Ultrasound is a powerful modality for guiding the intra-articular injection of both therapeutic medication and contrast material. Needle placement and the distribution of the injected material is confirmed visually, in real time and without ionising radiation. Procedure-related pain can be minimised, as visualisation of the needle path will reduce unnecessary trauma to the local tissue as well as decrease the number of attempts needed to perform the procedure.

Systematic reviews of the literature confirm the superior accuracy of ultrasound-guided intra-articular injection relative to non-imaged, landmark-guided injection. Other systematic reviews show similar accuracy of ultrasound guidance compared to fluoroscopic guidance, but with less patient discomfort. Intra-tendinous injection of corticosteroid can cause tendon rupture. Unintended extracapsular injection can result in local tissue atrophy. Both complications make precise joint injection critically important.

This article will review the basic techniques used in ultrasound-guided joint injections, with a focus on the commonly injected large joints, which include the shoulder, elbow, hip, knee and ankle. This review will also include an overview of the various injectable local anaesthetics and corticosteroids that are commonly used in the procedure.

**GENERAL TECHNIQUE**

Musculoskeletal ultrasound is ideally performed with a high-frequency (9 to 20 MHz) linear array transducer. This high-frequency transducer allows detailed evaluation of the joint capsule and tendon fibrils in the preliminary diagnostic portion of the examination. In the therapeutic portion of the examination, it allows for optimal visualisation of the injection needle. In patients with a larger physique, deeper joints such as the hip are better visualised with a lower frequency curved array transducer that allows for deeper penetration (Figure 1).

An initial diagnostic assessment of the joint involves an evaluation of the surrounding structures such as the bursae, tendons and joint capsule. This will aid in planning the needle approach, which must avoid vascular or nerve structures but still optimise the shortest distance to the intra-articular space. Most of the large joints have standard approach windows for safe, unobstructed intra-articular access. After the appropriate window is found, the skin is sterilised and draped. The transducer is also draped in a sterile fashion.

For subcutaneous/local anaesthesia, a 3.5-inch, 25-gauge needle is used to administer 1 or 2% lidocaine hydrochloride. If the joint...
in question is superficial enough, this same needle can be used to enter the joint capsule for the therapeutic injection. Otherwise, most joints can be accessed using a standard 5-inch, 22-gauge spinal needle. In cases where aspiration is required, a larger 18- to 20-gauge spinal needle is used, to facilitate the flow of the aspirated material (Figure 2).

For intra-articular anaesthetics, lidocaine hydrochloride, bupivacaine hydrochloride and ropivacaine hydrochloride are commonly used. Lidocaine hydrochloride (Xylocaine) is the most commonly used of the three local anaesthetics, with a rapid onset and duration of action that ranges from 80 to 120 minutes⁹. The rapid onset makes this ideal for both subcutaneous and intra-articular anaesthesia. Note that only 1% lidocaine concentration should be used, as higher doses have been associated with chondrocyte toxicity⁹,¹⁰. The 1% lidocaine can be mixed with an additional longer-acting anaesthetic such as bupivacaine hydrochloride (Marcaine). Bupivacaine has a slower onset (2 to 10 minutes) than lidocaine, but has a much longer duration of action – ranging from 180 to 360 minutes. For similar reasons of dose-related chondrocyte toxicity,

**Table 1**

<table>
<thead>
<tr>
<th>Local anaesthetic</th>
<th>Trade name</th>
<th>Onset</th>
<th>Duration of action (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine hydrochloride</td>
<td>Xylocaine</td>
<td>Rapid</td>
<td>80-120</td>
</tr>
<tr>
<td>Bupivacaine hydrochloride</td>
<td>Marcaine</td>
<td>Longest (2-10 min)</td>
<td>180-360</td>
</tr>
<tr>
<td>Ropivacaine hydrochloride</td>
<td>Naropin</td>
<td>Moderate</td>
<td>140-200</td>
</tr>
</tbody>
</table>

Table 1: Onset and duration times of common local anaesthetics.

**Table 2**

<table>
<thead>
<tr>
<th>Corticosteroid</th>
<th>Trade name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylprednisolone acetate</td>
<td>Depo-Medrol, Solu-Medrol, Duralone, Medralone</td>
</tr>
<tr>
<td>Triamcinolone</td>
<td>Kenalog</td>
</tr>
<tr>
<td>Betamethasone acetate, betamethasone sodium phosphate</td>
<td>Celestone Soluspan, Betaject</td>
</tr>
</tbody>
</table>

Table 2: Common corticosteroids and their trade names.
a lower concentration (0.25%) of bupivacaine is preferred. Ropivacaine hydrochloride (Naropin) at 0.5% concentration is another common anaesthetic which has a faster onset of action than bupivacaine, as well as a duration of action of 180 to 360 minutes. While some studies suggest it has lesser toxicity than bupivacaine, it costs two to three times more than bupivacaine.

The corticosteroids most commonly used in intra-articular injection are derivatives of prednisolone, which have strong anti-inflammatory potency. Both methylprednisolone and triamcinolone are highly insoluble in water and are distributed as microcrystalline suspensions. Since these require cellular hydrolysis for activation, these preparations will have delayed onset but a theoretically longer-lasting effect within the joint space. In contrast, dexamethasone sodium phosphate is a freely soluble preparation that would theoretically have a faster onset of action. Lastly, celestone soluspan contains both soluble and insoluble components that would theoretically add both the properties of faster onset and longer duration of action. Despite these theoretical differences however, studies that have analysed onset, duration of action and efficacy have shown wide overlapping ranges; a clear distinction between the clinical effects of each corticosteroid is very difficult to demonstrate. Choice of the corticosteroid thus remains highly varied between clinicians. This author chooses Triamcinolone preparations, as the clinical duration of action may last as long as 12 weeks.

As these medications have anti-inflammatory properties, systemic or intra-articular sepsis are absolute contraindications. Intra-articular fracture and joint instability are additional contraindications. The clinical decision of whether to inject or not is beyond the scope of this paper but should be based on a shared decision-making process.

SHOULDER TECHNIQUE
Shoulder injections are best performed in the lateral decubitus position, with the affected shoulder on the non-dependent side. The humerus should be internally rotated with the elbow in flexion, which will elongate the infraspinatus tendon and posterior joint capsule. The transducer is held in the transverse plane, parallel to the infraspinatus tendon (Figure 3). Structures of interest include the humeral head, infraspinatus tendon, posterior joint capsule, deltoid muscle and posterior glenoid (Figure 4). The needle approach is via a posterior lateral direction, which minimises the distance between the skin surface and the joint capsule. Subcutaneous lidocaine is used for local anaesthesia with a 25-gauge needle. In many patients, this same needle can be used to enter into the joint capsule. If body habitus does not allow, then the joint can be accessed using a standard 5-inch 22-gauge spinal needle. Further confirmation of needle tip placement within the joint space can be made with a test injection of 1% lidocaine (Figure 5a). A corticosteroid preparation, often mixed in the same syringe with 1% lidocaine and 0.25% bupivacaine can now be injected. As large volumes can produce patient discomfort, a total volume of 5 to 6 ml is recommended (Figure 5b).

The subacromial bursa lies deep to the acromion and deltoid muscle, extending over the superior margins of the supraspinatus and infraspinatus. Bursal inflammation can be seen in the setting of shoulder impingement and rotator cuff tendinopathy. Ultrasound-guided injection of corticosteroid is often performed for symptomatic relief. Ideally, the patient lies supine, with the arm in neutral position. The probe can be held in an oblique coronal position, visualising the deltoid muscle, acromion and supraspinatus insertion (Figure 6 and 7a). The bursa is the thin hypoechoic (dark) line between the rotator cuff and deltoid muscle. After the injection of local anaesthetic, a 25-gauge needle can be used to approach this hypoechoic line. A test injection of 1% lidocaine can then distend the bursa, confirming needle tip location. Next, the corticosteroid local anaesthetic preparation is injected. A total of 3 ml can be injected (Figure 7b). This injection can be performed in conjunction
Figure 5a: Confirmed needle placement (large arrow) deep to the infraspinatus (I) and posterior joint capsule. A test injection of 1% lidocaine has slightly distended the posterior joint recess with fluid (arrow head). Note the humeral head (H) and glenoid (G).

Figure 5b: Therapeutic injection of the corticosteroid and local anaesthetic mixture further distends the posterior joint recess (arrow head).

Figure 6: Subacromial bursa injection positioning; the transducer is held in the oblique coronal plane. The needle is angled toward the subacromial space.

Figure 7a: Oblique coronal view of the shoulder: acromion (A), supraspinatus tendon (S), deltoid muscle (D), and greater tuberosity (GT). The needle (arrow) is aimed toward the subacromial/subdeltoid bursa, which is the hypoechoic (dark) line between the supraspinatus tendon and deltoid muscle.

Figure 7b: Post-injection view of the subacromial/subdeltoid bursa: note the needle (large arrow) position and the bursa distended with the injected material (arrow head).
Figure 8: Elbow positioning: the arm is internally rotated and the elbow is flexed. The lateral margin of the radial capitellar joint space is now exposed.

Figure 9: Needle positioning for elbow injection: the needle is angled distally toward the articular surface of the radial head.

Figure 10: View of the elbow joint space along the lateral aspect of the radial head (R) and capitellum (C).

Figure 11a: Needle approach of the elbow injection: The needle (arrow) is inserted through the joint capsule toward the radial head articulating surface.

Figure 11b: The injected corticosteroid local anaesthetic preparation is now distending the lateral elbow joint recess (arrow head).

Figure 12: Positioning for the hip joint injection: the patient lies supine and the probe is held along the long axis of the femoral neck.

Figure 13: Oblique axial view of the hip joint: iliopsoas muscle (I), acetabulum (A), femoral head (FH), femoral neck (FN) and femoral head-neck junction (arrow head).
with a glenohumeral joint injection, as a tandem procedure. In this setting, the
glenohumeral joint is injected first. Then the
same needle is withdrawn slightly into the
expected region of the subacromial bursa.
The bursa is distended with a test injection
of 1% lidocaine, which is then followed
by the injection of the corticosteroid local
anaesthetic preparation.

ELBOW TECHNIQUE
An elbow injection is performed with the
patient lying supine. The arm is internally
rotated and the elbow is flexed, exposing
the lateral margin of the radial capitellar
joint space (Figure 8). The probe is positioned
along the long axis of the anterior lateral
joint space, visualising the radial head,
capitellum and anterior lateral joint capsule
(Figure 9 and 10). A 25- or 22-gauge needle
is inserted along the long axis of the joint
toward the radial head. If needed, the
needle tip location can be confirmed with
a test injection of 1% lidocaine. This is then
followed by the injection of 2 to 3 ml of the
corticosteroid local anaesthetic preparation
(Figures 11a and 11b).

HIP TECHNIQUE
The hip injection is best performed
with the patient lying supine. The feet
are ideally held between neutral to eight
degrees of internal rotation, which will
elongate the femoral neck. The transducer
is held in an oblique axial plane, parallel
to the femoral neck. This will expose the
femoral head-neck junction as the optimal
target (Figures 12 and 13). Note that the
femoral neurovascular bundle lies medial
to the femoral neck and thus should not
be within the field of view. Subcutaneous
lidocaine is used for local anaesthesia along
the expected path of the injection. Next, a
22-gauge spinal needle is used to approach
the joint capsule on the same plane as the
femoral neck (Figures 14 and 15a). Needle
tip location can be confirmed with a test
injection of 1% lidocaine. This is followed
by the injection of the corticosteroid local
anaesthetic preparation. Similar to the
shoulder, a total volume of 5 to 6 ml is
recommended (Figure 15b).

KNEE TECHNIQUE
A knee injection is performed with
the patient lying supine and the affected
knee flexed slightly. Positioning the
probe in the sagittal plane (Figure 16) can
easily identify the contours of the patella,
quadiceps tendon and distal femur. The
suprapatellar recess is the hypoechoic
dark) linear band emerging from the
superior border of the patellofemoral

Figure 14: Needle positioning for the hip injection: the needle is inserted along the long axis of the femoral neck.
Figure 15a: The needle (arrow) is inserted through the joint capsule, with the tip visualised at the junction of the femoral head (FH) and
femoral neck (FN).
Figure 15b: The injected corticosteroid local anaesthetic preparation is now distending the anterior hip joint capsule (arrow head).
Figure 16: Initial positioning for knee joint injection: the knee is slightly flexed and the probe is first positioned in the sagittal plane, midline
over the quadiceps tendon insertion and patella.
compartment (Figure 17). Identifying its location is easier in the presence of a joint effusion. At a level just superior to the patella or through the centre of the joint effusion, turn the probe 90 degrees to image the recess in the transverse plane. A 25- or 22-gauge spinal needle is then inserted using a lateral approach into the suprapatellar recess (Figures 18 and 19). If no joint effusion is present, the needle tip location can be confirmed with the test injection of 1% lidocaine. Similar to the shoulder and hip, a total of 5 to 6 ml of corticosteroid local anaesthetic preparation can be administered comfortably.

AN KLE TECHNIQUE

The ankle joint space is best visualised with the patient lying supine and the affected foot slightly plantar flexed (Figure 20). This will expose the anterior aspect of the talar dome and stretch the anterior joint capsule. The probe is held in the sagittal plane, visualising the anterior margin of the distal tibia, anterior talar dome and talar neck (Figure 21). A 25- or 22-gauge needle is inserted by an anterior approach toward the exposed talar articular surface (Figures 22 and 23). Approximately 3 ml of total corticosteroid local anaesthetic preparation can be injected.

SUMMARY

Ultrasound is a powerful tool for image guidance in musculoskeletal interventional procedures. Although non-imaged, landmark-guided procedures are still routinely performed in various practices, ultrasound adds a far greater level of precision and accuracy. As cortisone injections can be associated with both tendon rupture and local tissue atrophy, this precision is of utmost importance. Additionally, ultrasound guidance can minimise patient discomfort by limiting needle trauma to the local tissue and decreasing the number of failed attempts. While this paper has focused on the injections of corticosteroid

**Figure 17**: Sagittal view of the knee: femur (F), quadriceps tendon insertion (Q), patella (P) and small effusion distending the suprapatellar joint recess (arrow head).

**Figure 18**: Positioning for the knee joint injection: the probe is rotated into the transverse plane and the needle is inserted into the lateral suprapatellar recess.

**Figure 19**: Axial view of the suprapatellar knee during injection: quadriceps tendon (Q), femur (F), needle (large arrow) and suprapatellar joint recess fluid (arrow head).

**Figure 20**: Positioning for the ankle joint injection: the probe is held in the sagittal plane to visualise the anterior tibial talar joint recess.

**Figure 21**: Sagittal view of the knee: femur (F), quadriceps tendon insertion (Q), patella (P) and small effusion distending the suprapatellar joint recess (arrow head).
and local anaesthetic, this modality can also be used to introduce intra-articular contrast material for CT or MRI arthrography. In the setting of joint aspiration and potential septic arthropathy, ultrasound can provide similar guidance for tissue sampling. In this context, clear visualisation of the overlying soft tissue in the diagnostic portion of the exam can identify fluid collections, abscesses or infected bursa that could potentially be in the path of the sampling needle.

References