Ultrasound (US) guided interventional procedures around the elbow.

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Purpose

When we evaluating patients affected by elbow pain, a number of different pathologic conditions can be encountered.

These conditions include lateral epicondylitis, medial epicondylitis, olecranon bursitis and joint pathological conditions.

Ultrasound has emerged as a low-cost, effective, and radiation-free imaging modality, that can be used for diagnostic purposes as well as to guide percutaneous procedures to treat these diseases with a minimally invasive approach.

In each of these conditions, the role of ultrasonography is to select the pathological structure to be injected, accurately target the area to inject, in order to avoid intratendinous injection, injecting rather at the periphery and in contact, and in order to actually inject into a bursa or cyst cavity to avoid damaging adjacent vessels and nerves.

This implies continuously monitoring the path of the needle during the procedure and the distribution of the drug during injection.

The purpose of our work was to describe how we perform the ultrasound-guided procedures to treat the most common inflammatory and degenerative diseases of the elbow, placing special emphasis on practical suggestions for outcome improvement.
Methods and Materials

Diagnostic and subsequent interventional procedures of elbow are performed using high frequency broadband (7-15 MHz) linear transducers, depending on the depth of the target and the local anatomy.

Needle selection is based on the clinical question to be answered as well as the kind of drugs to be injected.

All devices and drugs must be prepared in full sterility before the procedure commences and all ultrasound-guided interventional procedures must be performed with an aseptic technique in order to avoid any risk of contamination by infectious organisms (bacteria, fungi, viruses).

We recommend a 2-step antisepsis procedure:

1- the area to be treated is wiped with a brown water-based 5% povidone-iodine solution;

2- after 3-5 min (time required to let this antiseptic to act), the same area is wiped with a transparent 2% chlorhexidine-based solution, which denatures the proteins and disrupts the cell walls of contaminating organisms, is bactericidal, and is long-acting; this second step improves skin sterility and avoids staining of the US probe.
LATERAL EPICONDYLITIS

Lateral epicondylitis is one of the most commonly diagnosed musculoskeletal disorders of the upper extremity. This pathology, also known as "tennis elbow," is a painful condition of the tendinous origin of the wrist extensor muscles.

Anatomically, the three major components of the common extensor tendon are the extensor carpi radialis brevis, the extensor digitorum, and the extensor carpi ulnaris tendon.

Injury is due to repetitive stress on the common extensor tendon around its attachment to the lateral humeral epicondyle in response to manual tasks, forceful activities, or sports that require high force combined with high repetition or awkward posture (tennis, water polo, baseball, fencing).

Lateral epicondylitis is more common than medial epicondylitis and generally affects individuals 40-60 years old, with equal prevalence among males and females.

The main symptom is pain, which is localized in the lateral elbow region, corresponding to the lateral epicondyle of the humerus.

It is typically related to activity and exacerbated by wrist and hand movements. Pain may radiate into the forearm and impair handgrip. Clinical tests, consisting of active and resisted movements of the extensor muscles of the forearm, provoke epicondylar pain (Cozen's sign: pain with resisted wrist extension). During clinical examination, a typical tenderness at the lateral side of the elbow will often become apparent. Symptom duration usually ranges from a few weeks to a few months.

In most cases, imaging is not necessary since the diagnosis of lateral epicondylitis is usually clinical, based on symptoms and findings during the physical examination.

Imaging can be used to evaluate the extent of tissue damage, to exclude other causes of elbow pain, when the clinical presentation is atypical, or to confirm the diagnosis in patients not responding to treatment.

In epicondylitis, the tendon can be thicker or thinner than normal, of poor definition, of decreased echogenicity, and accompanied by peritendinous effusion. In addition, the extensor tendon complex may show alterations in intratendinous vascularity. In severe cases, partial- or full-thickness tendon tears are seen as focal anechogenic areas with loss of the normal fibrillar pattern.
First-line therapy usually consists of ice application, immobility of the upper limb, and NSAIDs.

Shockwave therapy can reduce symptoms in the middle term. Surgical debridement is reserved for refractory cases.

US-guided scarification (dry needling) can be considered as a minimally invasive option.

**Interventional procedure**

The indication is the insertional overload tendinopathy of the common extensor tendon.

It is contraindicated in case of traumatic lesions of the common extensor tendon.

The objective is to cause local hyperemia and bleeding into the tendon, thus promoting post-procedural platelets-induced recovery phenomena.

"How We Do"

The patient is seated opposite the operator, the elbow is flexed 90° and the thumb points upward (Fig.1).

The common extensor tendon is visualized by means of a longitudinal scan: the proximal portion of the probe is placed on the hyperechoic bony line of the lateral epicondyle, while the distal part of the probe is aligned according to the common extensor tendon.

Afterwards a 20G needle is inserted with an in-plane approach (Fig.2), in either a distal-proximal or a proximal-distal direction and some anesthetic is injected along the path of the needle, in the peritendinous soft tissues (Fig.3) and in the degenerated portions of the common extensor tendon.

Then we perform a series of 15-20 repeated punctures (dry-needling) on the insertional portion of the degenerated tendon, hitting also the periostum that covers the lateral epicondyle (Figg.4-5).

Finally 1 ml of long-acting steroid (40mg/ml) is injected into the peritendinous soft tissues, superficially to the tendon enthesis (Figg.6-7) and then the needle is removed and a plaster applied.

After the procedure, the patient is kept under observation for at least 10 minutes. Pain may occur after treatment and is managed with oral NSAIDs. Patients are advised to use an orthotic support and to reduce their manual activity, although no systematic rest period is suggested.
Fig. 1: The patient is seated opposite the operator with the elbow flexed at 90° and the thumb points upward.

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
Fig. 2: The scheme shows the correct procedure to perform the anesthetic injection; CET = common extensor tendon, LE = lateral epicondyle, RH = radial head, arrowheads = 20G needle that inject a small amount of anesthetic.

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT

Fig. 3: US-guided anesthetic injection. The 20G needle (arrowheads) is inserted with an in-plane approach and the anesthetic (asterisks) is injected along the path of the needle, in the peritendinous soft tissues and in the degenerated portions of the common extensor tendon (CET); LE = lateral epicondyle, RH radial head.
Fig. 4: The scheme shows the correct procedure to perform dry-needling; CET = common extensor tendon, LE = lateral epicondyle, RH = radial head, arrowheads = 20G needle that perform dry-needling.

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
**Fig. 5:** US-guided dry-needling. The image shows the needle (arrowheads) during a series of 15-20 repeated punctures (dry-needling) on the insertional portion of the degenerated common extensor tendon (CET), hitting also the periostum that covers the lateral epicondyle (LE); the radial head (RH) is also visible.

**References:** radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT

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**Fig. 6:** The scheme shows the correct procedure to perform the steroid injection; CET = common extensor tendon, LE = lateral epicondyle, RH = radial head, arrowheads = 20G needle; asterisk = steroid.

**References:** radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
Medial epicondylitis, also known as "golfers elbow," is a painful condition of the tendinous origin of the wrist flexor muscles. Anatomically, the major components of the common flexor tendon include the pronator teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris, and flexor digitorum superficialis.

This condition is caused by repetitive stress on the common flexor tendon around its attachment to the medial humeral epicondyle due to manual tasks, forceful activities, and sports that require high force combined with repetitive val-gus stress on the elbow joint (golf, baseball, goal-keeper).

Medial epicondylitis is less common than lateral epicondylitis, with males slightly more often affected than females. The typical age range is from 30 to 50 years.

The main symptom is pain, which is localized in the medial elbow region, corresponding to the medial epicondyle of the humerus.
Pain is typically related to activity and is exacerbated by wrist and hand movements. Moreover, it may radiate into the forearm and impair handgrip.

Clinical tests, consisting of active and resisted movements of the flexor muscles of the forearm, provoke epitrochlear pain with resisted wrist flexion. During clinical examination, a typical tenderness at the medial side of the elbow will become apparent. The duration of epitrochleitis symptoms usually ranges from a few weeks to a few months.

In most cases, imaging is not needed since the diagnose of medial epicondylitis is usually clinical, based on symptoms and findings during the physical examination. Diagnostic imaging can be used to evaluate the extent of tissue damage, to exclude other causes of elbow pain, when the clinical presentation is atypical, or to confirm the diagnosis in patients not responding to treatment.

Ultrasound can demonstrate thinning or thickening of the tendon, sometimes associated with a peritendinous effusion. Also, tendon vascularity, evaluated using power Doppler, may be increased. More rarely, partial tears are seen.

First-line therapy usually consists of ice application, immobility of the upper limb, the use of orthotic devices, and NSAIDs.

Shockwave therapy can reduce symptoms in the middle term.

Surgical debridement is reserved for refractory cases.

US-guided scarification (dry needling) can be considered as a minimally invasive option.

**Interventional procedure**

The indication is the insertional overload tendinopathy of the common flexor tendon.

It is contraindicated in case of traumatic lesions of the common flexor tendon.

The objective is to cause local hyperemia and bleeding into the tendon, thus promoting post-procedural platelets-induced recovery phenomena.

"How We Do"

The patient is seated opposite the operator, the elbow is flexed 90° and the thumb points laterally (Fig.8).

The common flexor tendon is visualized by means of a longitudinal scan: the proximal portion of the probe is placed on the hyperechoic bony line of the medial epicondyle, while the distal part of the probe is aligned according to the common flexor tendon.
Afterwards a 20G needle is inserted with an in-plane approach, in either a distal-proximal or a proximal-distal direction while a small amount of anesthetic is injected along the path of the needle, in the peritendinous soft tissues and in the degenerated portions of the common flexor tendon (Fig.9-10).

Then we perform a series of 15-20 repeated punctures (dry-needling) on the insertional degenerated portion of the tendon, hitting also the peristum covering the medial epicondyle (Figg.11-12).

Finally 1 ml of long-acting steroid (40ml/ml) is injected into the peritendinous soft tissues, superficially to the tendon enthesis (Figg.13-14) and then the needle is removed and a plaster applied.

After the procedure, the patient is kept under observation for at least 10 minutes. Pain may occur after treatment and is managed with oral NSAIDs. Patients are advised to use an orthotic support and to reduce their manual activity, although no systematic rest period is suggested.

**Fig. 8**: The patient is seated opposite the operator with the elbow flexed at 90° and the thumb points laterally.
**Fig. 9:** The scheme shows the correct procedure to perform the anaesthetic injection; CFT = common flexor tendon, ME = medial epicondyle, arrowheads = 20G needle that inject a small amount of anaesthetic.

*References:* radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
**Fig. 10:** US-guided anesthetic injection. The 20G needle (arrowheads) is inserted with an in-plane approach and the anesthetic (asterisks) is injected along the path of the needle, in the peritendinous soft tissues and in the degenerated portions of the common flexor tendon (CFT); ME=medial epicondyle.

**References:** radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
Fig. 11: The scheme shows the correct procedure to perform dry-needling; CFT = common flexor tendon, ME = medial epicondyle, arrowheads = 20G needle that perform dry-needling.

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
**Fig. 12:** US-guided dry-needling. The image shows the needle (arrowheads) during a series of 15-20 repeated punctures (dry-needling) on the insertional portion of the degenerated common flexor tendon (CET); (ME)=medial epicondyle.

**References:** radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT

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**Fig. 13:** The scheme shows the correct procedure to perform the steroid injection; CFT=common flexor tendon, ME=medial epicondyle, U=ulna, arrowheads=20G needle; asterisk=steroid.

**References:** radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
Fig. 14: US-guided steroid injection. 1 ml of steroid (asterisks) is injected into the peritendinous soft tissues, superficially to the tendon enthesis (CFT); ME=medial epicondyle, U=ulna.

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT

OLECRANON BURSITIS

Olecranon bursitis is a relatively common condition that typically affects men between the ages of 30 and 60 years.

It is characterized by an inflammatory process with fluid distension or hypertrophy of the synovial membrane.

The most common cause of olecranon bursitis is local contusion: 66% of cases are aseptic and usually occur when trauma or repeated small injuries lead to bleeding into the bursa or the release of inflammatory mediators (student's elbow, miner's elbow).

Bursitis can also develop secondary to calcific enthesopathy of the distal triceps tendon, systemic disorders such as rheumatoid arthritis, gout, hydroxyapatite and calcium pyrophosphate deposition diseases, septic conditions, or chronic hemodialysis.

Patients usually complain of swelling in the olecranon region. Pain can vary from a subtle discomfort to an intense symptomatology.

Pressure or active and passive movements may result in a worsening of symptoms. If fever is present, the diagnosis of septic bursitis must be considered.

Olecranon bursitis is seen as a localized fluid collection and synovial wall hypertrophy.
Color- and power-Doppler imaging demonstrate soft-tissue hyperemia. Both edema of the surrounding soft tissues and cellulitis are frequently associated with hemorrhagic and septic bursitis. In patients with chronic renal failure, it is common to identify a calcified bursitis.

The presence of synovial proliferation and fibrosis suggests a differential diagnosis that includes solid tumor and chronic bursitis.

In patients with rheumatoid arthritis, subcutaneous nodules can be seen in the olecranon region and along the proximal ulna. Fluid collection can lead to bursal rupture dissecting the superficial soft tissues.

Most patients respond to conservative management, including ice, activity modification, and NSAIDs.

In cases of septic bursitis, oral antibiotics may be administered. Drainage in the acute phases usually relieves swelling and discomfort, while steroid injection is performed in chronic or recurrent bursitis.

**Interventional Procedure**

The indications are chronic or recurrent bursitis non-responsive to conservative treatment.

Septic bursitis can be drained but steroid should not be injected.

The objective is to drain distended olecranic bursa and to deliver anti-inflammatory drugs into the bursal space.

"How We Do"

The patient is positioned prone, with the forearm flexed and the hand lying on the examination table (Fig.15). This position can help to squeeze the bursa in case of a drainage procedure to address a consistent effusion.

A longitudinal US scan is performed on the olecranic region to assess the anatomical extension of the bursa and to identify the enlarged bursa (Fig.16).

A needle (14-20G) connected to a syringe is inserted with an in-plane approach until the tip enters the bursa (Fig.17).

In some patients the bursal content is very dense, such that drainage is extremely challenging; in these cases, a larger shielded cannula (Fig.18-19) and the application of
manual compression over the bursa may be helpful. A biopsy handle may also be used to obtain a more effective vacuum.

When the bursa has been completely drained, a small amount of log acting steroid (40mg/ml) is injected (Fig.20).

In case of infection, lavage using warm saline solution may help; in these cases, however, steroid injections are to be avoided.

The needle is then removed and a plaster applied at the cutaneous puncture site.

After the procedure, the patient is kept under observation for at least 10 min.

Pain may occur after treatment and is managed with oral NSAIDs.

The patient is advised to avoid stressing the olecranon region on hard surfaces for a few days.
Fig. 15: The patient is positioned prone, with the forearm flexed and the hand lying on the examination table; a longitudinal US scan is performed on the olecranic region to assess the anatomical extension of the bursa and to identify the enlarged bursa. **References:** radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT

![Longitudinal US scan of the olecranic region showing the enlarged bursa.](image)

Fig. 16: This longitudinal US scan, performed on the olecranic region (O), shows the enlarged bursa (asterisks). **References:** radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
Fig. 17: A needle connected to a syringe is inserted with an in-plane approach until the tip enters the bursa.

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
Fig. 18: The scheme shows the procedure to treat the olecranon bursitis; T=triceps tendon, O=olecranon.

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT

Fig. 19: US-guided treatment of olecranon bursitis. In this patient the bursal content is very dense, so we used a larger shielded cannula to perform the drainage; T=triceps tendon, O=olecranon.

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
Fig. 20: US-guided steroid injection. The image shows the injection of a small amount of steroid (circles) in the olecranic bursa; T = triceps tendon, O = olecranon.

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT

INTRA-ARTICULAR INJECTIONS

Intra-articular injections of the elbow can be performed in the treatment of a variety of pathological conditions. The drugs administered in these cases may be an anti-inflammatory agent, such as the use of steroids for rheumatoid arthritis or crystal-induced arthropathies, or a viscosupplement, such as hyaluronic acid, which is injected in joints involved by osteoarthritis. Local anesthetic can be injected to assess the intra-articular relevance of referred pain or as short-term analgesia. In traumatic fractures of the radial head, aspiration and analgesic injection are an option. This procedure can also be used to inject contrast agent within the joint for arthrography.

Interventional Procedure

The indications of intra-articular injection of steroids (long-acting steroid, 40mg/ml) are: rheumatoid arthritis, crystal arthropathies, degenerative osteoarthritis with articular effusion.

The indication of intra-articular injection of hyaluronic acid (low-molecular weight hyaluronic acid, 2ml) are: degenerative osteoarthritis without articular effusion.

The indications of intra-articular injection of local anesthetic are: assessment of intra-articular relevance of pain, traumatic fractures of the radial head.
The objective is to deliver anti-inflammatory or viscosupplement agents into the intra-articular joint space.

"How We Do"

The patient is seated facing the operator with the elbow flexed 90° and the hand in a neutral position.

The transducer is aligned longitudinally to visualize the humeral-radial joint (Fig.21).

Then a longitudinal US scan of the lateral articular recess is performed, examining the cortical bone of the capitulum humeri, the synovial meniscus, and the proximal radial epiphysis covered with hyaline cartilage; the humeral-radial joint line is then centered in the field of view (Figg.22-23).

Afterward a 20G needle is inserted perpendicularly to the skin at the center of the probe, with an out-of-plane (coaxial) approach (Fig.24). The passage of the needle tip into the joint is generally associated with a distinct feeling of capsular resistance followed by the sensation of a resistance-free space. When the needle tip (arrow) reaches the US scanning plane (Fig.25), it is visualized as a hyperechoic dot appearing in the anechoic articular space between the capitulum humeri and the radial head, underlying the common extensor tendon. The injection should be made slowly but with consistent pressure.

At the end of the injection, the needle can be removed and a plaster applied on the skin.

Finally, the patient should be kept under observation for at least 30 min after the procedure. Pain may occur after treatment and is managed with oral NSAIDs. A short resting period of 1 or 2 days should be recommended.
Fig. 21: The patient is seated facing the operator with the elbow flexed at 90° and the hand in a neutral position. The transducer is aligned longitudinally to visualize the humeral-radial joint

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
**Fig. 22:** Anatomical scheme of the radial-humeral joint; arrow=articular, RH=radial head, CH=capitulum humeri.

**References:** radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT

**Fig. 23:** US long-axis scan of the radial-humeral joint. The articular space (arrow) can be seen between the capitulum humeri (CH) and the radial head (RH). The synovial meniscus (asterisk) is also visible.

**References:** radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
Fig. 24: The scheme shows the correct procedure to perform the intra-articular injection; CET=common extensor tendon, CH=capitulum humeri, RH=radial head, arrowheads=21G needle.

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
Fig. 25: US-guided intra-articular injection. A 20G needle is inserted perpendicularly to the skin at the center of the probe, with an out-of-plane (coaxial) approach; when the needle tip (arrow) reaches the US scanning plane it is visualized as a hyperechoic dot appearing in the anechoic articular space between the capitulum humeri (CH) and the radial head (RH), underlying the common extensor tendon (CET).

References: radiology, Di.M.I., azienda ospedaliera universitaria san martino - Genova/IT
Conclusion

Ultrasound-guidance has been demonstrated to be helpful in improving the ability of physicians to diagnose and treat pathologic conditions around the elbow. It also has been demonstrated to increase procedure accuracy compared to palpation-guided procedures.

In summary, interventional procedures around the elbow have been demonstrated to be effective in treating a number of pathologic conditions and the use of ultrasound guidance further improves the effectiveness of such treatments.
References