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ORIGINAL ARTICLE

Diagnostic Role of High-Resolution US and MRI in Evaluation of Ulnar Nerve Entrapment Neuropathy and Soft Tissue Injuries Around the Elbow Joint

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ABSTRACT

Background: Excessive use disorders and inflammatory conditions often affect the elbow. Different types of imaging can be utilized to evaluate the elbow, such as computed tomography (CT), Magnetic resonance imaging (MRI), and ultrasonography (US). Imaging has an important role as it helps in evaluating elbow tendons and ligaments and bony lesions. This study aims to investigate the role of high-resolution ultrasound and MRI in assessing entrapment neuropathies and soft tissue injuries surrounding the elbow joint.

Methods: The current research was conducted as a cross-sectional analysis and involved thirty participants that presented with elbow pain and /or any discomfort in elbow area. All patients underwent elbow US and MRI studies.

Results: On evaluating diagnostic accuracy of US in comparison to MRI as the gold standard test in patients with ulnar neuropathy; US showed a 90% sensitivity and 84.2% specificity. On evaluating the diagnostic accuracy of US in comparison to MRI as the gold standard test in patients with epicondylitis tendinopathy; US showed a 93.3% sensitivity and 86.7% specificity. On evaluating the diagnostic accuracy of US in comparison to MRI as the gold standard test in patients with distal biceps brachii injury; US showed 66.7% sensitivity and 76.2% specificity.

Conclusion: Ulnar nerve entrapment and neuropathy in the elbow region is a frequent entrapment mono-neuropathy. Our findings indicate that the use of ultrasound (US) is an accurate and precise tool for identifying ulnar neuropathy at the elbow and can be used in conjunction with other diagnostic techniques to increase diagnostic reliability. Additionally, US is becoming more and more preferred for the diagnosis of medial and lateral epicondylitis with high sensitivity & specificity. However, in terms of diagnosing and classifying distal biceps brachii injuries, ultrasound demonstrated lower sensitivity than MRI, which was attributed to deep anatomic structures and problematic patient positioning.

Keywords: Ultrasound; MRI; Soft tissue; Ulnar; Elbow

INTRODUCTION

Currently, both ultrasound (US) and magnetic resonance imaging (MRI) offer thorough assessments of the elbow joint and surrounding nerves. These imaging techniques are primarily employed to diagnose compressive and traumatic injuries affecting the joint and nerves. Numerous studies have outlined the methodologies and diagnostic potential of these imaging modalities for such purposes (1).

Nerves in the upper extremities are vulnerable to various types of injury, with the majority involving compression or trauma. In addition to the median, ulnar, and radial nerves, there are other motor and sensory nerves that must also be considered. Although MRI is valuable due to its high contrast resolution, ultrasound is the favored modality in clinical practice because of its superior spatial resolution, ease of accessibility, and cost-effectiveness (2).

When investigating entrapment neuropathies, there are three key goals: confirming nerve dysfunction, identifying the cause of compression, and ruling out other conditions affecting the nerve. In cases of traumatic nerve injury, imaging, particularly ultrasonography can provide critical information about the type of nerve damage, its exact location, and any potential spread to nearby tissues (3).

Ulnar neuropathy is the second most common entrapment neuropathy after carpal tunnel syndrome. The ulnar nerve can become compressed at various points in the upper extremity, including the wrist, elbow, and arm. Identifying the exact location of ulnar nerve injury is essential for clinical and therapeutic management. The most frequent site of ulnar nerve entrapment is at the elbow, specifically in the cubital tunnel, a condition referred to as ulnar neuropathy at the elbow (UNE). Diagnosis is made through a combination of patient history, clinical examination, and electrodiagnostic testing. Ultrasound has been proposed as an accurate and non-invasive diagnostic tool, especially when electrodiagnostic tests yield false-negative or non-localizing results. However, ultrasound is not yet included in standard guidelines due to conflicting findings in patients with UNE and those without neuropathy (4).

MRI is commonly used to evaluate ulnar neuropathy. To date, no studies have assessed the diagnostic value of combining ultrasonography with MRI for UNE (5).

Tendinopathy of the common extensor tendon (CET) at the lateral humeral epicondyle, also known as lateral epicondylitis (LE), lateral epicondylalgia, or tennis elbow, affects up to 1.3% of the population. This condition typically stems from an issue at the CET enthesis, particularly involving the extensor carpi radialis brevis tendon. Lateral epicondylitis is characterized by pain and tenderness over the lateral humeral epicondyle, along with discomfort during resisted dorsiflexion and radial deviation of the wrist. While diagnosis is primarily clinical, imaging may be used when traditional treatments fail (6).

Currently, MRI is considered the most reliable imaging technique for diagnosing chronic elbow pain. However, its high cost and contraindications limit its widespread use. Ultrasound, on the other hand, offers several advantages, including availability, non-invasiveness, cost-effectiveness, and the absence of contraindications. As a result, ultrasound is increasingly recognized as a valuable tool for diagnosing tendon pathologies like lateral epicondylitis. Despite this, few studies have compared the diagnostic accuracy of ultrasound to MRI in detecting CET tears (5).

The goal of this research is to examine the role of high-resolution ultrasound and MRI in evaluating entrapment neuropathies and soft tissue injuries around the elbow joint.

METHODS

This study was a cross-sectional analysis involving thirty participants who experienced elbow pain or discomfort conducted at the Radiology Department of Zagazig University Hospital. The research spanned from May 2023 to May 2024. Institutional review board (IRB) approval was obtained (ZU-IRB #6419/20-9-2020), and written consent was collected from all participants prior to the study's initiation. The research adhered strictly to the ethical principles outlined in the Declaration of Helsinki, ensuring the protection of all individuals involved.

Participants included in the study were those referred from the Rheumatology and Orthopedic outpatient clinics with elbow pain or discomfort. Exclusion criteria applied to individuals with metallic implants, pacemakers, intra-ocular foreign bodies, cochlear implants, or claustrophobia. Each patient underwent thorough history taking, detailing the exact location of the pain, symptom onset, injury mechanism (e.g., trauma, sports injury, or autoimmune conditions such as rheumatoid arthritis), and additional symptoms like tingling, numbness, swelling, or limited movement.

Electrophysiological data for the ulnar nerve was collected from the patients' medical records when available and compared to the US studies.

Imaging Techniques:

A. Ultrasound Examination

Ultrasound was performed using a Toshiba Aplio 500 machine at Zagazig University Hospital's Radiology Department. High-frequency linear transducers (10-18 MHz) were used, along with Color and Power Doppler imaging to detect hyperemia and assess the regional structures. An experienced sonographer, who was blinded to the clinical data, performed the ultrasound assessments.

A.i. Anterior elbow assessment: The elbow was fully extended, and the palm faced upward. The transducer was placed perpendicularly on the humerus for both transverse and longitudinal images 5cm above and below the joint, focusing on the biceps brachii.

A.ii. Medial elbow assessment: The elbow was externally rotated and extended, with the transducer aligned along the forearm. The medial epicondyle, common flexor tendon, and ulnar nerve were evaluated.

A.iii. Lateral elbow assessment: The arm was rotated inward and slightly flexed. The transducer was positioned longitudinally over the lateral elbow to assess the common extensor tendon.

Posterior elbow assessment: The elbow was often examined in flexed position while the palm is flat on the table (the "crab" position) to evaluate the triceps tendon to its insertion (long and short axis), the olecranon fossa (examining at 45° flexion may increase the amount of fluid in the fossa, if any).

A.iv. Image interpretation by US:

Main soft tissues lesions detected such as common extensor origin (Lateral epicondylitis), common flexor origin (Medial epicondylitis). The triceps and distal bicep brachii were examined carefully in both the axial and longitudinal views for detection of any lesions- tendinosis (tendon thickening), tendon thinning, hyper-echogenicity, hypo-echogenicity and edema- Partial tear: Anechoic clefts and incomplete fiber discontinuity- Complete tear: Complete tendon discontinuity and retraction.

The ulnar nerve was examined at three levels: 4 cm proximal to the medial epicondyle, 4 cm distal, and the largest cross-sectional area between these points. The probe was carefully aligned to ensure accurate measurements of the cross-sectional area (CSA) at each level. Ulnar nerve morphological changes: Caliber changes, fascicular changes and presence of neuroma- Ulnar nerve sonographic changes: nerve hypo echogenicity and caliber changes ats site of entrapment.

B. Magnetic Resonance Imaging (MRI)

The MRI was conducted using a Philips Achieva 1.5T dStream machine. The patients were reassured and informed about the procedure and the importance of remaining still.

B.i. Patient positioning: All scans were performed with the patient in a supine position, arm at their side, and palm facing up. A 16-L flex coil was used for the elbow imaging.

B.ii. MRI protocol: The imaging sequence included T1-weighted and T2-weighted images in axial, sagittal, and coronal planes. Additionally, coronal STIR images and specific sequences for magnetic resonance neurography (STIR and FIESTA) were obtained. The field of view (FOV) ranged from 12 to 16 cm, with a matrix size of 256 x 256. Slice thickness varied between 2-4 mm, with inter-slice gaps of 0.2-0.5 mm.

B.iii. MRI Image interpretation: Two radiologists (H.A.M. and A. A. E) with 16 and 10 years of experience in musculoskeletal MRI, respectively) independently, and in a blinded fashion, reviewed all MRI data using the picture archiving and communication system (PACS; Paxera Ultima, Paxera Viewer version 5.0.9.6, Paxera Health, Newtone, MA, USA). Clinical data and operative reports were concealed from the radiologists. The images were assessed for the presence of common extensor, common flexor, and distal biceps brachii lesions defined by partial or complete tendon discontinuity “high signal cleft at T2 & STIR images” or non-visibility, peri tendinous edema, or avulsion injuries “better evaluated at T1 WIs”. Any tendon injury was assessed on the axial, coronal, and sagittal images. Furthermore, the ulnar nerve was evaluated at the axial images for caliber changes, nerve discontinuity, entrapment, and neuroma. Finally, the radiologists assigned a final MRI diagnosis of the tendon lesions and UN status as positive or negative based on subjective assessment.

Statistical Analysis

Data were analyzed using SPSS 20 software. Qualitative data were expressed as frequencies and percentages, while quantitative data were presented as mean ± standard deviation (SD) after normality testing with the Shapiro-Wilk test. The significance level (P value) determined statistical outcomes, with results deemed significant at $P \leq 0.05$. ANOVA or Kruskal-Wallis tests were used for comparisons between more than two independent samples.

RESULTS

The study involved 30 patients who presented with elbow pain, limited joint movement, or paresthesia. Of the total number of participants, 18 were male (60%) and 12 were female (40%). The age of the patients ranged from 32 to 64 years, with a mean age of 50.2 ± 8.3 years. The most frequent diagnosis was epicondylitis, observed in 50% of the patients, followed by ulnar nerve neuropathy in 36.7%, and distal biceps brachii tendon injuries in 30% of the cases (Table 1).

Fifteen patients underwent electrophysiological studies of the ulnar nerve, and out of these, 10 were found to have ulnar neuropathy. Among these patients, 5 (33.3%) had mild neuropathy, 3 (20%) had moderate neuropathy (Figures 1 and 2), and 13.3% were diagnosed with severe neuropathy according to their nerve conduction studies (NCS). The cross-sectional area (CSA) of the ulnar nerve was measured using ultrasound with a mean of 5.2 ± 2.9 mm, ranging from 3 to 14 mm. A statistically significant difference was found between ulnar nerve CSA and neuropathy severity based on NCS results ($p<0.05$), indicating that as CSA increased, the severity of neuropathy also increased (Table 2).

When comparing the diagnostic performance of ultrasound to MRI (used as the reference standard) for detecting ulnar neuropathy, ultrasound exhibited a sensitivity of 90% (95% confidence interval: 58.7% to 99.8%) and a specificity of 84.2% using 95% confidence interval: 60.4% to 96.6% (Table 3).

For the assessment of tendon injuries, the common extensor (lateral epicondylitis) and common flexor tendons (medial epicondylitis) were both evaluated with ultrasound and MRI. Lateral epicondylitis was more common, affecting 33.3% of patients (Figures 2 and 3), whereas medial epicondylitis was present in 16.7%. The diagnostic accuracy of ultrasound for epicondylitis was high, with a sensitivity of 93.3% using 95% confidence interval: 86.1% to 99.8% and specificity of 86.7% using 95% confidence interval: 59.5% to 98.3% (Table 4).

The distal biceps brachii tendon was also assessed using ultrasound and MRI. MRI confirmed tendon injuries in nine patients, while ultrasound detected tendon abnormalities in six patients. The sensitivity and specificity of ultrasound for detecting distal biceps brachii tendon injuries were 66.7% using 95% confidence interval: 29.9% to 92.5% and 76.2% using 95% confidence interval: 52.8% to 91.8%, respectively (Table 5 and Figure 4).

Table 1: Baseline data among studied patient including demographic data, presenting symptoms, NCS, and UN CSA by US.

Variable	Patients (N=30) (N. %)
Age: mean±SD range median (IQR)	 50.2±8.3 (32 – 64) 49.5 (12.5)
Sex: - Male - Female	 18 (60%) 12 (40%)
Etiology (N. %) Inflammatory Mechanical	 8 (26.7%) 22 (73.3%)
Laterality (N. %) Right Left	 19 (63.3%) 11 (36.7%)
Disease duration (days) mean±SD range median (IQR)	 20.6±6.7 (4-36) 20 (7.8)
Presenting symptoms Tingling & numbness (N. %) Pain (N. %) Limitation of movement (N. %)	 12 (40%) 22 (73.3%) 6 (20%)
NCS: (n=15) – Normal – Mild – Moderate – Severe	 5 (33.3%) 5 (33.3%) 3 (20%) 2 (13.3%)

Variable	Patients (N=30) (N. %)
US CSA (mm) mean±SD Range Median(IQR)	 5.2±2.95 (3-14) 4 (3)

Table 2: CSA of the ulnar nerve at the elbow in different ulnar neuropathy severity groups (using Kruskal-Wallis test).

	NCS findings				P-value
	Normal (n=5)	Mild (n=5)	Moderate (n=3)	Severe (n=2)	
CSA (mm) mean±SD (range)	 3.6±0.5 (3-4)	 6±0.1 (6-7)	 9.3±0.6 (9-10)	 13.5 ±0.7 (13-14)	**0.004**

Table 3: Ulnar neuropathy by US and MRI among studied patients (n=30).

		MRI		Total	Diagnostic accuracy
		Positive	Negative		
US	**Positive**	10	3	13	Sensitivity = 90% Specificity = 84.2% Accuracy = 86.7% PPV = 76.9% NPV = 94.1%
	Negative	1	16	17	
	Total	11	19	30	

Table 4: Epicondylitis tendinopathy by US and MRI among studied patients (n=30).

		MRI		Total	Diagnostic accuracy
		Positive	Negative		
US	**Positive**	14	2	16	Sensitivity = 93.3% Specificity = 86.7% Accuracy = 90% PPV = 87.5% NPV = 92.9%
	Negative	1	13	14	
	Total	15	15	30	

Table 5: Distal biceps brachii by US and MRI among studied patients (n=30).

		MRI		Total	Diagnostic accuracy
		Positive	Negative		
US	**Positive**	6	5	11	Sensitivity = 66.7% Specificity = 76.2% Accuracy = 73.3% PPV = 54.5% NPV = 84.2%
	Negative	3	16	19	
	Total	9	21	30	

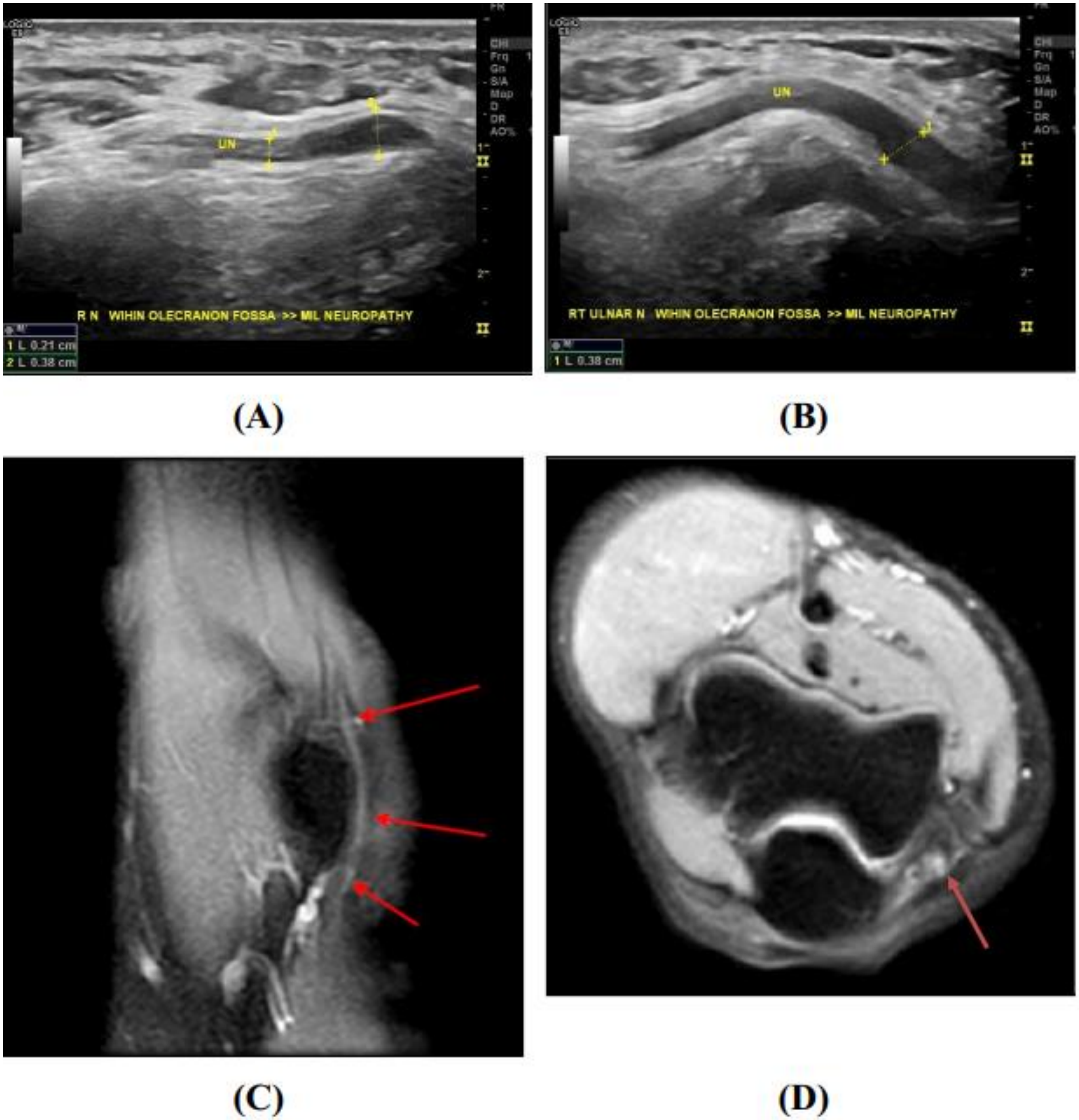


Figure 1: 58 years old female patient complaining of right medial elbow pain, weakness, numbness, and decreased strength of the hand grip for about 8 months. Grey scale ultrasound scan revealed swollen ulnar nerve and increased its cross sectional area about 14 mm^2 and AP diameter 3.8 mm with loss of its fasciculations within the cubital tunnel denoting moderate ulnar nerve entrapment, (Fig. A) & (Fig. B). MRI images revealed swollen ulnar nerve with T2 hyperintensity within the cubital tunnel at sagittal STIR images (Fig. C), and axial PDW Fat Sat images "red arrows" (Fig.D), no nerve tear or neuroma seen.

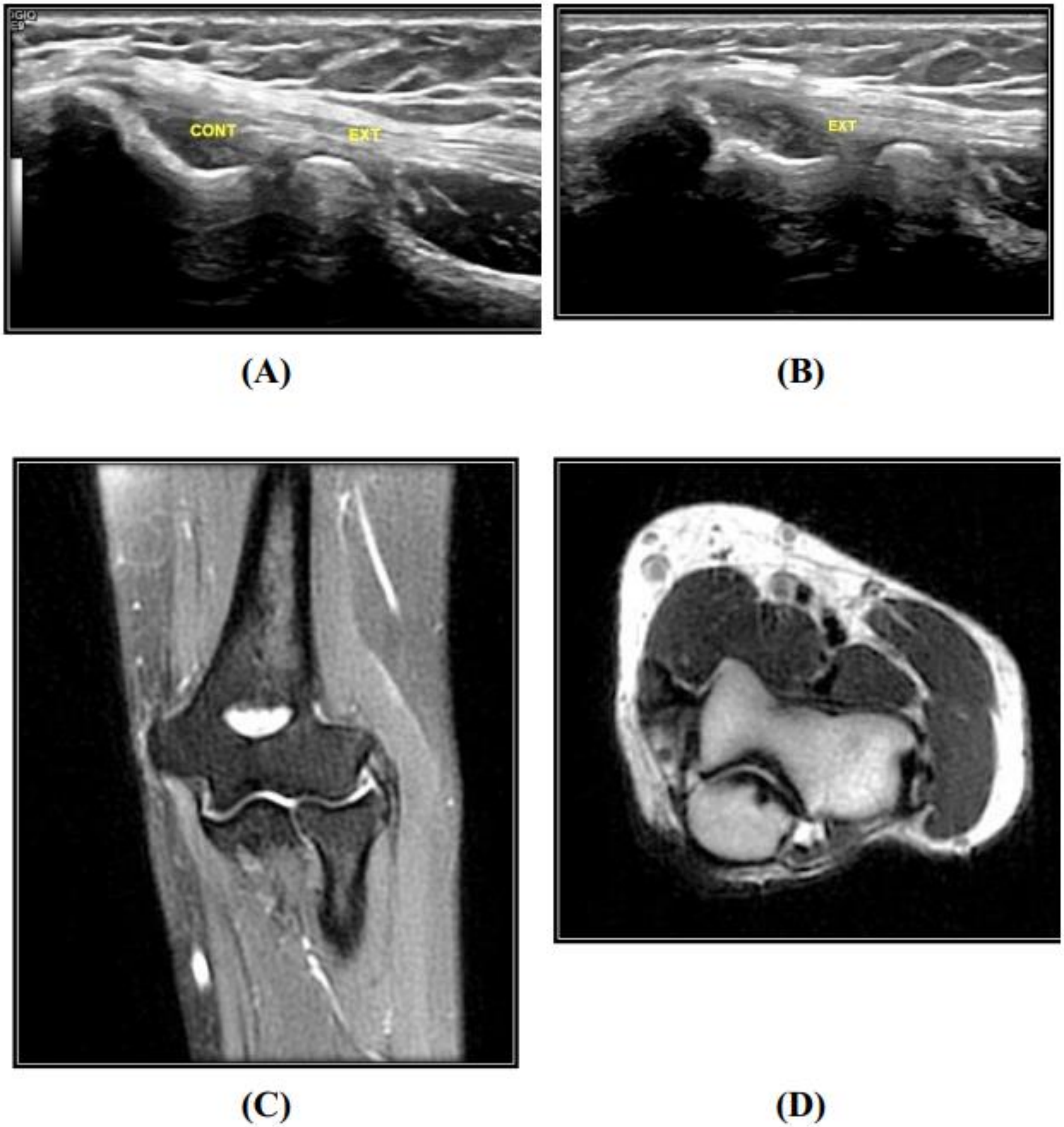
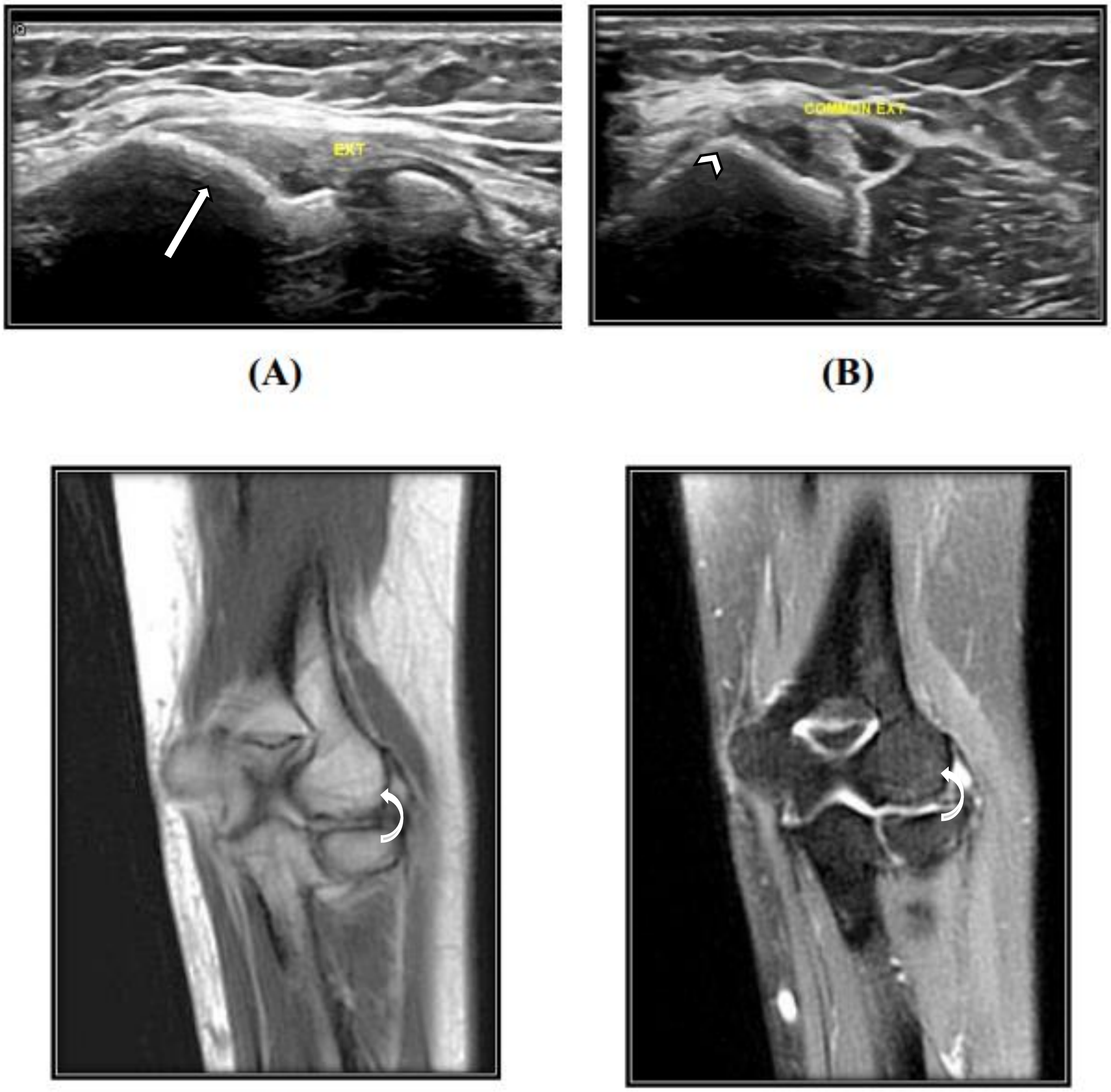


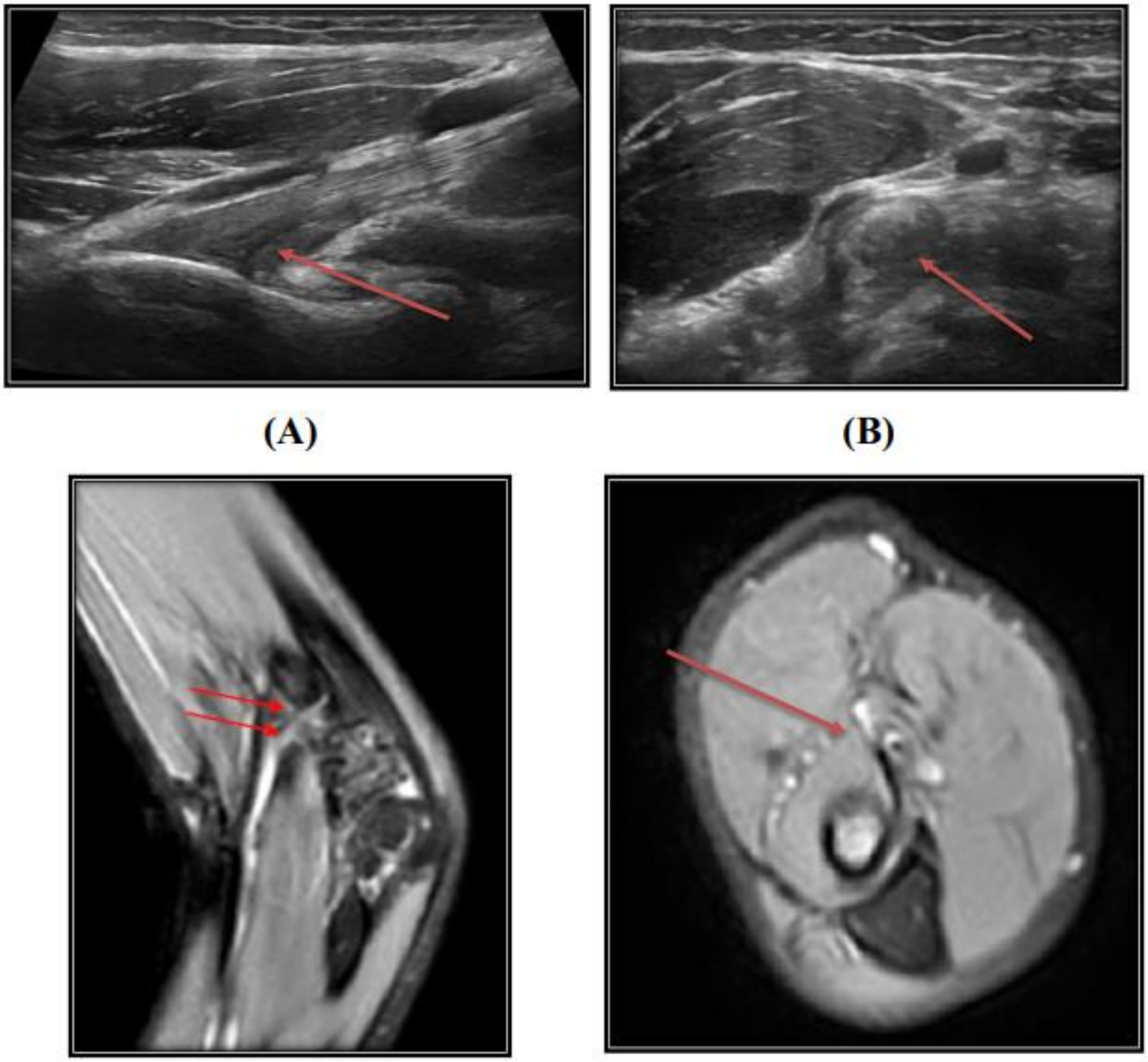
Figure 2: 51 years old female complaining of Right lateral elbow pain extending to the dorsum of the forearm for about 6 months .Grey scale ultrasound scan revealed thickening of the CET, associated with area of focal hypo echogenicity “arrow” (Fig. A) and cortical irregularities at the lateral humeral epicondyle denoting lateral epicondylitis with osseus changes “arrow head” (Fig. B). MRI images revealed mild thickening of the CET, associated with focal area of intra tendinous hyperintensity seen within common extensor tendon near itshumeral attachment at Coronal STIR “arrow” (Fig. C), and axial T2 images “arrow head” (Fig. D), no tendon tear or retraction.



(A) (B)

(C) (D)

Figure 3: 43 years old male patient complaining of left lateral elbow pain and limitation of movement for about 3 months. Grey scale ultrasound scan revealed focal area of hypoechogenicity seen within deep part of the common extensor tendon with partial interruption of itscontinuity in LS view “arrow” (Fig. A) and TS view “arrow head” (Fig. B). MRI images revealed partial interruption of the common extensor tendoncontinuity with abnormal fluid signal seen within its substance at coronal T2 WIs “curved arrow” (Fig. C), and coronal STIR images “curved arrow” (Fig. D).



(A) (B)

(C) (D)

Figure 4: 48 years old male patient complaining of left anterior elbow pain andlimitation of movement for about 2 months. Grey scale ultrasound scan “anterior approach” revealed focal area of hypoechogenicity seen within the distal biceps brachii tendon near its insertion with mild surrounding edema in LS view (Fig. A) and TS view “red arrows” (Fig. B). MRI images revealed partial interruption of the distal biceps brachii tendon near its radial attachment with mild surrounding edema at sagittal STIR (Fig. C), and axial STIR images “red arrows” (Fig. D).

DISCUSSION

MRI is widely recognized for its high precision in evaluating ligaments and tendons around the elbow joint and its ability to detect a variety of soft tissue and skeletal abnormalities. Ultrasonography offers several advantages, including speed, cost-effectiveness, accessibility, and greater comfort for patients. It is particularly useful for individuals with claustrophobia or those who cannot undergo MRI due to contraindications (7).

The objective of this research was to evaluate the diagnostic performance of high-resolution ultrasonography and MRI in detecting ulnar nerve entrapment neuropathy and soft tissue injuries around the elbow joint. Ulnar neuropathy at the elbow, which occurs when the ulnar nerve is compressed in the cubital tunnel due to repetitive elbow movement, trauma and anatomical abnormalities, was a focal point of the study. Physiological compression can occur when the tunnel's volume decreases during elbow flexion (8).

The study identified a strong relationship between increased ulnar nerve CSA and the severity of ulnar nerve dysfunction, as indicated by electrophysiological studies. This was particularly evident in patients who reported numbness and tingling in the fourth and fifth digits, weakness or clumsiness in hand muscles controlled by the ulnar nerve, and pain in the medial aspect of the elbow. Some patients also presented with sensory loss in the ulnar nerve distribution and muscle weakness in the hand muscles innervated by the ulnar nerve.

These results align with the study by Ellegaard et al. (8), who found that patients with significant axonal loss, as opposed to demyelination, had larger nerve CSA. Their findings also confirmed that ultrasound is a reliable diagnostic tool for detecting ulnar neuropathy, especially when electrodiagnosis is unavailable. Similarly, another study found a significant correlation between the CSA of the ulnar nerve and the severity of neuropathy as indicated by nerve conduction studies (9).

A further study identified a notable relationship between nerve conduction velocity at the elbow and the ulnar nerve CSA (10). In the current study, MRI diagnosed ulnar nerve lesions in 11 patients, while ultrasound detected the condition in 10, with 1 false-negative case. Ultrasound showed 90% sensitivity (95% confidence interval: 58.7%–99.8%) and 84.2% specificity (95% confidence interval: 60.4%–96.6%) in detecting ulnar neuropathy. These results are in line with Kim et al. (11), who reported 93.8% sensitivity and 88.3% specificity for ultrasound. Similarly, Rayegani et al. (9) found 84% sensitivity and 80% specificity for ultrasound in diagnosing ulnar neuropathy.

Regarding tendinopathy, this study found that lateral epicondylitis (66.7%) was more prevalent than medial epicondylitis (33.3%) in the studied population. Comparative analysis between ultrasound and MRI for the diagnosis of epicondylitis revealed an ultrasound sensitivity of 93% and specificity of 86.7%. These findings are consistent with Bachta et al. (5), who reported that ultrasound demonstrated a sensitivity of 94.52% for detecting common lateral elbow tendinopathy, compared to 100% for MRI.

These results also concur with Konarski et al. (12), who reported that ultrasound showed a sensitivity of 95% and a specificity of 92% in diagnosing epicondylitis. Ultrasound remains a practical and accessible alternative to MRI, although MRI is often regarded as the gold standard for diagnosing distal biceps ruptures. However, the time and expense required for MRI could affect the timing and success of subsequent surgical intervention (13).

In this study, nine patients were found to have distal biceps brachii tendon injuries on MRI, while ultrasound detected abnormalities in six patients, yielding a sensitivity of 66.7% and specificity of 76.2% (14). Rodríguez et al. (15) found that both ultrasound and MRI had high sensitivity and specificity for diagnosing distal biceps tendon ruptures, with ultrasound achieving over 85% sensitivity and MRI achieving over 98%. Despite MRI’s higher sensitivity and specificity, ultrasound remains a reliable and cost-effective diagnostic tool and could serve as the initial modality for evaluating partial or complete distal biceps tendon ruptures in patients presenting with relevant symptoms.

The diagnostic accuracy of ultrasound for detecting complete distal biceps tendon ruptures was reported by Tagliafico et al. (16) to be 95% sensitive and 71% specific. Discrepancies in results, such as those seen in this study, may be due to the challenges of imaging deep structures with ultrasound, as well as the importance of operator expertise and familiarity with musculoskeletal ultrasound techniques

Limitations

This study was a monocentric study with a relatively small sample size, many patients were not included due to the lack of MRI studies.

In addition, the limitations of ultrasound, the examination of deep anatomic structures, the reliance on skilled operators, and musculoskeletal radiologists familiar with the imaging modality are some of the imaging pitfalls of US.

CONCLUSION

The elbow is commonly affected by conditions related to overuse and inflammation. Due to its speed, affordability, widespread availability, and ease of use for patients, ultrasound imaging has emerged as a highly effective tool for assessing elbow joints and soft tissue issues. It also serves as a useful alternative for individuals who experience claustrophobia during MRI procedures.

Ulnar neuropathy, a frequent form of entrapment mono-neuropathy at the elbow, can be effectively diagnosed using ultrasound. Our findings suggest that ultrasound is both sensitive and specific in detecting ulnar neuropathy and can be used alongside other diagnostic methods to enhance diagnostic accuracy.

Moreover, ultrasound is increasingly favored for diagnosing medial and lateral epicondylitis, offering high sensitivity and specificity. However, when it comes to diagnosing and evaluating injuries of the distal biceps brachii, ultrasound has shown lower sensitivity compared to MRI, likely due to the challenges posed by the depth of anatomical structures and difficulties in patient positioning.

Recommendations

Further Prospective research with larger sample size and multi centric designs may be needed to validate and generalize the findings. Second, we didn't evaluate other tendons and nerves around elbow joint as our study was limited to non-traumatic soft tissue injuries, third the wide age range of patients may screw the results, further research is required to better understand the relationship between age and various injuries around elbow joint.

Conflict of interest

The authors declared that they have no conflicts of interest with respect to authorship and/or publication of this article.

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REFERENCES

1. De la Fuente J, Blasi M, Martínez S, Barceló P, Cachán C, Miguel M, Pedret C. Ultrasound classification of traumatic distal biceps brachii tendon injuries. Skeletal Radiology. 2018 Apr;47:519-32.Sampath SC, Sampath SC, Bredella MA. Magnetic Resonance Imaging of the Elbow : A Structured Approach. 2013;5(1), 34-49.
2. Cha YK, Kim SJ, Park NH, Kim JY, Kim JH, Park JY. Magnetic resonance imaging of patients with lateral epicondylitis: Relationship between pain and severity of imaging features in elbow joints. Acta Orthopaedica et Traumatologica Turcica. 2019 Sep 1;53(5):366-71.
3. Deniel A, Causeret A, Moser T, Rolland Y, Dréano T, Guillin R. Entrapment and traumatic neuropathies of the elbow and hand: an imaging approach. Diagnostic and Interventional Imaging. 2015 Dec 1;96(12):1261-78.
4. Agarwal A, Chandra A, Jaipal U, Saini N. Imaging in the diagnosis of ulnar nerve pathologies—a neoteric approach. Insights into imaging. 2019 Dec;10:1-2.
5. Bachta A, Rowicki K, Kisiel B, Żabicka M, Elert-Kopeć S, Płomiński J, Tłustochowicz W, Maliborski A. Ultrasonography versus magnetic resonance imaging in detecting and grading common extensor tendon tear in chronic lateral epicondylitis. PLoS One. 2017 Jul 27;12(7):e0181828.
6. Piccolo CL, Galluzzo M, Ianniello S, Trinci M, Russo A, Rossi E, Zeccolini M, et al. Pediatric musculoskeletal injuries: role of ultrasound and magnetic resonance imaging. Musculoskeletal surgery. 2017 Mar;101:85-102.
7. Michelin P, Leleup G, Ould-Slimane M, Merlet MC, Dubourg B, Duparc F. Ultrasound biomechanical anatomy of the soft structures in relation to the ulnar nerve in the cubital tunnel of the elbow. Surgical and Radiologic Anatomy. 2017 Nov;39:1215-21.
8. Ellegaard HR, Fuglsang-Frederiksen A, Hess A, Johnsen B, Qerama E. High-resolution ultrasound in ulnar neuropathy at the elbow: a prospective study. Muscle & nerve. 2015 Nov;52(5):759-66.
9. Rayegani SM, Raeissadat SA, Kargozar E, Rahimi-Dehgolan S, Loni E. Diagnostic value of ultrasonography versus electrodiagnosis in ulnar neuropathy. Medical Devices: Evidence and Research. 2019 Feb 22:81-8.
10. Scheidl E, Böhm J, Farbaky Z, Simó M, Bereczki D, Arányi Z. Ultrasonography of ulnar neuropathy at the elbow: axonal involvement leads to greater nerve swelling than demyelinating nerve lesion. Clinical Neurophysiology. 2013 Mar 1;124(3):619-25.
11. Kim JH, Won SJ, Rhee WI, Park HJ, Hong HM. Diagnostic cutoff value for ultrasonography in the ulnar neuropathy at the elbow. Annals of rehabilitation medicine. 2015 Apr;39(2):170.
12. Konarski W, Poboży T, Kotela A, Hordowicz M, Poboży K. Ultrasound in the Differential Diagnosis of Medial Epicondylalgia and Medial Elbow Pain—Imaging Findings and Narrative Literature Review. InHealthcare 2022 Aug 13 (Vol. 10, No. 8, p. 1529). MDPI.
13. Miller TT, Shapiro MA, Schultz E, Kalish PE. Comparison of sonography and MRI for diagnosing epicondylitis. Journal of clinical ultrasound. 2002 May;30(4):193-202.
14. de la Fuente J, Blasi M, Martínez S, Barceló P, Cachán C, Miguel M, Pedret C. Ultrasound classification of traumatic distal biceps brachii tendon injuries. Skeletal Radiology. 2018 Apr;47:519-32.

15. Rodríguez CG, López CG, Del Olmo Hernández T, Marco SM, Edo OJ, Lafuente JÁ. Distal biceps tendon rupture: diagnostic strength of ultrasonography and magnetic resonance. Revista Española de Cirugía Ortopédica y Traumatología (English Edition). 2020 Mar 1;64(2):77-82.
16. Tagliafico AS, Bignotti B, Martinoli C. Elbow US: anatomy, variants, and scanning technique. Radiology. 2015 Jun;275(3):636-50.

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