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Ultrasound assessment of the elbow

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Abstract

Ultrasonography of the elbow is a very helpful and reliable diagnostic procedure for a broad spectrum of rheumatic and orthopedic conditions, representing a possible substitute to magnetic resonance imaging for evaluation of soft tissues of the elbow. Musculoskeletal ultrasound (US) shows many advantages over other imaging modalities, probably the most important being its capability to perform a dynamic assessment of musculoskeletal elements with patient's partnership and observation during examination. In addition, ultrasonography is cost effective, easy available, and has excellent and multiplanar capability to visualize superficial soft tissue structures. Among all imaging procedures, US is highly accepted by patients. US assessment of the elbow requires good operator experience in the assessment of normal anatomy, and suitable high-quality equipment. US of the elbow provides detailed information including joint effusions, medial and lateral epicondylitis, tears of the distal biceps and triceps tendons, radial and ulnar collateral ligament tears, ulnar nerve entrapment, cubital or olecranon bursitis and intra-articular loose bodies. The aim of this paper is to review the screening technique and the basic normal and pathological findings in elbow US.

Keywords: elbow, ultrasound, anatomy, synovitis, epicondylitis, ulnar nerve entrapment

Introduction

Ultrasonography (US) can provide clinically useful information about elbow joint involvement in a wide variety of pathologic conditions. In the rheumatology background most attention-grabbing are pathological changes of synovial space, joint surfaces, tendons and tendon insertions, as well as soft tissues around joint and peripheral nerves, such as the ulnar nerve [1-3].

Similarly to other imaging modalities, elbow US is still considered an operator-dependent procedure, thus it requires experienced operator and continuous clinical feedback in order to give reliable reports and diagnosis. Nevertheless, US of the elbow offers a number of advantages over other imaging tools such as magnetic resonance imaging, being less time consuming, having better cost-effectiveness ratio and superior spatial resolution and giving important possibility of dynamic examination [1,4,5].

Due to technical limitations of US, such as difficulties in contact with curved body surfaces, bone shadowing and diminished ability to visualize deep structures, US of the elbow should be performed according to a four-

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quadrant approach [1 3,5], represented by anterior, lateral, medial and posterior aspects of the elbow joint [1,5,6].

The aim of this review is to provide an introduction to US imaging of the elbow, and to summarize findings associated with basic rheumatic and orthopedic disorders.

Anterior elbow

US examination of the anterior aspect of the elbow should be performed with patient sitting and facing the operator with extended elbow lying on an appropriate table [1,5,6]. Structures of interest in this region in sequence from superficial to deep areas are: the brachialis muscle, the brachioradialis muscle, the pronator teres muscle, the distal biceps tendon, the radial vessels, the median nerve, the radial nerve, the supinator muscle, the extensor carpi radialis longus muscle, the flexor digitorum profundus muscle, the humeroulnar, the humeroradial and the proximal radioulnar joint [1-6] (fig 1). These three elbow joints share a common capsule and thus have common joint space [7].

With the probe positioned at the level of the brachialis muscle both in transverse and sagittal plan, the anterior coronoid recess of elbow joint is visualized in order to study the joint space and detect joint effusion and synovitis that are imaged as anechoic or hypoechoic material determining joint space widening of more than 2 mm when measured between the anterior aspect of humeral bone and joint capsule, accompanied with fat pad dislocation [1,3,7,8]. In patients with inflammatory arthritis US can depict pannus as a relatively hypoechoic non-displaceable tissue sometimes associated with effusion. Bone erosions are imaged as intra-articular discontinuities of the bony surface visible in 2 perpendicular planes [9].

One of the causes for anterior elbow pain is the rupture of distal biceps tendon (DBT), accounting for less than 5% of the biceps tendon pathology [1,10]. This tendon originates from two belies of the biceps brachii muscle, and it is approximately 7 cm long [1]. DBT is flattened and bent laterally before insertion to the medial surface of radial tuberosity. The tendon can be difficult to visualize, because of the local anisotropy due to its deep course and inclination at the point of its insertion [1,3]. The DBT has also an aponeurotic attachment on lacertus fibrosus, which is in close relation to the median nerve and brachial artery. The rupture typically occurs during lifting heavy objects by persons after 40 years of age. It is always presented clinically as palpable defect along anterior arm and with retracted biceps muscle forming a bulge [1,10]. Sometimes, these physical signs can be hidden due to appearance of large edema or hematoma. The complete tear can be imaged as total absence of the tendon, which is almost always markedly retracted, often more than 10 cm from the distal insertion [1,3]. Partial tears and tendinosis of the DBT are very uncommon [1]. The tendon, which has not a synovial sheath, is in close relashionship with the cubital bursa that is located between the tendon and the radial tuberosity, in order to reduce local friction during the movements of the joint. Occasionally, cubital bursitis can be an outcome of repetitive mechanical injuries, and sometimes it is able to mimic tenosynovitis on US screen, because the swollen bursa can surround the DBT [1,11].

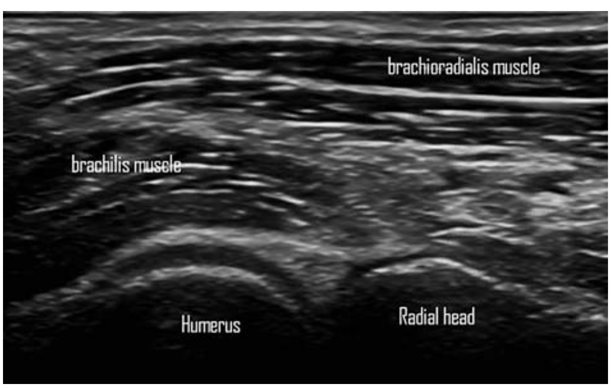

Fig 1. Ultrasound of the normal elbow. Longitudinal view of the anterior aspect of the elbow – radial side

Besides the knee joint, the elbow is probably the second most common site for detection of loose bodies in joint space [1]. The loose bodies are most often found in the anterior recess of the elbow. The surrounding joint effusion enhances their visualization, and in patients without joint effusion, the intra-articular injection of saline can improve the sensitivity of US in detecting them.

US can be of great help in depicting radiographically occult fractures of the radial head and separation of the distal humeral epiphysis in children. The fractures are always depicted with US as an interruption of cortical bone seen in two perpendicular planes [1,12,13].

Lateral elbow

The lateral elbow should be examined in semi extended position, with the probe longitudinal to the radial aspect of the joint [1,6].

Anatomical structures to be examined in this region of the elbow include the common extensor tendon origin (CEO) and the lateral collateral ligament (LCL). The CEO comprises the fused tendons of the extensor carpi radialis brevis, the extensor digitorum, the extensor digiti minimi and the extensor carpi ulnaris muscle, which attach at the front area of the lateral epicondyle of the humerus [1-5]. The common extensor tendon (CET) is a

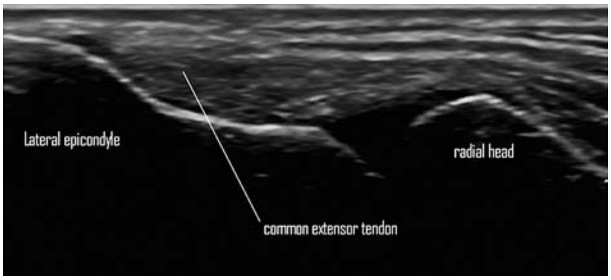

Fig 2. Ultrasound of the normal elbow. Longitudinal view of the lateral epicondyle and the common extensor tendon insertion

flattened, beak-shaped structure at the US examination (fig 2). The individual input of tendon fibers in the CET is impossible to be distinguished by US, but the extensor carpi radialis brevis makes up the most of deep portion, and the extensor digitorum comprises to the surface layer [1]. LCL is situated immediately deep to the CET, and it is in fact a complex formed by Radial Collateral Ligament (RCL), starting from the lateral epicondyle, continuing with annular ligament, which is surrounding radial head, and the Lateral Ulnar Collateral Ligament (LUCL), from the lateral epicondyle to the supinator crest of ulna. All these components of LCL are functioning as lateral stabilizer of the joint [1-3].

The most common disorder of the elbow is lateral epicondylitis, also known as "tennis elbow". The lateral epicondylitis is a lesion caused by excessive use of the CET, involving repetitive traction of osteotendinous attachment, and predominantly affecting the extensor carpi radialis brevis tendon [1]. The term "lateral epicondylitis" refers to a patho-histologic condition consisting of mucoid degeneration of the tendon, with a small number of inflammatory cells [1,14,15]. It is assumed that the condition is the result of frequent trauma causing very small tears of the tendon. US can be useful in confirmation of clinical diagnosis, revealing the severity of disease and its response to the treatment. US findings in patients with lateral epicondylitis are usually various: hypoechoic swelling of tendon insertion, adjacent bone attachment irregularity, focal or diffuse areas of decreased echogenicity in the tendon with loss of the fibrilar pattern, calcifications within the CET, discrete or massive cleavage sites inside the tendon, peritendinous soft tissue thickening, or thin layer of fluid superficial to the tendon insertion [1,3,4,6,14-16]. The most frequent finding is the injury of the deep fibers of the extensor carpi radialis brevis component of the CET [1,6,14]. However, during the early stage the lesions can be restricted to the superficial fibers. The anterolateral and middle segment of the CET are often involved, while the posterior part is usually spared [1]. In advanced disease, US can demonstrate bony spurs and cortical erosions adjacent to the insertion. These changes of insertion often do not correlate with disease activity in inflammatory conditions [1]. The use of power Doppler can show the presence of pathologic vascularity in case of local inflammation [17].

RCL sonographically appears as an echogenic thin fibrillar structure, located close to the deep fibers of the CET. In case of injury, this ligament becomes more clearly identifiable at US examination. The apparent injury is always accompanied with discontinuity of the ligament fibers, and sometimes with a small hematoma placed in proximity of the capitellum of the humerus [1,6]. LCL injury has been associated with lateral epicondylitis. It was stated that ligammentous injury can lead to failure of conservative treatment of epicondylitis [18,19].

Medial elbow

The medial portion of the elbow should be assessed with the patient in neutral position with the arm placed on an appropriate table [1-6]. Local anatomic structures to be examined by US include the common flexor tendon origin (fig 3), the ulnar collateral ligament (UCL) and the medial aspect of the elbow joint [1,6,20].

The common flexor tendon (CFT) attaches at the level of the medial epicondyle of the humerus, and is represented by the fusion of the tendons of pronator teres, flexor carpi radialis, flexor digitorum superficialis, palmaris longus and flexor carpi ulnaris. The CFT is broader and shorter than the CET, and is visibly separated from the adjacent local structures [1].

Medial epicondyltis, also known as „golfer's elbow", is a degenerative tendinosis that frequently involves the insertion of the CFT caused by overuse of the flexor-pronator group of forearm muscles. Patho-histologic analysis of the CFT in the medial epicondylitis has identified

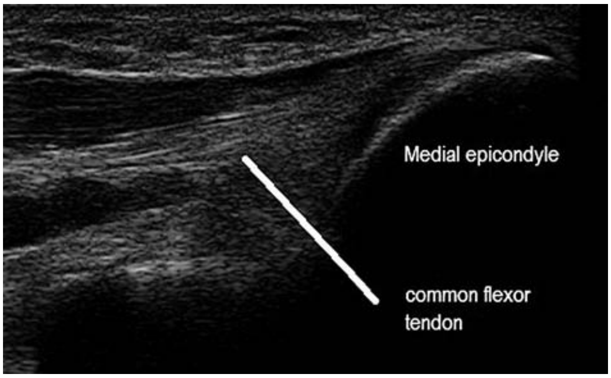

Fig 3. Ultrasound of the normal elbow. Longitudinal view of the medial epicondyle and the common flexor tendon insertion

a process of tendinosis with fibroblastic proliferation and fibrilar collagen degeneration [1,20]. US assessment of medial epicondylitis shows similar findings with lateral epicondylitis, with evidence of focal hypoechoic or anechoic areas in the tendon, cortical irregularity of the tendon insertion, tendon thickening, intratendineous calcifications and increased vascularity depicted by power-Doppler examination [1,20]. The majority of changes in the CFT are observed at the musculotendineous origin of flexor carpi radialis and pronator teres muscle, but sometimes tears can occur inside palmaris longus, flexor digitorum superficialis and flexor carpi ulnaris [1,20].

The UCL is much stronger than the RCL, and has typical triangular shape and is formed by three parts (6): the strongest is the anterior band, which is placed deep to the CFT and extended from the medial epicondyle to the coronoid process of the ulna; the posterior portion runs from the coronoid process to the olecranon; and the middle band connects the anterior and posterior parts.

The injuries of the UCL usually occur with or without tear of the adjacent CFT, commonly as a result of repeated subclinical trauma during throwing or posterior luxation of the elbow. US evaluation shows a ligament that appears as a thin hypoechoic band at the bottom of the CFT. In case of rupture, a hypoechoic or anechoic gap can be visualized within the ligament, often surrounded by some amount of fluid [1].

Posterior elbow

The posterior aspect of the elbow is examined by placing the patient in a "crab" position, with the joint flexed 90° degrees and the palm resting on the table [1-3]. The major structures of interest in this area are: the olecranon joint recess, the olecranon bursa, the triceps tendon and muscle, the cubital tunnel and the ulnar nerve [4-6]. The cubital tunnel and the ulnar nerve can be also examined with the elbow in semi-extension and pronation and with rocking movements of flexion-extension, to depict the nerve snapping around the medial epicondyle [1,21-23].

The olecranon fossa is fulfilled with a iso-echoic posterior fat pad. The detection of an anechoic or hypoechoic collection, deep in the olecranon fossa, together with the dislocation of the fat pad represents a sign of elbow joint effusion that is easily displaced at probe compression. In presence of synovitis, synovial hypertrophy and thickening can be detected by US; in addition, in case of active inflammation local hypervascularity can be demonstrated by power-Doppler [1-3,6,24].

Olecranon bursitis is easily detected by US, showing the bursal wall distension with presence of local hypoechoic or anechoic intra-bursal material [1,25]. Doppler modalities are able to demonstrate the presence of pathological signal in case of local active inflammation. In case of crystal-deposition diseases hyperechoic spots inside the bursa can be demonstrated by US.

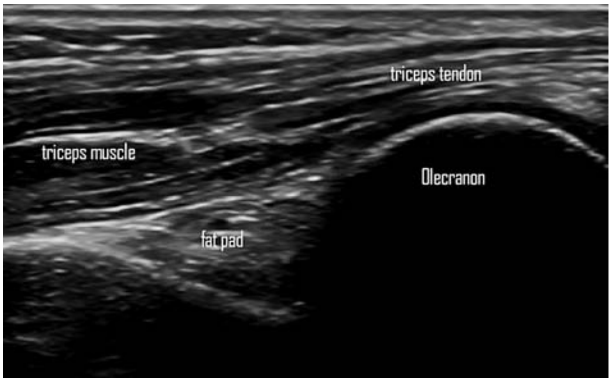

Fig 4. Ultrasound of the normal elbow. Long axis view of the triceps tendon and posterior recess of the elbow

The distal triceps tendon (DTT) attaches at the posterior and the superior part of the olecranon process [1,3,6] (fig 4). Acute tear of the distal triceps tendon can constitute a cause of ulnar nerve compression syndrome. This can happen with or without snapping of the medial triceps belly around medial epicondyle. In case of complete tendon tear, US is able to depict a retracted and wavy tendon with various degrees of local effusion [1,3]. Tears and tendinosis of the distal triceps tendon can be demonstrated by US evaluation [1].

The cubital tunnel is a relatively long bony and fibrous channel extending all over the posterior and the medial aspect of the elbow. The boundaries of the cubital tunnel include the olecranon process, the medial epicondyle and a fibrous retinaculum called the Osborne fascia. The retinaculum carries on distally with an arcuate aponeurosis placed between the ulnar and the humeral bellies of the flexor carpi ulnaris muscle [1,3-6]. US examination of the cubital tunnel is performed by keeping the patient's arm abducted over the examination table [1]. Clinical symptoms of the ulnar nerve compression include pain at medial aspect of the elbow, sensory symptoms like the paresthesia or anesthesia of the fourth and fifth fingers and corresponding skin of the palmar and dorsal aspect of the hand, and weakness and muscle atrophy [1,20,23,26]. The weakness can be prominent in the dorsal interosseous muscles, the abductor digiti minimi, the flexor digitorum profundus of the fourth and fifth digits (which flexes the distal phalanges of those fingers) and the flexor carpi ulnaris muscle (flexion at the wrist in the ulnar direction) [27].

The clinical diagnosis can be complicated because the sensory and the motor symptoms can also arise in conditions like cervical radiculopathy, brachial plexopathy, peripheral polyneuropathy and the occasional ulnar nerve entrapment inside Guyon's canal [26,27]. US assessment of the ulnar nerve may be used to support the clinical and electrophysiological diagnosis of compressive ulnar neuropathy at the cubital tunnel [1,21-23,26]. It may also be helpful in identifying the causes that determine nerve entrapment (nerve snapping around medial epicondyle, olecranon fractures and injuries, bone deformities or spurs in the condylar groove, loose bodies, rarely tumors, ganglion cysts) [1,26].

On the transverse approach the ulnar nerve is seen as an oval structure that, sometimes appears bifid, with a hypoechoic fascicular pattern; it is located close to the bony surface of the medial epicondyle. Throughout progressive flexion of the elbow in some cases (mainly with congenitally short or absent retinaculum of the cubital tunnel) the ulnar nerve can be temporally dislocated. This condition can consist of either intermittent anterior displacement from the medial epicondyle, or snapping out from the channel [1].

The entrapment of the ulnar nerve at the elbow is the second most prevalent compressive neuropathy, after entrapment of the median nerve in the carpal tunnel [26]. Occasionally, repeated friction and contact with bony surface can cause neuritis and functional loss [1,21,22,26]. The lesion of the ulnar nerve can take place at the bony surface of the medial epicondyle, but also at the edge of the arcuate ligament [1,26].After compression, the ulnar nerve appearance on US is usually represented by narrowing of its distal part, and marked swelling of the proximal part with a hypoechoic aspect [1,26]. The entrapped nerve shows enlarged cross-sectional area proximally from the site of compression with respect to normal opposite side [1]. The US finding that seems to be the most helpful is an increase of either the diameter or the cross-sectional area of the nerve, just proximal to the site of compression [1,21-23,26].

Conclusions

Although elbow is not as frequently affected in rheumatic disorders as knee or shoulder, US of the elbow might be very useful in making a precise diagnosis of the lesion. The possibility of directly visualizing tendons insertion, nerves and joint spaces increases the accuracy of clinical examination and allows a direct approach by guided injections for appropriate pathology. The increasing number of publications on that matter are a prove for that. Also, as elbow is included in clinical scores available for RA, visualization of fluid and synovitis in the elbow makes the quantification of disease activity more accurate.

Conflict of interest: none

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