Real-time sonoelastography and color-Doppler ultrasound (US) evaluation of the common extensor tendon (CET) after US-guided treatment of lateral epicondylitis

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Lateral epicondylitis (tennis elbow) was first described by F. Runge in 1873. Since then, much controversy over the pathophysiology and treatment of this disorder has been reported. This condition is an overuse injury involving the extensor muscles that originate on the lateral epicondylar region of the distal humerus. It is more properly termed as tendinosis and more frequently involves the origin of the extensor carpi radialis brevis muscle. Any activity involving wrist extension and/or supination can be associated with overuse of the muscles originating at the lateral epicondyle. Tennis has been the activity most commonly associated with this disorder. The risk of overuse injury increases 2-3 times in tennis players with more than 2 hours of play per week and 2-4 times in players older than 40 years. Several risk factors have been identified, including improper technique, size of racquet handle, and racquet weight.

Nevertheless only 10% of patients affected by this condition are tennis players. In fact, lateral epicondylitis is extremely common in today's active population.

For work-related lateral epicondylitis, a systematic review identified 3 risk factors: handling tools heavier than 1 kg, handling loads heavier than 20 kg at least 10 times per day, and repetitive movements for more than 2 hours per day. Besides that low job control and low social support are psychosocial factors associated with lateral epicondylitis.

Many authors proposed different aetiologies for lateral epicondylitis, such as inflammatory processes of the radial humeral bursa, synovium, periosteum, and the annular ligament. However, Nirschl and Pettrone attributed the cause of this disorder to microscopic tearing with formation of reparative tissue (i.e., angiofibroblastic hyperplasia) in the origin of the extensor carpi radialis brevis (ECRB) muscle. This microtearing and repair response can lead to macroscopic tearing and structural failure of the origin of the ECRB muscle.

Concomitant intra-articular lesions (e.g., loose bodies, synovitis, ulnohumeral osteophytes, chondral lesions) have been visualized during elbow arthroscopy in patients with lateral epicondylitis. However, while concomitant intra-articular pathology has been noted, this process is currently considered an extra-articular process.

Clinically, lateral epicondylitis is characterized by an initial mild pain localized in the lateral elbow region (lateral epicondyle) which gradually worsens and becomes stabbing or burning often associated with weak grip strength and moderate swelling.

These symptoms usually last all day long and aggravate during daily activities or sports.

The diagnosis of this condition is practically clinical, however imaging can help in some ways.
Radiographs can be helpful in ruling out other disorders or concomitant intra-articular pathology (eg, osteochondral loose body, posterior osteophytes). Calcification in the degenerative tissue of the extensor carpi radialis brevis muscle origin can be seen in chronic cases.

Magnetic resonance imaging can demonstrate the increased thickening and signal intensity changes of the common extensor tendon origin at the lateral epicondyl, the presence of macroscopic tear of the extensor carpi radialis brevis, with or without tears of the extensor digitorum communis and variable disruption of fibers. Tendinopaties and partial tears of the common extensor tendon are characterized by a high signal intensity in T2-weighted imaging. This technique can detect other concomitant pathologic findings such as edema and/or fracture lines after trauma and loose bodies.

US may be useful to confirm the clinical diagnosis in doubtful or refractory cases, to reveal the extent and severity of the disease and to monitor the response to therapy (Fig. 1 on page 5).

The main US features of lateral epicondylitis are preinsertional hypoechoic swelling of the tendon with focal or diffuse areas of decreased reflectivity in the tendon substance and loss of the fibrillary pattern related to tendinosis, fluid adjacent to the common tendon and ill-defined tendon margins. In high-grade tendinosis, the angiofibroblastic infiltration based on migration of fibroblasts and vascular granulation tissue within the tendon substance causes a striking hypervascular pattern of the intratendinous hypoechoic areas at color and power Doppler imaging.

Spurring at the common extensor tendon insertion and cortical irregularities at the anterolateral surface of the lateral epicondyle may also be recognized, although bony changes do not correlate with disease activity. Intratendinous calcifications may also be seen.

Recently also sonoelastography has demonstrated to be effective in the diagnosis of lateral epicondilitis, because this technique can visualize alterations of the elastic tissutal properties (Fig. 2 on page 5).

The treatment of this disorder is extremely various and consist of: icing the painful area, immobility, oral sommistration of NSAIDs, shockwaves, steroid injection and surgery.

Surgery is recommended only after a patient fails conservative treatment. Multiple surgical techniques have been described for this problem. These include releasing the common extensor origin (open or percutaneously, with or without repair), debriding the pathologic tissue in the ECRB tendon, releasing the posterior interosseous nerve, arthroscopic release, anconeus rotation, and denervation of the lateral epicondyle.

The purpose of our work was to evaluate the imaging appearance of the CET in patients who underwent a combined US-guided percutaneous treatment of lateral epicondylitis,
based on dry needling and local steroid injection, correlating those findings with clinical outcome.

Dry needling is a procedure that consists in repeated puncturing (scarification) of the common extensor tendon enthesis and of the lateral epicondyle periostium, which causes local hyperaemia and a little bleeding in the injured area.
**Fig. 1:** US and color-Doppler US evaluation of the CET in a longitudinal scan: (#) color-Doppler signal, (LE) lateral epicondyle, (RH) radial head.

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**Fig. 2:** RT-sonoelastography of CET: (#) hard tendinous area, (*) soft tendinous area, (o) intermediate stiffness tendinous area, (LE) lateral epicondyle.

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Methods and Materials

IRB approval and informed consent were obtained.

We studied 40 patients (26 males, 14 females, mean age 48±7.4 years) suffering from lateral epicondylitis, who underwent to a combined US-guided percutaneous treatment.

A visual analogue scale (VAS from 0 to 10) was used to evaluate the degree of pain at baseline and at 2, 12, 36 and 48 weeks after the procedure (Fig. 3 on page 7).

US, real-time sonoelastography and color-Doppler were performed at baseline and at 2, 12, 36 and 48 weeks after the treatment (Fig. 4 on page 7, Fig. 5 on page 7, Fig. 6 on page 8, Fig. 7 on page 9, Fig. 8 on page 10, Fig. 9 on page 11, Fig. 10 on page 12, Fig. 11 on page 12, Fig. 12 on page 12).

Sonoelastographic findings were converted into a semi-quantitative score (blue to red, from 1 to 5, respectively).

Color-Doppler findings were translated into a semi-quantitative score (grade 0=normal, grade 1=slight, grade 2=moderate, grade3=marked).

Wilcoxon and Kruskall-Wallis tests were used to obtain our statistical analysis.
Images for this section:

**Fig. 3:** Visual analogue scale score

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**Fig. 4:** a Pre-treatment RT-sonoelastography of CET:(#)hard tendinous area,(*)soft tendinous area,(o)intermediate stiffness tendinous area,(LE)lateral epicondyle. b Pre-treatment color-Doppler US of CET:(#)color-Doppler signal,(LE)lateral epicondyle, (RH)radial head.

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**Fig. 5:** Procedure: the scheme represents a well performed coronal scan of the enthesis. It allows a correct and continuous monitoring of the needle up to the enthesis.

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Fig. 6: The video shows the injection of a small amount of local anaesthetic in the peritendineous soft tissues.

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Fig. 7: The video shows how dry needling is performed on the insertional portion of the common extensor tendon and on the periostium

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Fig. 8: The video shows the steroid injection procedure. The needle is retracted to reach the peritendineous soft tissues and a small amount of steroid (1ml of triamcinolone acetonide 40 mg/ml) is injected, avoiding the tendon.

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Fig. 9: a RT-sonoelastography of CET at 2 weeks:(#)hard tendinous area,(*)soft tendinous area,(o)intermediate stiffness tendinous area,(LE)lateral epicondyle. b Color-Doppler US of CET at 2 weeks:(#)color-Doppler signal,(LE)lateral epicondyle,(RH)radial head.
Fig. 10: a RT-sonoelastography of CET at 12 weeks: (#) hard tendinous area, (*) soft tendinous area, (o) intermediate stiffness tendinous area, (LE) lateral epicondyle. b Color-Doppler US of CET at 12 weeks: (#) color-Doppler signal, (LE) lateral epicondyle, (RH) radial head.

Fig. 11: a RT-sonoelastography of CET at 36 weeks: (#) hard tendinous area, (*) soft tendinous area, (o) intermediate stiffness tendinous area, (LE) lateral epicondyle. b Color-Doppler US of CET at 36 weeks: (#) color-Doppler signal, (LE) lateral epicondyle, (RH) radial head.
Fig. 12: a RT-sonoelastography of CET at 48 weeks:(#)hard tendinous area,(*)soft tendinous area,(o)intermediate stiffness tendinous area,(LE)lateral epicondyle. b Color-Doppler US of CET at 48 weeks: no color-Doppler signal,(LE)lateral epicondyle, (RH)radial head.

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Results

Patients treated had a fast and permanent decrease of symptoms.

VAS at baseline was 7.2±0.9, at 2 weeks 2.5±0.4, at 12 weeks 1.5±0.6, at 36 weeks 1.0±0.6 and at 48 weeks 0.4±0.4; p<0.01 for all compared to baseline (Fig. 13 on page 15).

Real-time sonoelastography values were 4 [2-5] (median [25th-75th percentiles]) at baseline; 4 [3-5] after 2 weeks; 3 [2-4] after 12 weeks; 1 [1-3] after 36 weeks and 1 [1-2] after 48 weeks (Fig. 14 on page 15).

Color-Doppler values were 3 [2-3]; 3 [2-3]; 2 [2-3]; 0 [0-2]; 0 [0-1], respectively (Fig. 14 on page 15).

High correlation was found between VAS score in respect to real-time sonoelastography (r=0.818) or color-Doppler (r=0.849).
Fig. 13: Graphic results of VAS

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Fig. 14: Graphic results of color-Doppler and sonoelastographic evaluation

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Conclusion

The post-procedural assessment of CET after 48 weeks showed a good recovery of the normal fibrillary echotexture.

A complete recovery of tendinous stiffness was demonstrated by real-time sonoelastography and no signal at color-Doppler evaluation was present.

These morphological changes were stimulated by the growth factors released by platelets and white blood cells during dry needling.

Real-time sonoelastography and color-Doppler are effective in assessing pre and post-treatment CET damage with high correlation to clinical symptoms.

They can be effectively used in the follow-up of patients treated for lateral epicondylitis using an US-guided percutaneous treatment.
References

Personal Information

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