Case 5 Ultrasound Guided Injection Lateral Elbow Pain Marzieh Abbasi

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Case study: (Lateral epicondylitis)

Clinical information*:* A 46-year old female was referred by her GP to the Imaging Department for an ultrasound-guided injection. She presented to the clinic with ongoing severe pain in her right elbow that had become increasingly unbearable over the last 6 months. There was no history of acute injury to the elbow and the patient was a nurse by profession. The patient had difficulty in typing and raising her arm, affecting her ability to work. Non-steroidal anti-inflammatory drugs (NSAIDs) combined with physiotherapy were the initial treatments, however these were ineffective and there was no improvement in pain. There was point tenderness over the right lateral epicondyle of the distal humerous common extensor origin. Prior to injection, an MRI assessment confirmed the diagnosis of lateral epicondylitis showing a focal increased tendon signal of the common extensor origin, with the loss of the normal fibrillar pattern that is reflective of tendinopathic changes.

Patient's preparation: The elbow is one of the more awkward joints to scan and can be scanned in different positions. In this case, the patient was asked to remove clothing from the elbow, seated facing the examiner with the arm on the pillow.

Ultrasound machine: A Canon-Aplio i800 ultrasound machine was used to carry out the examination. An Ultra-Wideband Linear i18LX5 Transducer was selected for the scan. Technical parameters including depth, focus, TGC, Overall gain and frequency were adjusted throughout the examination for optimising the image quality. The Canon ultrasound system is also equipped with Super Micro-Vascular Imaging (SMI) technology which is beyond conventional colour Doppler allowing detection of small vessels with low velocity. SMI Doppler was applied for assessment of hyperaemia where inflammation was suspected. Finally, comparison views of the contralateral elbow was also performed and documented. Dynamic ultrasound evaluation of anterior, posterior, medial and lateral aspect of elbow joints was performed in both cross-sectional and longitudinal planes.

Ultrasound findings: The radio-humeral and ulnar-humeral articulations appeared normal. There were no erosions, osteochondral defects, joint fluid, synovial thickening or neovascularisation. The radial and ulnar collateral ligaments appeared normal. The triceps muscle, tendon and olecranon fossa appeared normal. The common flexor origin appeared normal. The longitudinal sonogram demonstrated a thickened inhomogeneous common extensor tendon. There was a small hypoechoic area noted within the tendon substance, which is in keeping with possible small intra-tendinous tear or tendinosis. The small micro tear in the deep fibres of the common extensor origin along with moderate neovascularisation and a positive ultrasound provocation test lead to a diagnosis of degeneration called "*lateral epicondylitis*" which involves the tendon origins.

Lateral epicondylitis has been identified as a degenerative condition involving no inflammatory factors. It has been shown to be caused by repetitive motion of the elbow joint over a long period of time. There is a higher occurrence within certain occupations and sporting activities, as well as smoking and obesity being identified as risk factors (Sorani & Campbell, 2016). The main contributing factors for the pathophysiology are microtears from reoccurring trauma in the hypovascular areas of the tendon and the subsequent failure of normal tendon repair, causing angiofibroblastic degeneration (Kraushaar & Nirschl, 1999). Lateral epicondylitis, more commonly known as Tennis elbow, presents with pain upon elbow rotation, as well as pain of the lateral elbow when the wrist is extended. It is a widely accepted theory that the degenerative process seen is due to repetitive mechanical overuse or overloading at the lateral elbow, along with abnormal repair processes, that causes scar formation and malalignment of collagen fibres in the extensor carpi brevis (Casu & Obradov-Rajic, 2018). Histological analysis supports this, showing immature fibroblastic and vascular infiltration of the origin of the extensor carpi radialis. Due to this, 'tendinopathy' or 'epicondylosis' is now preferred over 'epicondylitis', although the term tennis elbow is still in use (Bhabra et al, 2016). The non-inflammatory description is questioned by Torp-Pedersen and colleagues (2008) due to the discovery of evidence depicting reduced hyperaemia with colour Doppler after an injection of corticosteroid. This suggests the involvement of inflammation, although non-inflammatory is still the widely accepted description.

The presentation of lateral elbow pain in clinical practice is typically attributed to common extensor tendon impairment, known as lateral epicondylitis, although other causes are possible and must be considered. These possible alternative diagnoses consist of degeneration and trauma of the lateral ligament components; postero-lateral elbow instability; posterolateral synovial fold impingement; radiocapitellar joint osteoarthritis; and nerve entrapment, including of the posterior interosseous nerve (PIN) and the lateral antebrachial cutaneous nerve. These conditions need a very different approach in treatment to lateral epicondylitis due to the difference in causative factors, making the challenge of a correct diagnosis of lateral elbow pain essential. For example, where rehabilitation therapy or physiotherapy is recommended for lateral elbow pain which is caused by tendinopathy of the common extensor tendon or for mild PIN neuropathy, it is not for full-thickness tears of the tendon or high-grade PIN neuropathy. These conditions often require treatments involving surgery, due to the more severe nature of them (Obuchowicz & Bonczar, 2016), reinforcing the need for correct diagnosis of lateral elbow pain to decide on the appropriate treatment.

Clinical and imaging diagnostics

Clinical indications are often the first signs leading to a possible diagnosis. These include pain provocation on palpation of the region, when the elbow is extended with the forearm in pronation, and using a resisted wrist or middle finger extension manoeuvre (Lungu, et al, 2018). Imaging modalities are called upon to aid diagnosis and exclude differential diagnoses. Ultrasound is often the initial modality of choice, with MRI the most reliable imaging modality to evaluate more precisely the extent of tendon injury (Bachta, et al, 2017). Even though MRI may be able to evaluate tendon injury more precisely than ultrasound, it is not a suitable imaging modality as a screening tool for the vast majority of patients presenting with lateral elbow pain. This is due to the cost, the availability of the machines, whereas ultrasound is more widely available and accessible, and is less costly. Ultrasound has been shown to have a relatively high sensitivity in the detection of symptomatic lateral epicondylitis, but a low specificity in a study by Levin et al (2005). They conclude that ultrasound is the most useful imaging modality for determining the extent of the tendon damage in symptomatic patients. Batcha et al (2017) also showed evidence in their study that ultrasound is a reliable modality in evaluating the tendino-ligamentous structures of the lateral elbow region, with a conclusion that ultrasound assessment has comparable results to MRI assessment. Similarly, Obuchowicz and Bonczar (2016) undertook a comparative study between MRI and sagital sonogram, which observed that early degenerative changes of the common extensor tendon at the lateral humeral epicondyle are not visible under MRI. They theorised that this was due to the signal intensity being similar to that of collagen, so in effect the degenerative changes that could lead to an early diagnosis were 'hidden'. In this regard, the high spatial resolution of modern ultrasound devices and the ability to quickly select and adjust the imaging plane during the scan are of great practical importance (Tran & Chow, 2007). Moreover, real-time dynamic ultrasound provides a principle advantage by allowing the functional assessment of tendons and ligaments. The key indications of lateral epicondylitis on ultrasound are focal tendon thickening with loss of fibrillar architecture along with low reflective change. Microtears appear as areas of focal deficiency with associated neovascularity under Doppler, with enthesopathic changes such as bone formation on the lateral epicondyle. Ultrasound also aids guided injection therapies, which are considered when the initial conservative treatments do not satisfactorily reduce pain and improve movement.

Treatment options

Injection therapy is the most common treatment option, with choices of corticosteroids; tendon fenestration (dry needling) with supplementary autologous blood injection and platelet-rich plasma (PRP); prolotherapy; and sclerotherapy. Often local anaesthetic is included with the injection, as local pain relief, but also to facilitate the intra-articular distribution.

Corticosteroids:

Primary cares often choose corticosteroid injections as the first therapy, with anecdotal evidence rather than scientific evidence to back this up, although in the short term, it has been described as effective. A review of 13 Randomised Controlled Trials (RCT) by Smidt et al (2002) showed the efficacy of the corticosteroid when compared to placebo, local anaesthetic and conservative management for pain levels and grip strength at the 6 week follows up. Beyond this, the side effects of concomitant risk of steroid flare; skin discolouration; and subcutaneous fatty atrophy along with the lack of evidence of effectiveness in the long term mean it is not a viable long term treatment

(Chiavaras & Jacobson, 2013). Smidt et al (2002) also showed a high frequency of relapse and recurrence after corticosteroid injection, as the inhibitor processes of cortisone may result in the intra-tendinous injection leading to deleterious long-term effects with permanent structural changes and tendon atrophy.

Tendon fenestration:

Percutaneous ultrasound-guided tendon fenestration, also called dry needling, involves repetitive puncturing by needle into the area of focally thickened tendon. It is believed to stimulate tendon healing by breaking down the chronic degenerative changes thereby altering a chronic degenerative painful condition to an acute inflammatory condition, whereupon tendon regeneration and healing can occur (Lungu, et al, 2018). As fenestration is often used in conjunction with other percutaneous therapies such as autologous whole blood, prolotherapy and PRP injections, it can be difficult to assess whether fenestration by itself is effective. Stenhouse et al (2013) found positive effects of acupuncture and fenestration, with another study by Mishra et al (2014) finding similar effects of fenestration with PRP as opposed to fenestration alone. Similarly, Gonzalez-Iglesias et al (2011) described fenestrations effectiveness in treatment management of rock climbers, although with many gaps in literature, future studies need to establish exactly where the fenestration should occur, the optimal number of sessions, and whether it can be effective for other body parts.

Autologous blood injection (ABI) & Platelet-rich plasma (PRP):

Autologous blood injection is used in conjunction with tendon fenestration to trigger an inflammatory response in the degenerative areas of the tendon (Suresh et al, 2006). PRP is also an alternative to autologous blood injections to trigger the healing process in degenerative tendons due to the high concentration of growth factors and the ability to improve repair mechanisms within the tendons (James et al, 2007). Thanasas and colleagues (2011) showed improvements at 6 weeks of those who were treated with PRP injection compared to those treated with autologous blood injection, although no statistically significant differences were seen between the groups at the 3 and 6 month follow-ups. Similarly, Gosens et al (2011) conducted double-blind RCT showing a significant ($p<0.005$) difference in favour of a PRP group over a corticosteroid group, with follow-up intervals up to 2 years. In another RCT, where assessors were unaware of the treatment, at 8 weeks, ABI was found to be more effective than corticosteroid in all outcomes (Kazemi et al, 2010). A study by Krogh et al (2013) found PRP was not more effective than corticosteroid at 1 month follow-up, or at 3 months as well as placebo, although tendon thickness was reduced in those treated with corticosteroid over PRP or placebo. Wolf et al (2011) added a control group to their RCT to try to explain any placebo affect associated with injection, with patients randomised to receive ABI, corticosteroid with lidocaine, or saline with lidocaine. Results were improved in all 3 groups with no differences at the 2 and 6 month follow-ups.

Prolotherapy:

Prolotherapy is a percutaneous injection of an irritant into the degenerative areas of tendons, or ligaments to promote a healing process through cellular proliferation and formation of collagen, leading to stronger repair of damaged fibres at the lateral epicondyle (Sims et al, 2014). The most common irritants used are hyperosmolar dextrose and sodium morrhuate. Clinical trials in the efficacy of prolotherapy are limited, although the small number of studies that there have been show promising results (Sorani & Campbell, 2016). These studies are limited by their patient size, a lack of consistent standardised techniques and lack of long-term follow-up. A study by Zeisig et al (2008) compared injections of polidocanol to those of lidocaine/epinephrine in a double-blind RCT, showing results of improvement in grip strength and visual analogue scores (VAS) in both groups at 3 months, with no difference between the groups.

Sclerosing therapy:
Treatment of varices and vascular malformations is often by sclerosing agents such as polidocanol, and has a direct effect on the intima of blood vessels, causing thrombosis and vessel occlusion. Sclerotherapy can target the neovascularity often present in tendinopathy, which often correlates with pain, although this pain is more likely to be secondary to the associated neural ingrowth in the areas of tendinopathy (Alfredson et al, 2006). This may result in sclerotherapy reducing tendiopathic pain by eliminating nociceptive nerve fibres, found next to neovessels directly (by destruction) or indirectly (by ischaemia), although a systematic review found no benefit of polidocanol compared to a placebo (Krogh et al, 2013).

Procedure

With the current lack of imaging parameters to diagnose, determine prognosis and monitor tendon healing, promising preliminary results of ultrasound guided tendon fenestration for treatment may suggest this intervention therapy is a valuable alternative to the standard conservative treatment. My unit commonly utilises corticosteroid injections for MSK therapy, but not routinely for treatment of lateral epicondylitis. This is due to insufficient scientific evidence, and high risk of adverse affects including steroid flare; skin discolouration; and subcutaneous fatty atrophy. Although there are studies showing some evidence of the effectiveness of other injectable substances such as autologous blood injection and platelet-rich plasma, these therapies are currently not included in my departmental protocols due to cost, lack of sufficient training, and current insufficient conclusive evidence in trials. Instead, if the patient confirms no allergy to local anaesthetic, such as lidocaine, it can be used alongside dry needling. The inclusion of lidocaine ensures the procedure of the dry needling is tolerated by patient due to the immediacy of pain relief, allowing the correct positioning of the needle, leading to optimum treatment. Recent studies have concluded that this option reduces patient pain and improves their mobility, along with a low risk of harm in the short and long-term.

With all this in mind, treatment of fenestration with lidocaine was decided upon as the best treatment option for the patient of this study. This was fully explained to her, and verbal consent was obtained. Using ultrasound guidance and aseptic technique, 3mls of 1% lidocaine was injected into the skin and soft tissues overlying the common extensor origin. After this the extensor origin was dry needled using an in-plane approach and a blue needle. The transducer was placed on the lateral epicondyle and the needle was inserted in the centre of the transducer in a long axis position at an angle of about 30-45^{o} to the surface of the skin, depending on the area of interest. The needle was then advanced parallel to the sound beam, after which small aliquots of 0.25% lidocaine were injected in and around the tendon. This completed the procedure, and no immediate complications were noted. The patient was also advised to seek physiotherapy to complement the injection therapy. Improvement in pain was mentioned after the procedure by the patient at a 3 week follow up. Although it was a short follow up time period, whether the improvement seen was due to dry needling techniques or lidocaine was of question.

Altay et al (2002) compared injection of corticosteroid with local anaesthetic to local anaesthetic alone by fenestration, with a follow-up treatment after 2 weeks where pain persisted. The Verhaar criteria were used to score pain relief, satisfaction, grip strength and presence of provoked pain upon resisted wrist extension. Results showed no difference between the 2 groups in the time period up to 1 year post initial injection, concluding that injection technique is more important than substance injected. Another study of randomised patients by Dogramaci et al (2009) split into groups of single injection with local anaesthetic, peppered injection of corticosteroid with local anaesthetic, or peppered injection of only local anaesthetic. The group of peppered corticosteroid with local anaesthetic had a significant ($p<0.011$) improvement in VAS along with a higher percentage of excellent scores on the Verhaar criteria than the other groups at the 6month follow-up. Okcu et al (2012) found similar results while assessing with Disabilities of the Arm, Shoulder and Hand scores (DASH), again with statistically significant ($p<0.017$) results favouring the peppered injection group at 1 year follow-up, although results of 38% of patients with inadequate follow-up were excluded. Often local anaesthetic is included with the injection, as local pain relief, but also to facilitate the intra-articular distribution.

The limited studies that exist do support injection therapy, although more studies using validated clinical, biomechanical and radiological parameters are needed. A focus on timing of the injection, which substance to use, inclusion or not of local anaesthetic, the volume to be injected, and side effects need scientific evidence, with many experts disputing what is best. Current comparisons into the effectiveness of each type of treatment are questionable due to a lack of standard guidelines, most injections being performed without ultrasound guidance, and no definition to the amount of fluid to be injected, as well as the number and depth of injections. As the pathophysiology is not fully understood, the action of treatments on the tendon and the patient's symptoms cannot be fully comprehended.

Conclusion

Ultrasound, as an imaging modality, is successfully utilised to assess soft tissue structures of the lateral elbow, and is able to differentiate between the possible causes of lateral elbow pain. The anatomy of the elbow area is complex, and lateral elbow pain has many possible causes. It can be caused by a single pathological factor, as is the case in lateral epicondylitis, or there may be other potentially symptomatic pathologies coexisting alongside each other. The elbow region needs to be meticulously assessed by ultrasound examination with advanced scanning skills, and understood with an in depth knowledge of the anatomy. Treatment by injection therapy is often utilised as treatment for lateral epicondylitis. The various forms of this therapy have differing outcomes, as shown by a number of studies, although there are still a limited number of high-quality and unbiased control trials to produce an accurate assessment of all the available injection variants. What is becoming clear in literature is the assistance ultrasound provides to these injection therapies through its ability to offer real-time dynamic imaging of the tendon, assistance in detecting the precise location of tendon abnormality, as well as its ability to also guide the needle accurately to the area of interest. With all literature taken into consideration, currently fenestration with lidocaine is the recommended treatment in our department for lateral epicondylitis. This is due to its cost, relative ease of training to provide effective application, high patient tolerance, and evidence of its ability in the short term to reduce symptoms, and having less risk factors or adverse effects than other therapies. It is clear that further studies with Level 1 evidence are needed into all the variants of injection therapies to fully evaluate if any particular therapy has any significant advantage over another in the short and long-term reduction of symptoms.

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