and are most common in men > 40 years of age, injuries typically occur at or near its insertion into the radial tuberosity as a result of forced hyperextension with the arm flexed and supinated. **(Chen and Chew : 2006)**

Tendon ruptures are characterized by complete discontinuity of the tendon, increased intratendinous signal, peritendinous fluid/hematoma, and muscle and tendon retraction , the tendon does not retract if the bicipital aponeurosis (lacertus fibrosis) remains intact , Partial tears are visible on MR as thinning, increased intratendinous signal, peritendinous fluid, and, occasionally, a proximally thickened tendon. **(Williams et al: 2001)**

Biceps tear is a very obvious dysfunction and imaging needed to give more information to the orthopedist when preparing the patient for surgery, Typically X-rays show irregularity of the radial

tuberosity in chronic biceps tendon injuries and rarely an avulsion fracture when the bicep injury extend to take a piece of bone with it. **(Buck et al., 2009)**

On ultrasound, muscle tissue appears predominately hypoechoic with interspersed hyperechoic septations, This appearance is produced by muscle fibers grouped together to form fascicles, which are visible at ultrasound as hypoechoic bundles separated by the echogenic fibroadipose perimysium septa, accuracy of ultrasound is 94% when ultrasound was used to diagnose tendon tears in general and 92% accuracy in differentiating full-thickness from partial-thickness. **(Parker et al : 2008)**

MRI is the imaging tool of choice to show soft tissue damage which give more information regarding the size of the tear, location of the tear , T2-weighted, gradient-echo, or short tau inversion recovery (STIR) images are best for showing the high signal abnormality of hemorrhage as well as the inflammation and fluid seen against the normal low signal intensity of the tendon , Partial tears are visible on MR as thinning, increased intratendinous signal and peritendinous fluid . A chronic biceps tendon tear may result in atrophy of the tendon and muscle belly with fatty infiltration of the muscle. **(Major and Crawford: 2002)**

Six patients (12%) with biceps tendon injury (Figure : 6) were included in this study, all were male with their ages ranged between 28 and 42 years , they were presented by severe pain following lifting a heavy object. clinically there was retraction of the proximal tendon remnant and muscle belly, which is seen on clinical examination as the "Popeye sign".

On imaging, plain radiography show irregularity of the radial tuberosity with obliteration of the supinator fat stripe. Avulsion fracture was seen in one patient. Ultrasound demonstrate rupture of the distal biceps tendon with hemorrhage in the gap. MR imaging was ideally suited to evaluate injuries of the biceps tendon. T2-weighted, gradient-echo, or short tau inversion recovery (STIR) images are best for showing the high signal abnormality of hemorrhage as well as the retracted tendon.

The triceps muscle lies in the posterior compartment of the arm and is composed of three heads , Although inflammation of the triceps is fairly common, ruptures of the triceps tendon are rare , radiography is useful in evaluating triceps injury, since up to 80% of patients will have avulsion fractures of the olecranon , complete disruption results in areas of high signal intensity separating the low-intensity tendon fragments , the triceps tendon normally has striations of increased signal that insinuate between the distal tendon fibers and should not be mistaken for tears **(Carrino et al : 2001)** . Two patients (4 %) with triceps abnormality (Figure : 7) was included in this study , both were male 35 & 40 years presented by pain at the elbow with history of trauma . Sagittal MR images show areas of high signal intensity with associated tendon retraction and avulsion fracture of the olecranon.

Common Extensor and Flexor Tendons (epicondylitis) injuries can be evaluated with MRI or Sonography, typically, imaging studies are not performed unless the patient has failed conservative treatment **(Chung and Kim : 2003).** In patients with lateral epicondylitis (tennis elbow) , the primary site of involvement is the common extensor tendon origin and the main symptom is tenderness and pain that starts at the lateral epicondyle of the elbow , the pain usually gets worse when the patient bend the wrist joint backward or hold something with straightened elbow , the physical examination is often most helpful in diagnosing tennis elbow , the X-rays mostly help to rule out other problems with the elbow joint and my show calcification on the lateral epicondyle at the connection of the extensor tendon **(Peterson : 2000)** . On ultrasound lateral epicondylitis show focal hypoechoic area in the deep part of the tendon **(Connell et al 2001) .**

MRI reveals thickening and intermediate signal within the tendon origin in cases of tendinopathy, thinning or partial disruption of the tendon in Partial tears with increased T2W signal within and adjacent to the tendon origin , complete rupture of the tendons will lead to a tendinous gap containing fluid signal, and distal retraction of the involved muscle(s) , dystrophic calcifications can arise adjacent to the lateral epicondyle and are best depicted on gradient-echo images **(Miller et al : 2002)**

Twenty eight patients (56 %) with clinical presentation of epicondylitis were included in this study , twenty four patients (48 %) were clinically diagnosed as lateral epicondylitis (Figure 8) and four patients (8 %) were diagnosed clinically as medial epicondylitis (Figure 9) , 22 patients were male and 6 patients were female with average age 45 years , they presented clinically with history of repeated minor trauma and squash players .

Injuries to the common flexor tendon origin (golfer's elbow or medial tennis elbow) are less common than injuries of the common extensor tendon origin **(Richard; et al, 2008)** .

Common flexor tendon injury occurs at the origins of the flexors and pronator teres which occurs in 1% to 3% of adults who are 35 to 55 years of age, and it is often seen in golfers, high-performance throwers, swimmers, racketball and squash players **(Schickendantz et al , 2002) .**

Coronal fat-suppressed T2W images demonstrate hyperintensity of the common flexor

origin , MR arthrography is the modality of choice in detection of partial and complete tears **(Sellards and Kuebrich , 2005) .**

In this study; Ultrasound show thickened tendon with loss of homogeneous internal echo- texture and focal hypoechoic area in the deep part of the tendon with increased flow on Doppler examination were the typical character of epicondylitis on U/S study. On MRI; epicondylitis show thickened tendon with poorly defined low to intermediate signal change on T1 weighted images and relative increased signal on T2 weighted images. Fat suppression and STIR imaging show cystic change on the affected tendon. Associated collateral ligament abnormality was found in four patients.

Additional support for the elbow is provided by the radial and ulnar collateral ligament complexes, the radial (lateral) collateral ligament (RCL) complex is composed of the lateral ulnar collateral ligament, RCL proper, and the annular ligament , injury to the RCL complex is less common than medial ligament injury and is usually the result of varus stress or subluxation/ dislocation , the lateral ulnar collateral ligament is the primary stabilizer against varus stress, and its disruption can lead to posterolateral rotatory instability of the elbow **(Han et al, 2009).**

The ulnar (medial) collateral ligament consists of three bands (anterior , posterior & transverse) and is much stronger than the RCL , the anterior band is the dominant structure and the primary stabilizer against valgus stress on the elbow , it courses anteriorly from the anteroinferior surface of the epicondyle and attaches to the medial edge of the coronoid process , the posterior band is smaller and extend from behind the medial epicondyle and courses slightly posteriorly to attach onto the medial aspect of the olecranon, the transverse band is clinically less significant it is smaller or sometimes absent **(Munshi et al , 2004).**

Fourteen patients (28 %) from the selected patients with clinical presentation of ligaments injury were included in this study (Twelve patients were male and two were female with the main ages 38 years) ; nine patients (18 %) were MCL injury (Figure 10 & 11) and five patients (10 %) were LCL injury (Figure 12) , regarding the clinical history , twelve patients were presented with history of trauma associated with elbow dislocation , two patients presented with history of previous operation at the affected elbow joint .

On MRI acute ruptures are seen as discontinuity and an abnormal course of a ligament, Partial tears are more difficult to diagnose with imaging; articular-surface tears are more accurately assessed with MR arthrography **(Saupe et al 2009) .**

In this study plain radiographs show calcification within the anterior bundle of MCL, osteophytes arising from the olecranon, loose bodies, osteochondral lesions of the capitellum and occasionally avulsion fractures of the medial epicondyle .

Ultrasound is an effective imaging technique for assessment of the normal thickness and echopattern of the elbow collateral ligaments, changes in the thickness or disturbed homogenous echogenicity is highly indicative of ligament pathology.

MRI show periligamentous or bone marrow edema on short tau inversion recovery (STIR) or T_2 weighted fat saturated images. Full-thickness tears of the MCL were accurately identified with MRI, but partial-thickness tears were less easily diagnosed as these involve the deep portion of the anterior bundle of MCL. MR arthrography improves the detection of these partial tears.

5. Conclusion

Clinical backgrounds were very important to provide accurate diagnosis. All imaging modalities were complementary to each other, Plain radiography remains very important in the evaluation of elbow pain and dysfunction and should be performed routinely. Ultrasound has been shown to be helpful for diagnosing partial or complete tear of the distal biceps tendon, collateral ligaments and rapid detection of joint effusion or peri-articular collection. MDCT is very important in the evaluation of elbow pain and dysfunction , The coronal and Sagittal reformatting images were important in detection of para-osteal soft tissue abnormality .MRI was superior to other imaging modalities in assessment of painful elbow due to its better real multi-planar capability and highly tissue characterization.

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