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INTERVENTIONAL MSK PROCEDURES SPECIAL FEATURE: REVIEW ARTICLE

Radiological intervention of the hand and wrist

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ABSTRACT

The role of radiological guided intervention is integral in the management of patients with musculoskeletal pathologies. The key to image-guided procedures is to achieve an accurately placed intervention with minimal invasion. This review article specifically concentrates on radiological procedures of the hand and wrist using ultrasound and fluoroscopic guidance. A systematic literature review of the most recent publications relevant to image-guided intervention of the hand and wrist was conducted. During this search, it became clear that there is little consensus regarding all aspects of image-guided intervention, from the technique adopted to the dosage of injectate and the specific drugs used. The aim of this article is to formulate an evidence-based reference point which can be utilized by radiologists and to describe the most commonly employed techniques.

INTRODUCTION

The role of radiological guided intervention is integral in the management of patients with musculoskeletal pathologies. The key to image-guided procedures is to achieve an accurately placed intervention with minimal invasion. This review article specifically concentrates on radiological procedures of the hand and wrist using ultrasound and fluoroscopic guidance. A systematic literature review of the most recent publications relevant to image-guided intervention of the hand and wrist was conducted. During this search, it became clear that there is little consensus regarding all aspects of image-guided intervention, from the technique adopted to the dosage of injectate and the specific drugs used. The aim of this article is to formulate an evidence-based reference point which can be utilized by radiologists. The authors acknowledge that there are many ways to undertake these procedures; however, the most commonly employed and easily reproducible techniques have been described, based on our own practice. This does not mean that alternative techniques are not equally effective.

ULTRASOUND-GUIDED PROCEDURES OF THE HAND AND WRIST

Ultrasound allows dynamic evaluation and intervention of musculoskeletal disorders without exposing the patient to ionizing radiation. Musculoskeletal (MSK) ultrasound requires a thorough understanding of the relevant anatomy and normal variants and correct use of the ultrasound equipment.

It is important to understand the many artefacts inherent to MSK ultrasound when using this modality for guidance technique. This will enable the radiologist to make a detailed assessment and to perform safe and accurate interventions.

General points:

- For musculoskeletal work, a high-frequency linear-array probe of 10 MHz or more should be used. Owing to the anatomically small areas injected, a small footprint probe such as a hockey-stick probe is particularly useful.
- A basic clinical history from the patient should be obtained.
- Ergonomics—the operator should be comfortable and take time to position the patient.
- Prior to any intervention, the patient should be asked if they have any allergies or are on any anticoagulants.
- Consent procedure: although the incidence of complications with these injections is very low,¹ an explanation of the procedure and the possible risks, benefits and contraindications associated with it, should be undertaken. In the hand and wrist, these are infection, neurovascular or tendon injury, and, if steroids are used, post-procedure steroid flare-up and fat necrosis.
- Aseptic technique is mandatory.
- A good “gel stand-off” between the patient and probe may improve visualization.
- Needles should be pre-filled to avoid injecting air, which will obscure subsequent ultrasound images.

- When using ultrasound to guide interventional procedures, the probe position is described as an “in-plane” or “out-of-plane” technique. When using the in-plane approach, the needle is inserted parallel to the probe and the length of the needle can be observed in the longitudinal view in real time, as it is advanced towards the target (Figure 1a,b). With the out-of-plane approach, the needle is inserted perpendicular to the transducer, and the needle shaft is imaged in cross-section and can be identified as a hyperechoic dot within the image (Figure 1c,d). A small amount of injectate can be used to confirm the location of the needle tip. Where possible an in-plane technique should be used as it allows constant visualization of needle placement and a safe injection. The out-of-plane technique can be useful when access to the target site is limited or difficult.
- Injectate typically consists of 1–2 ml of a combination of steroid and local anaesthetic. The specific volume will depend on the capacity of the space/joint injected. It is our practice to use between 20–40 mg triamcinalone acetate with 1% or 2% lidocaine. We recognize that the choice of glucocorticosteroid used will vary on the basis of individual preference and departmental policy, and the relative merits of the different formulations remains controversial and is beyond the scope of this article. However, Speed² has highlighted the issues in a review article which we would recommend to the reader. In

this article, it is pointed out that agents with low solubility (such as Triamcinalone hexacetonide) should be avoided owing to the theoretical risk of greater local side-effects.

ULTRASOUND-GUIDED SMALL JOINT INJECTIONS

Carpometacarpal joint injection

The first CMC is a saddle-shaped joint between the articulations of the base of the first metacarpal and the trapezium, also known as the trapeziometacarpal joint. It is the unique shape of this joint which affords the thumb its wide range of motion.

Pathophysiology and indication

The first carpometacarpal (CMC) joint is frequently affected by osteoarthritis, most commonly seen in females in their fifth to sixth decades of life.³ Symptoms include thumb and radial wrist pain and functional limitation especially with grasping, pinching and twisting motions. Conservative management is the mainstay of treatment, and steroid injections are considered after simple measures such as rest, analgesics and splinting have failed to relieve the patients' symptoms. Although accessing the first CMC joint blind is a relatively straightforward procedure and carried out by many physicians, studies have shown that ultrasound-guided injections improve accuracy and efficacy.^{3,4} This is especially true in cases of advanced

Figure 1. In-plane and out-of-plane injection techniques. (a) The relative probe and needle position for an in-plane (longitudinal) injection technique. (b) Ultrasound image demonstrating an in-plane approach for injecting the thumb carpometacarpal joint. The entirety of the needle can be visualized in longitudinal section (short arrows). MC, base of thumb metacarpal; Trap, trapezium. The long arrow indicates a loose body in the osteoarthritic joint. (c) The relative probe and needle position for an out-of-plane (short axis) injection technique. (d) Ultrasound image demonstrating an out-of-plane approach. A cross-section of the needle can be seen as a hyperechoic dot (arrow). Please note a larger 21-G needle has been used in the Figure 1a and c for clarity. However, in practice as stated in the text a smaller needle is more appropriate for use in the hand and wrist.

osteoarthritis where joint space loss and deformity make accessing the joint difficult.

Technique

Scan the joint and identify the base of the thumb metacarpal which forms a “step” adjacent to the trapezium. It is also important to identify the abductor pollicis longus (APL) and extensor pollicis brevis (EPB) tendons crossing the CMC joint and also the radial artery in order to avoid inadvertent puncture.

Patient position (Figure 2a): patient seated with hand resting on a bed or alternatively supine with arm by the side and thumb facing upwards.

Probe position: high-frequency linear probe.

- Place transducer longitudinally across the CMC joint so that centre of probe is at the level of the joint and identify the radial artery (Figure 2b). Slide probe to the dorsal or volar side of the artery (Figure 2c).

Needle position (Figures 1b and 2c):

- Aseptic technique and patient consent.
- Short 25-G needle.
- Anaesthetize skin.
- Insert the needle parallel to the probe from a distal to proximal approach and advance the needle tip into the joint.
- Injectate volume of 1 ml.
- Note capsular distension upon injection.

The scaphotrapeziotrapezoid joint

The scaphotrapeziotrapezoid (STT) joint allows transmission of forces across the proximal and distal carpal rows and, therefore, is subjected to specific degenerative patterns. This typically progresses from the scaphotrapezoidal to the scaphotrapezial joints in an ulnar to radial direction.⁵

Pathophysiology and indication

The STT joint is the second most common site of radiographic osteoarthritis in the wrist.⁵ Symptomatic patients present with reduced grip-strength and radial-sided wrist pain that can sometimes radiate up the forearm. The pain is described as a dull ache that can often be localized to the thenar eminence on deep palpation but unlike the CMC joint, not with movement of the thumb. Conservative treatment is the first line approach with anti-inflammatory drugs, splinting and steroid injections. Given its close proximity to the first CMC joint and similar symptoms, identifying symptomatic STT arthritis can be difficult. Thus, accurately targeted steroid injections into the STT joint will have the dual diagnostic as well as a therapeutic role.⁶

Technique

The STT joint communicates with the midcarpal joint, and therefore, a midcarpal joint injection under fluoroscopy can be used to treat STT arthritis, and this is the approach favoured by the authors of this article. Midcarpal injection is described in the arthrography section. An alternative approach is to inject the STT joint directly using the following technique:

Figure 2. Longitudinal imaging of the thumb CMC joint for injection. (a) Patient position for an in-plane CMC joint injection. (b) Longitudinal imaging of the CMC. Note the radial artery with Doppler signal (arrows) runs in close proximity to the joint and it is important to avoid it. (c) Repositioning the probe slightly, in this case slightly dorsal to the position in b, allows safe access to the joint (arrow indicates needle position for in-plane approach). MC, thumb metacarpal; Trap, trapezium.

Patient position: patient seated with hand supinated and resting on a bed or alternatively supine with arm by the side.

Probe position: high-frequency linear probe.

- Place transducer longitudinally across the radius and scan distally until the centre of the probe is directly over the scaphoid–trapezium joint. The flexor carpi radialis tendons can be seen running superficial to the joint.

Needle position (Figure 3):

- Aseptic technique and patient consent.
- Short 25-G needle.
- Anaesthetize skin.
- Out-of-plane approach: insert the needle perpendicular to the centre of the probe at an angle of 45°.
- Advance the needle until a hyperechoic dot is seen within the joint.
- Injectate volume of 1 ml.
- In cases of advanced osteoarthritis, asking the patient to slightly extend wrist and applying either radial or ulnar deviation can help to open up the joint.

Wrist joint injection (radiocarpal joint)

Injection is usually made into one of the three compartments in the wrist: the distal radioulnar joint (DRUJ), the radiocarpal and midcarpal joints. Each can be injected under fluoroscopic guidance, and the technique is described later in this chapter under arthrography. However, ultrasound can also be used to guide therapeutic injection into these joints, and this is commonly carried out into the radiocarpal joint.

The radiocarpal joint is a synovial joint between the articulation of the distal radius and proximal carpal row, with the exception of the pisiform. The joint capsule and extrinsic wrist ligaments contribute to the stability of the wrist. There are four principle ligament groups: the volar and dorsal radiocarpal ligaments and the radial and ulnar collateral ligaments.

Pathophysiology and indication

Wrist pain and restricted function are the most commonly described symptoms in patients with radiocarpal arthropathy. Steroid injections are an important adjunct in the management of these chronic conditions with the goal to preserve function and control

pain.¹ Steroid injection may also be helpful in the management of dorsal impingement of the wrist. This condition occurs in athletes undertaking repetitive wrist dorsiflexion as part of their sport; it is typically seen in gymnasts and may be associated with joint synovitis and/or capsular thickening.⁷

Technique

Patient position (Figure 4a): patient seated with hand resting on a bed or alternatively supine with arm by their side. The wrist should be placed on a support so that it is slightly flexed. Sometimes a little ulnar deviation will help open up the joint space.

Probe position: high-frequency linear probe.

- Place transducer longitudinally across the radioscaphoid joint so that the centre of the probe is at the level of the joint.

Needle position (Figure 4b):

- Aseptic technique and patient consent.
- 25-G needle.
- Anaesthetize skin.
- In-plane technique. Advance the needle into the joint directed toward the radius.⁸
- Injectate volume of 2–3 ml.

ULTRASOUND-GUIDED TENDON SHEATH INJECTIONS

Trigger finger

The flexor tendon sheath system consists of a continuous synovial sheath that provides the tendons with a smooth gliding bed and segmental pulleys—focal thickened areas of the retinacular tendon sheath. The pulleys are arranged in cruciform and annular patterns overlying the membranous synovial sheath. There are five annular pulleys (A1–5) for each digit (Figure 5). They affix the tendons to the phalanges and prevent “bow-stringing” of the tendons during flexion.

Pathophysiology

Trigger finger occurs owing to inflammation and hypertrophy of the retinaculum and over time this causes a disparity in size between the flexor tendon and the surrounding pulley. The result is a restriction in motion of the flexor tendon causing continual friction which perpetuates the inflammation and can lead to areas of nodularity forming on the tendon. Eventually, this can cause the finger to become locked in flexion, either owing to a nodule catching on the edge of the pulley or owing to pulley hypertrophy. When more forceful attempts are made to extend, the digit classically snaps open with significant pain.⁹ The first annular pulley (A1) is at the level of the metacarpal head and is the most commonly affected in trigger finger.¹⁰

The exact aetiology is unknown but this condition most commonly affects females in the fifth to sixth decade and there is a higher incidence in patients with diabetes and rheumatoid arthritis.¹¹

Indication and rationale

In a large retrospective study examining the management of trigger finger, Nimigan *et al*¹² concluded that steroid injection therapy should be offered as first line treatment. They found success rates of 52% which were similar to those cited by Fleisch *et al*¹³ in their

Figure 3. Ultrasound image of scaphotrapeziotrapezoid joint in longitudinal section. The dot indicates the needle position for an out-of-plane injection. MC, thumb metacarpal base; Sca, scaphoid; Tra, trapezium. Arrows indicate flexor carpi radialis longus.

Figure 4. Longitudinal imaging of the radiocarpal joint for injection. (a) Patient position for an in-plane radiocarpal joint injection. Note that the wrist is gently flexed over a support. (b) Ultrasound image of the radiocarpal joint in longitudinal section. The arrow indicates the needle position for an in-plane injection. Cap, capitate; L, lunate; R, radius.

systematic review of 57%. More specifically however, Nimigan et al¹² found steroid injections to work better in non-diabetic patients, as reported in other studies which may be due to patients with diabetes having more diffuse tendon sheath stenosis rather than focal pathology.¹⁴ These studies were on patients in whom blind steroid injections were performed, whereas Bodor et al¹⁵ achieved a success rate of up to 90% when analysing patients receiving ultrasound-guided A1 pulley injection and noted no effect of any concurrent diagnosis on treatment outcome. Percutaneous release of the annular pulley under ultrasound guidance has also been described. Whereas previously specific cutting devices were used, Rajeswaran et al¹⁶ describe a technique where a customized 19-G needle is used to achieve division of the annular pulley. Although their study group was small, they found this to be a very effective method of releasing the A1 pulley with a much shorter recovery time than open surgical release.

Technique

Initial ultrasound assessment and identification of anatomical structures is the key to precise injection. The technique outlined below is an out-of-plane approach based on that described by Bodor et al.¹⁵ Using this technique, there is a target triangle to aim the tip of the needle into, the borders are formed by the flexor digitorum superficialis, flexor digitorum profundus and volar plate medially, metacarpal head inferiorly and the A1 pulley as the diagonal border of the triangle (Figure 6a). The benefit of having a specified target is to promote consistency of the technique amongst radiologists. Of course, with the proviso that this may need modifying according to the individual patient if access was a problem.

Patient position (Figure 6b): patient seated with palm supinated and resting on a bed.

Probe position: high-frequency linear probe.

- Place transducer transversely at the level of the metacarpophalangeal (MCP) joint and identify the thickened A1 pulley overlying the flexor tendons as well as the adjacent digital arteries—Doppler can be used to help identify these small vessels.
- Centre probe on the target triangle.

Needle position (Figure 6a):

- Aseptic technique and patient consent.
- Short 25-G needle-steep trajectory.
- Anaesthetize skin.

- Under constant visual guidance aim to see the needle tip within the target triangle.
- Injectate volume of 1 ml.
- End result should be distension of the tendon sheath.

Alternatively, an in-plane technique can be used, which has the advantage of constant visualization of the entire length of the needle.

Probe position:

- Place probe longitudinally over affected flexor tendon at the level of the MCP joint.
- Identify A1 pulley as hypoechoic thickening of volar aspect of tendon sheath (Figure 7a).

Needle position (Figure 7b):

- Short 25-needle with a shallow trajectory from distal to proximal.
- Aim to see the needle tip in the tendon sheath just distal to the A1 pulley.

De Quervain's tenosynovitis

This is a painful stenosing tenosynovitis affecting the tendons within the first extensor compartment, namely the abductor pollicis longus (APL) and the extensor pollicis brevis (EPB) tendons (Figure 8).

Pathophysiology

The APL and EPB are tightly secured against the radial styloid by an overlying extensor retinaculum thus creating a fibro-osseous tunnel. The retinaculum becomes thickened as a consequence of overuse and impinges upon the tendons which become tendinopathic and fluid accumulates within the tendon sheath. Patients typically present with dorsoradial wrist pain, limitation of movement and swelling. In the majority of cases, there is a history of repetitive forceful gripping and repetitive thumb movements.¹¹

Indication and rationale

A pooled quantitative literature review to evaluate the different treatments for De Quervain's tenosynovitis found steroid injection alone to be an effective treatment with an average success rate of 83%.¹⁷ Once coupled with ultrasound guidance, studies

Figure 5. Illustration of the digital flexor pulley system; A1-5.

have reported a higher success rate (97%) for steroid injections.¹⁸ Initially, it was thought that the APL and EPB tendons were encompassed in a single compartment; however, from

evaluation at open surgery and from cadaveric examination, anatomical variations have been identified. Specifically, in some individuals a septum exists that divides the tendons into two subcompartments¹⁹ (Figure 9). The incidence of this septum has most recently been reported as 52%; this study corroborated the findings of others that a septum exists in all patients who failed non-operative treatment and needed surgery.²⁰ This would imply that conservative treatment is more likely to fail in patients with two subcompartments unless the symptomatic compartment or both compartments are injected. It is not a standard practice to separately inject both compartments; however, a sensible approach would be to attempt to identify a septum. If present then once the APL compartment is distended with steroid, the needle tip should be advanced in an ulnar direction and steroid instilled into the EPB compartment. If a septum is not identified (it can be very subtle and easily missed) but only the APL tendon sheath distends, then it is likely that a septum is present and again an attempt should be made to inject the EPB subcompartment. If the disease process only involves one subcompartment, then this should obviously be targeted.

Technique

Patient position (Figure 10a): patient seated with elbow flexed and forearm resting on a bed. The hand should be in a neutral position so the radial styloid is facing up.

Probe position: high-frequency linear probe.

- Place probe transversely over radial styloid.
- Identify first extensor compartment: APL lies closest to the radial artery.
- Look for evidence of tenosynovitis: tendon sheath thickening, fluid distension and neovascularization. Examine the integrity of the tendon.
- Look for the presence of a septum.

Needle position (Figure 10b):

- Aseptic technique and patient consent.
- Skin entry should ideally be on the ulnar side of first extensor compartment to avoid radial artery.
- 25-G needle and anaesthetize skin.
- Keep a very shallow trajectory.
- Under constant visual guidance, pass the needle deep to the tendons and inject into the tendon sheath. The approach deep to tendons is preferred as it reduces the risk of superficial extravasation and steroid-induced fat atrophy.
- Injectate volume of up to 2 ml.
- If injectate does not surround both tendons, suggesting a septum, the needle tip should be re-positioned so that it is adjacent to the EPB tendon and the rest of the injectate should be instilled around it.

ULTRASOUND-GUIDED CARPAL TUNNEL INJECTION

The carpal tunnel is located at the base of the palm, just distal to the level of the distal skin crease. It is bounded dorsally by the carpal bones and on the palmar side by the flexor retinaculum, creating a fibro-osseous tunnel which transports the median nerve and finger flexor tendons from the forearm to the hand. The proximal bone landmarks for the carpal tunnel are the

Figure 6. Out-of-plane approach to A1 pulley injection. (a) Ultrasound image at the level of the A1 pulley in transverse section demonstrates the target triangle for an out-of-plane injection of the first annular pulley. The dot indicates the needle position; arrows show the A1 pulley; FDP, flexor digitorum profundus; FDS, flexor digitorum superficialis; L, lumbrical; MC, metacarpal; VP, volar plate. (b) Patient position for first annular pulley injection to obtain the image in Figure 7a.

pisiform and the scaphoid (Figure 11a), and the distal landmarks are the hook of hamate and the trapezium (Figure 11b).

Pathophysiology

Carpal tunnel syndrome (CTS) is a median nerve entrapment neuropathy which causes paraesthesia and pain in the distribution of the nerve and eventually thenar muscle atrophy. The mechanism is not completely understood but is caused by a combination of genetic, environmental and occupational factors (diabetes, obesity, pregnancy and hypothyroidism). These act to cause increased pressure within the carpal tunnel and subsequent median nerve compression.

Indication and rationale

In the subset of patients with pre-disposing medical disorders, the initial treatment is to treat the underlying condition. In those with persistent symptoms despite medical treatment and in patients with idiopathic CTS, the treatment options consist of conservative management with local steroid injection and/or wrist splinting *vs* surgical decompression.

The definitive treatment of CTS for the majority of patients is surgical decompression, achieving a cure rate in excess of 90%.^{21,22} The recommendations outlined in the American Academy of Orthopaedic Surgeons²³ clinical practice guidelines

for the treatment of CTS, suggest the use of local steroid injection or splinting, before considering surgery. Graham et al²⁴ reviewed the English literature and found that a number of studies report that initial response rates to steroid injections alone were an average of 76%, whereas the percentage of patients who remained asymptomatic at 1 year was an average of 14.5%. This was similar to patients treated with splinting alone where the average initial response rate was 70% and this dropped to 12%. Studies conducted to investigate the combined use of steroid injection and splinting found no symptomatic benefit over isolated injection or splinting therapy.^{25–27} Therefore, patient choice plays a very important role in deciding which therapy to opt for. More recently, ultrasound-guided microsurgery technique for carpal tunnel release has been described.²⁸ This is a minimally invasive procedure using a blunt cannula device which is positioned deep to the transverse carpal ligament under image guidance. Once in a safe position, the cutting surface of the device is deployed and the transverse carpal ligament is completely divided. This procedure was performed on only three patients in this study, but no complications were reported and all three patients had a successful outcome.

Technique

Ultrasound-guided injection has the benefit of allowing both diagnostic assessments of the carpal tunnel and any structural

Figure 7. Longitudinal approach to A1 pulley injection. (a) Ultrasound image demonstrates the normal appearance of the A1 pulley in longitudinal section (arrows); FDP, flexor digitorum profundus; FDS, flexor digitorum superficialis; MC, metacarpal; PP, proximal phalanx; VP, volar plate. (b) The in-plane injection in the longitudinal plane is demonstrated. The needle is shown (arrowheads) with its tip below and thickened and irregular annular pulley (arrows). MC, metacarpal; PP, proximal phalanx.

Figure 8. Illustration of the dorsal extensor compartments of the wrist I–VI, highlighting the first extensor compartment which is affected by De Quervain's stenosing tenosynovitis. APL, abductor pollicis longus; ECRB, extensor carpi radialis brevis; ECRL, extensor carpi radialis longus; ECU, extensor carpi ulnaris; EDL, extensor digitorum longus; EDM, extensor digitorum minimi; EI, extensor indices; EPB, extensor pollicis brevis; EPL, extensor pollicis longus.

anomalies and of ensuring accurate needle placement to avoid median nerve injuries.²⁹

Two principle injection techniques have been described depending on whether the needle is “in-plane” with the transducer or “out-of-plane” with it.^{29,30} As the median nerve is a very superficial structure, the in-plane approach is preferred as this maximizes visualization of the needle and avoids nerve injury. In addition, if adhesions are present between the overlying flexor retinaculum or underlying flexor tendons then some authors advocate the use of hydro dissection.³¹ With this technique, a bolus of saline is used in the injectate to separate the nerve away from the flexor retinaculum; however, this cannot be used with the out-of-plane approach since the entire needle path cannot be visualized.

Patient position: patient seated or supine with forearm resting on a bed in a supinated and slightly dorsally flexed position (Figure 11c).

Probe position: high-frequency linear probe.

- Once the carpal tunnel contents have been examined, place transducer transversely along proximal wrist crease and identify the median nerve—it has a characteristic speckled appearance. It is easiest to inject the carpal tunnel close to the proximal border (Figure 11b).
- Move the probe in ulnar direction and identify ulnar nerve and artery adjacent to the pisiform (Figure 11c).

Needle position (Figure 12):

- Aseptic technique and patient consent.
- Although it is possible to direct the injection from either the radial or ulnar side of the wrist, we prefer to adopt a radial approach to avoid injury to the ulnar neurovascular bundle. In our practice, we inject at the level of the proximal wrist crease as suggested by others.²⁹
- 25-G needle.
- Anaesthetize skin.
- Keep a very shallow trajectory.

- Under constant visual guidance advance the needle tip and pierce flexor retinaculum.
- Injectate volume of 2 ml.
- Injectate delivered in equal portions above and below the nerve.

Post-procedure considerations:

- Patients may experience hand numbness for the duration of the local anaesthetic and therefore should refrain from driving.

ULTRASOUND-GUIDED ASPIRATION OF GANGLION CYSTS

Ganglion cysts are the most common benign masses to occur within the hand and wrist. They are normally encountered in young adults (20–40 years) with a 2:1³² female predominance.

Pathophysiology

The aetiology of ganglion cysts is unclear but they may represent the sequelae of synovial herniations or coalescence of small degenerative cysts arising from the joint capsule or tendon sheath. Ganglia have a thin connective tissue capsule but no true synovial lining and contain mucinous material.³³ Within the hand and wrist, up to 70% arise dorsally in relation to the scapholunate ligament, 20% are on the volar aspect and arise from the radiocarpal or scaphotrapezoid joint. The remaining 10% arise from the flexor tendon sheaths or in association with the distal interphalangeal joints.¹¹

Indication and rationale

The majority of patients are asymptomatic and given the spontaneous resolution rate of ganglia being as high as 58% then reassurance and observation is normally advised. In those

Figure 9. Ultrasound image of the first dorsal extensor compartment in transverse section. This patient has a septum between the tendons. The patient has De Quervain's stenosing tenosynovitis, but it only affects the compartment contacting extensor pollicis brevis (EPB). The arrows indicate the retinaculum which shows low reflective thickening (*) in the compartment containing the EPB. APL, abductor pollicis longus; Rad, radius.

Figure 10. Injection of first Extensor compartment for De Quervain's tenosynovitis. (a) Patient position for injection into first extensor compartment. (b) Ultrasound image of the first dorsal extensor compartment in transverse section for an in-plane injection. Note the thickened retinaculum (*). The arrows indicate the needle. APL, abductor pollicis longus; Art, radial artery; EPB, extensor pollicis brevis; Rad, radius.

patients with symptoms (pain, paraesthesia, interference with activity, skin changes), the treatment options are either aspiration or surgical treatment. Surgical excision does have

a lower recurrence rate than aspiration but conversely a higher complication rate and a longer recovery time.³⁴ If symptomatic relief is the patient's primary concern, then simple puncture

Figure 11. Normal carpal tunnel anatomy and positioning for injection. (a and b) Ultrasound image of the proximal (a) and distal (b) carpal tunnel in transverse section. Note the superficial position of the median nerve (MN) immediately deep to the retinaculum (arrowheads) and superficial to the flexor digitorum tendons (shaded area); UA, ulna artery; UN, ulna nerve. (c) Patient position for carpal tunnel injection to obtain an image in (a).

Figure 12. Ultrasound image of the carpal tunnel in transverse section with in-plane carpal tunnel injection for carpal tunnel syndrome. The needle (arrows) has been positioned with its tip deep to the median nerve (MN). Following injection here the needle can be repositioned for further injection superficial to the nerve. Arrowheads, flexor retinaculum.

and aspiration are advocated as the first line treatment. Many clinicians inject steroid into the cyst cavity following aspiration. This was first introduced by Becker in 1953, based on the mistaken theory that ganglia are inflammatory in origin and he reported a high success rate (86%). However, these patients were only followed up for 2 months and subsequent studies looking at the efficacy of steroids report no benefit over aspiration alone.³⁵

Technique

Patient position: patient seated with elbow flexed to 90° and forearm resting on a bed or lying supine with arm by their side. The forearm is pronated for a dorsal cyst or supinated for a volar or flexor tendon sheath cyst.

Probe position: high-frequency linear probe.

- Use a gel stand-off for superficial structures.
- Cyst identification—anechoic mass with posterior acoustic enhancement (Figure 13). All anechoic masses must undergo power Doppler assessment to exclude a vascular malformation. This is especially true of volar-sided cysts which must be identified separate to the radial artery.
- Place transducer in short (transverse) axis over the cyst to allow visualization.

Needle position:

- Aseptic technique and patient consent.
- Use an in-plane approach for constant needle visualization.
- 25-G needle to anaesthetize the skin.
- 18-G needle advanced directly into the cyst.
- 5 ml Leur lock syringe using continuous suction. A larger syringe can be used to give more suction.
- Move the needle tip in different positions within the cyst if there is no yield and if there is still no aspirate than repeat the procedure using a larger bore needle. Injecting directly into the cyst can help break up its viscosity if it has still not been possible to aspirate it.
- Steroid injection is dependent on local practice preference.

Post-procedure considerations:

- Warn patient of high-risk of recurrence.

WRIST ARTHROGRAPHY

MR arthrography has become the preferred modality of imaging patients with suspected internal derangement of the wrist in most centres. It allows detailed evaluation of the integrity of the intercarpal and capsular ligaments of the wrist as well as the triangular fibrocartilage complex (TFCC). In its simplest form, this technique requires contrast distension of the radiocarpal joint under fluoroscopic guidance, followed by MRI using a dedicated wrist coil. The premise of this investigation is to detect a contrast leak out of the joint injected and into another wrist compartment, thereby indicating internal derangement. Joint injection for arthrography can also be undertaken under ultrasound guidance; however, we prefer to utilize fluoroscopy as it allows dynamic assessment of carpal stability and the passage of contrast into the midcarpal or distal radioulnar joints may be seen, providing useful diagnostic information.

Pathophysiology

The radiocarpal joint is a synovial joint formed by the articulation of the distal radius and proximal carpal row—not including the pisiform. In order to maintain mobility without sacrificing stability, the wrist joint has a complex configuration of ligaments on the volar and dorsal sides of the joint. These can be divided into extrinsic ligaments which link the carpus to the radius and the ulna or intrinsic (intercarpal) ligaments which connect the carpal bones to one another. The volar ligaments are important stabilizers of the joint; the dorsal ligaments are less well developed.

Indication and rationale

The main indication for wrist arthrography is in a trauma setting to demonstrate the presence of a clinically suspected tear or defect in one of the connecting structures—intercarpal ligaments, TFCC or capsular attachments.³⁶ Once the normal mechanics of the wrist joint are disrupted, instability of the carpal bones can lead to weakness, stiffness, chronic pain and early arthritis.

Figure 13. Ultrasound image of the scaphotrapezotrapezoid joint in longitudinal section. A ganglion cyst (G) is seen arising from the dorsum of the joint. Note the posterior acoustic enhancement indicating its cystic nature (arrows). Sca, scaphoid; Tra, trapezium.

Figure 14. Injection of the radiocarpal joint under fluoroscopic guidance. The fluoroscopy image demonstrates contrast within the radiocarpal joint. The needle tip is at the proximal pole of the scaphoid (arrow).

Technique

A contentious issue with wrist arthrography is whether to adopt a single or triple compartment injection technique—within the literature no real consensus exists.

The main proponents of triple compartment injection state that while central and radial TFCC tears are easily diagnosed with a single radiocarpal injection, peripheral tears of the ulna attachment of the TFCC as well as incomplete proximal tears are missed unless contrast is injected into the DRUJ.^{37,38} Levinsohn et al³⁸ also found that midcarpal joint injection was more sensitive at looking at intercarpal ligament integrity than radiocarpal injection alone. However, triple compartment injections require a considerable intervening period of time (3 h in Levinsohn et al³⁸

study) between the first radiocarpal injection and subsequent DRUJ and midcarpal injections as well as three separate skin punctures. Indeed, authors not in favour of triple compartment injections report that they are more expensive, time-consuming and uncomfortable for the patient, while providing little advantage over the single compartment injection.³⁹ Amrami⁴⁰ considered single compartment arthrography to be more definitive and easier to interpret than multicompartiment injections—in the latter, it may be difficult to differentiate complete from incomplete ligament tears and also the direction of the contrast flow.

Although there is no definite consensus, most authors would agree that the most sensible approach to wrist arthrography would be to carefully tailor it to the clinical symptoms. Most radiologists would start with a radiocarpal injection and add a DRUJ injection in patients with ulnar-sided pain when no communication was demonstrated following the initial injection.⁴¹ The use of midcarpal injection should be reserved for those cases where there is a high index of suspicion of intercarpal ligament injury, with a normal initial radiocarpal injection.⁴²

Patient position: patient prone with symptomatic arm extended in a PA position, above their head (superman position) and wrist in slight flexion over a rolled towel.

Intensifier position: PA projection centred on radiocarpal joint.

Radiocarpal joint—target the scaphoid, close to its proximal articular surface (Figure 14).

- Consent and aseptic technique.
- Anaesthetize skin.
- 25 G short needle attached to short connecting tube and 5 ml syringe.
- Injectate:
 - (1) confirm intra-articular position with 1 ml iodinated contrast.
 - (2) 2 ml dilute gadolinium contrast solution *e.g.* Magnevist 2 mMol.
 - (3) Do not over distend to avoid contrast extravasation.

Figure 15. Injection of the distal radioulnar joint (DRUJ) under fluoroscopic guidance. (a) The fluoroscopy image demonstrates contrast within the DRUJ joint. Note the filling defect within the contrast within the DRUJ (arrow). (b) T_1 weighted axial MR image from the subsequent MR-arthrography study demonstrated the filling defect to represent a displaced flap of cartilage from the torn triangular fibrocartilage (arrows).

Figure 16. Injection of the midcarpal joint under fluoroscopic guidance. Fluoroscopy image demonstrating a midcarpal joint injection. Note the presence of contrast into the scaphotrapezotrapezoid joint (*).

- Inject under continuous screening and watch flow of contrast.
- Remove the needle.
- If no communication identified, stress wrist with the ulna and radial deviation and clenched fist under continuous screening. If there is still no communication proceed to the second compartment injection.

DRUJ in patients with ulnar-sided pain (Figure 15)—from the dorsal wrist advance needle to ulna close to its radial margin at

the level of the DRUJ, directing needle radially for easier joint access.

- Injectate:
 - (1) confirm intra-articular position with 0.5 ml iodinated contrast.
 - (2) 1.5 ml Magnevist.
- Inject under continuous screening and stress wrist.

Midcarpal joint in patients with high clinical suspicion of intercarpal ligament injury (Figure 16)—target the needle tip from a dorsal approach to the triquetrohamate space.

- Injectate:
 - (1) confirm intra-articular position with 1 ml iodinated contrast.
 - (2) 2 ml Magnevist.
- Inject under continuous screening.
- Remove the needle and stress wrist whilst screening—normal midcarpal injection may extend to involve the second–fifth carpometacarpal joints.

Post procedure: proceed to MRI within 30 min of the procedure.

CONCLUSION

Image-guided intervention within the hand and wrist is commonly undertaken and for many patients is the preferred option compared with much more invasive procedures. Extensive review of the current literature has revealed that there are often many potential techniques and potential injectates to consider for each of the pathologies described above. This review provides an evidence-based method for each of the hand and wrist injections and a summary of the current evidence for each technique will hopefully provide the reader with a sound understanding of the potential benefits of each of these injections as well as an understanding of the alternative treatment options.

REFERENCES

- Stephens MB, Beutler AI, O'Connor FG. Musculoskeletal injections: a review of the evidence. *Am Fam Phys* **78**; 971: 2008.
- Speed CA. Injection therapies for soft-tissue lesions. *Best Pract Res Clin Rheumatol* **21**; 333–47: 2007. doi: [10.1016/j.berh.2006.11.001](https://doi.org/10.1016/j.berh.2006.11.001)
- Di Sante L, Cacchio A, Scettri P, Paoloni M, Ioppolo F, Santilli V. Ultrasound-guided procedure for the treatment of trapeziometacarpal osteoarthritis. *Clin Rheumat* **30**; 1195–200: 2011. doi: [10.1007/s10067-011-1730-5](https://doi.org/10.1007/s10067-011-1730-5)
- Orlandi D, Corazza A, Silvestri E, Serafini G, Savarino EV, Garlaschi G, et al. Ultrasound-guided procedures around the wrist and hand: how to do. *Eur J Radiol* **83**; 1231–8: 2014. doi: [10.1016/j.ejrad.2014.03.029](https://doi.org/10.1016/j.ejrad.2014.03.029)
- Dietz MJ, Ryu J. Isolated scaphotrapezotrapezoidal (STT) arthritis. *Current Rheum Rev* **8**; 266–8: 2012.
- Smith J, Brault JS, Rizzo M, Sayeed YA, Finnoff JT. Accuracy of sonographically guided and palpation guided scaphotrapezotrapezoid joint injections. *J Ultrasound Med* **30**; 1509–15: 2011.
- Rettig AC. Athletic injuries of the wrist and hand part II: overuse injuries of the wrist and traumatic injuries to the hand. *Am J Sports Med* **32**; 262–73: 2004. doi: [10.1177/0363546503261422](https://doi.org/10.1177/0363546503261422)
- Goncalves B, Ambrosio C, Serra S, Alves F, Gil-Agnostinho A, Caseiro-Alves F. US-guided interventional joint procedures in patients with rheumatic diseases—when and how we do it? *Eur J Radiol* **79**; 407–14: 2011. doi: [10.1016/j.ejrad.2010.04.001](https://doi.org/10.1016/j.ejrad.2010.04.001)
- Kale S. Medscape Reference 2014. Available from: <http://emedicine.medscape.com/article/1244693-overview>
- Makkouk AH, Oetgen ME, Swigart CR, Dodds SD. Trigger finger: etiology, evaluation and treatment. *Curr Rev Musculoskelet Med* **1**; 92–6: 2008. doi: [10.1007/s12178-007-9012-1](https://doi.org/10.1007/s12178-007-9012-1)
- Teh J, Vlychou M. Ultrasound-guided interventional procedures of the wrist and hand. *Eur Radiol* **19**; 1002–10: 2009. doi: [10.1007/s00330-008-1209-1](https://doi.org/10.1007/s00330-008-1209-1)
- Nimigan AS, Ross DC, Gan BS. Steroid injections in the management of trigger fingers. *Am J Phys Med Rehab* **85**; 36–43: 2006. doi: [10.1097/01.phm.0000184236.81774.b5](https://doi.org/10.1097/01.phm.0000184236.81774.b5)
- Fleisch SB, Spindler KP, Lee DH. Corticosteroids injections in the treatment of trigger

- finger: a level I and II systematic review. *J Am Acad Ortho Surg* **15**; 166–71: 2007.
14. Ryzewicz M and Wolf JM. Trigger digits: principles, management and complications. *J Hand Surg Am* **31**; 135–46: 2006. doi: [10.1016/j.jhsa.2005.10.013](https://doi.org/10.1016/j.jhsa.2005.10.013)
 15. Bodor M and Flossman T. Ultrasound-guided first annular pulley injection for trigger finger. *J Ultrasound Med* **28**; 737–43: 2009.
 16. Rajeswaran G, Lee JC, Eckersley R, Katsarma E, Healy JC. Ultrasound-guided percutaneous release of the annular pulley in trigger digit. *Euro Radiol* **19**; 2232–7: 2009. doi: [10.1007/s00330-009-1397-3](https://doi.org/10.1007/s00330-009-1397-3)
 17. Richie CA 3rd and Briner WW Jr. Corticosteroid injection for treatment of de Quervain's tenosynovitis: a pooled quantitative literature evaluation. *J AM Board Fam Med* **16**; 102–6: 2003.
 18. McDermott JD, Ilyas AM, Nazarian LN, Leinberry CE. Ultrasound-guided injections for de Quervain's tenosynovitis. *Clin Orthop Relat Res* **470**; 1925–31: 2012. doi: [10.1007/s11999-012-2369-5](https://doi.org/10.1007/s11999-012-2369-5)
 19. Mahakkanurauh P and Mahakkanurauh C. Incidence of a septum in the first dorsal compartment and its effects on therapy of de Quervain's disease. *Clin Anat* **13**; 195–8: 2000.
 20. Zingas C, Failla JM, Van Holsbeeck M. Injection accuracy and clinical relief of de Quervain's tendonitis. *J Hand Surg Am* **23**; 89–96: 1998. doi: [10.1016/S0363-5023\(98\)80095-6](https://doi.org/10.1016/S0363-5023(98)80095-6)
 21. Katz JN, Keller RB, Simmons BP, Rogers WD, Bessette L, Fossel AH, et al. Maine carpal tunnel study: outcomes of operative and nonoperative therapy for carpal tunnel syndrome in a community based cohort. *J Hand Surg Am* **23**; 697–710: 1998. doi: [10.1016/S0363-5023\(98\)80058-0](https://doi.org/10.1016/S0363-5023(98)80058-0)
 22. Gerritson AA, de Vet HC, Scholten RJP, Bertelsman FW, de Krom MC, Bouter LM. Splinting *versus* surgery in the treatment of carpal tunnel syndrome. *JAMA* **288**; 1245–51: 2002.
 23. Clinical practice guideline on the treatment of carpal tunnel syndrome. American Academy of Orthopaedic Surgeons. 2008. Available from: <http://www.aaos.org/research/guidelines/ctstreatmentguideline.pdf>
 24. Graham RG, Hudson DA, Solomons M, Singer M. A prospective study to assess the outcome of steroid injections and wrist splinting for the treatment of carpal tunnel syndrome. *Plast Reconstr Surg* **113**; 550–6: 2004. doi: [10.1097/01.PRS.0000101055.76543.C7](https://doi.org/10.1097/01.PRS.0000101055.76543.C7)
 25. Gelberman RH, Aronson D, Weisman MH. Carpal tunnel syndrome. Results of a prospective trial of steroid injection and splinting. *J Bone Joint Surg Am* **62**; 1181–4: 1980.
 26. Weiss AP, Sachar K, Gendreau M. Conservative management of carpal tunnel syndrome: a reexamination of steroid injection and splinting. *J Hand Surg Am* **19**; 410–15: 1994. doi: [10.1016/0363-5023\(94\)90054-X](https://doi.org/10.1016/0363-5023(94)90054-X)
 27. Gonzalez MH and Bylak J. Steroid injection and splinting in the treatment of carpal tunnel syndrome. *Orthopedics* **24**; 479–81: 2001.
 28. Buncke G, McCormack B, Bodor M. Ultrasound-guided carpal tunnel release using the manos CTR system. *Microsurgery* **33**; 362–6: 2013. doi: [10.1002/micr.22092](https://doi.org/10.1002/micr.22092)
 29. Smith J, Wisniewski SJ, Finnoff JT, Payne JM. Sonographically guided carpal tunnel injections: the ulnar approach. *J Ultrasound Med* **27**; 1485–90: 2008.
 30. Grassi W, Farina A, Filipucci E, Cervini C. Intralesional therapy in carpal tunnel syndrome: a sonographic-guided approach. *Clin Exp Rheumatol* **20**; 73–6: 2002.
 31. Malone DG, Clark DC, Wei N. Ultrasound-guided percutaneous injection, hydrodissection and fenestration for carpal tunnel syndrome: escription of a new technique. *J App Res* **10**; 116: 2010.
 32. Freire V, Guerini H, Campagna R, Moutounet L, Dumontier C, Feydy A, et al. Imaging of hand and wrist cysts: a clinical approach. *AJR Am J Roentgenol* **199**; W618–28: 2012. doi: [10.2214/AJR.11.8087](https://doi.org/10.2214/AJR.11.8087)
 33. Beaman FD and Peterson JJ. MR imaging of cysts, ganglia and bursa about the knee. *Radiol Clin North Am* **45**; 969–82: 2007.
 34. Suen M, Fung B, Lung CP. Treatment of ganglion cysts. *ISRN Orthopaedics* **2013**; 940615: 2013.
 35. Varley GW, Neidoff M, Davis TR, Clay NR. Conservative management of wrist ganglia: aspiration *versus* steroid infiltration. *J Hand Surg Br* **22**; 636–7: 1997. doi: [10.1016/S0266-7681\(97\)80363-4](https://doi.org/10.1016/S0266-7681(97)80363-4)
 36. Gilula LA, ed. *The traumatized hand and wrist: radiographic and anatomic correlation*. Philadelphia, PA: Saunders; 1992.
 37. Ruegger C, Schmid MR, Pfirrmann CW, Nagy L, Gilula LA, Zanetti M. Peripheral tear of the triangular fibrocartilage: depiction with MR arthrography of the distal radioulnar joint. *AJR Am J Roentgenol* **188**; 187–92: 2007.
 38. Levinsohn EM, Palmer AK, Coren MD, Zinberg E. Wrist arthrography: the value of the three compartment injection technique. *Skeletal Radiol* **16**; 539–44: 1987. doi: [10.1007/BF00351268](https://doi.org/10.1007/BF00351268)
 39. Manaster BJ. The clinical efficacy of triple-injection wrist arthrography. *Radiology* **178**; 267–70: 1991. doi: [10.1148/radiology.178.1.1984317](https://doi.org/10.1148/radiology.178.1.1984317)
 40. Amrami KK. Magnetic resonance arthrography of the wrist: case presentation and discussion. *J Hand Sur Am* **31**; 669–72: 2006. doi: [10.1016/j.jhsa.2006.03.015](https://doi.org/10.1016/j.jhsa.2006.03.015)
 41. Maizlin ZV, Brown JA, Clement JJ, Grebenyuk J, Fenton DM, Smith DE, et al. MR arthrography of the wrist: controversies and concepts. *Hand* **4**; 66–73: 2009. doi: [10.1007/s11552-008-9149-4](https://doi.org/10.1007/s11552-008-9149-4)
 42. Cooney WP. *The wrist: diagnosis and operative treatment*. 2nd edn. Philadelphia, PA: Lippincott Williams & Wilkins; 2011.