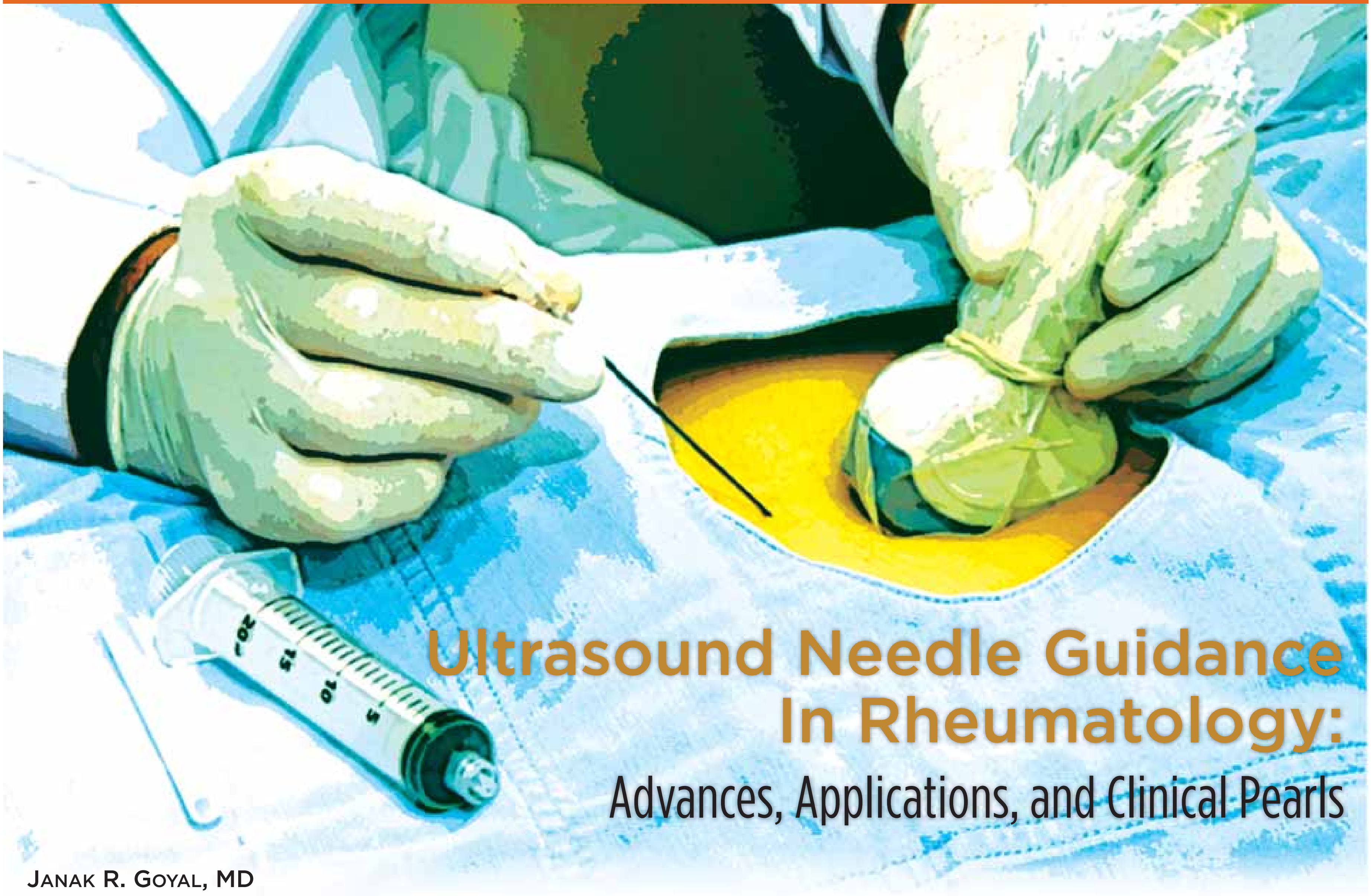

# Ultrasound Needle Guidance In Rheumatology:

## Advances, Applications, and Clinical Pearls

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Over the past 7 decades, ultrasound (US) imaging has evolved into an increasingly versatile tool to visualize the interior structures of the body. Its potential for medical diagnosis was first recognized in 1942, when Karl Theo Dussik attempted to locate tumors with the first sonograms of the human brain.[1] Dussik's research also included the first reported use of musculoskeletal US to measure the acoustic attenuation of articular tissues, including skin, tendon, bone, and cartilage.[2] His pioneering work led to establishing the effects of various pathologic processes in articular tissues on acoustic attenuation, laying the groundwork for diagnostic musculoskeletal US.

Modern use of US in rheumatology began in 1978 with the first demonstration by P.L. Cooperberg of synovitis of the knee in rheumatoid arthritis. Cooperberg compared gray scale images of synovial thickening and joint effusion with clinical and arthrographic findings before and after therapeutic injection of yttrium-90.[3] Since then, the applications of the technology have flourished to such an extent that musculoskeletal US at the point of care was recently hailed as "potentially the most exciting development in clinical rheumatology practice in recent years."[4]

### Benefits and Applications Of Musculoskeletal Ultrasound

US imaging offers a wide range of potential benefits for musculoskeletal examination and procedural guidance for joint and soft tissue injections and aspirations. The technology has been shown to be 6.5 times more sensitive than x-rays for early, accurate diagnosis of small bone erosions in patients with rheumatoid arthritis, and 3.4 times more sensitive in late disease.[5] Use of US at the point of care can significantly reduce medical errors and offer efficient real-time diagnosis, and in appropriate clinical scenarios, can replace or supplement more expensive imaging technologies, such as computed tomography (CT).[6] Patients also are spared the cumulative radiation burden of CT scans, which has become a growing public health concern.

Compared with traditional

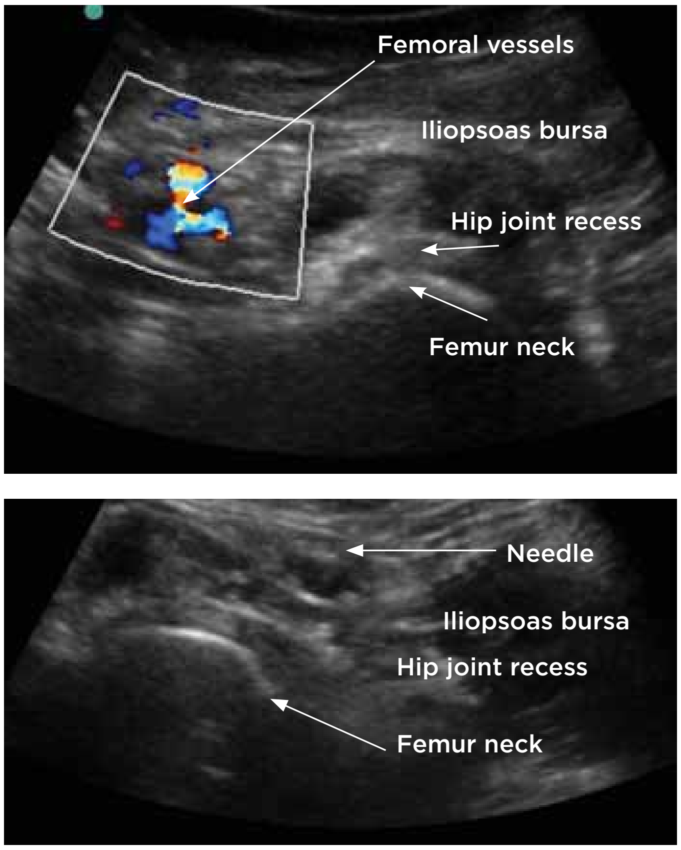


**Figure 1. Iliopsoas bursa injection.**

**Accurate iliopsoas bursa injection benefits from imaging guidance. Ultrasound is an excellent imaging tool for performing iliopsoas bursa injections in an office setting. Injury to nerves and vessels can be avoided by defining surrounding anatomy to accurately plan the path of the needle**

blind injections, use of US to guide intra-articular injections was shown in a recent study to significantly improve accuracy and patient outcomes. In the randomized clinical trial involving 184 patients with inflammatory arthritis and an inflamed joint (shoulder, elbow, knee, wrist, or ankle), approximately 33% of corticosteroid injections guided by clinical examination proved inaccurate. In the same trial, US-guided injections performed by trainee rheumatologists had a higher rate of accuracy (83%) than achieved by more senior rheumatologists using blind techniques (66%). Accurate injections led to greater improvements in visual analog scale (VAS) scores for assessment of pain, function, and stiffness of the target joint at 6 weeks.[7]

The ability to position a needle accurately within the joint space also is important for diagnostic aspiration of synovial fluid. Palpation guidance has been shown to have poor accuracy even for large joints, such as the knee, and may be even more of a clinical challenge for small joints, such as the interphalangeal and metacarpophalangeal (MCP). In one study, needle placement was intra-articular in 59% of palpation-guided aspirations in patients with early inflammatory arthritis, compared with 96% of US-guided aspirations.[8]

Another study found that in patients with inflammatory arthritis, US guidance of a joint injection with triamcinolone acetonide resulted in an 81% reduction in procedural pain. Not only was patient comfort during the injection significantly improved compared with patients who received palpation-guided injections, but the US group achieved a 35% reduction in initial pain scores, a 32% increase in therapeutic duration, and a 33% annual reduction in cost-per-responder, demonstrating that US guidance improves comfort, clinical outcomes, and cost-effectiveness.[9]

### Limitations of Musculoskeletal Ultrasound

Musculoskeletal procedures typically are performed with a "free-hand" technique that allows direct visualization of the needle tip in real time as it is advanced toward its target under vigilant observation. However, as the angle becomes steeper, the needle tends to become more difficult to visualize in approaches to deep anatomic targets, such as hip and shoulder joints, and the knee in obese patients. Strategies to improve visualization include heel-toe angling and probe rocking, in order to use tissue movement as a surrogate marker to identify the location of the needle through reverberation artifact. Other workarounds involve injecting a small amount of fluid and watching its spread to localize the needle tip or rotating the probe 90 degrees to examine the needle in its short axis.

A recent study compared the echogenicity of 8 common brands of needles used for nerve blocks.[10] The needles were inserted into animal tissue under standardized conditions and US images were taken of each needle. Physicians trained in performing US-guided procedures were then asked to rank the clarity of the blinded needle images on a 5-point scale. Although some brands and models of needles were more easily visualized than others, the smaller the needle, the lower its clarity tended to be under US.[10] Some companies have marketed disposable needles designed to be more easily visible under US, but due to cost considerations, they have not been widely adopted.

Uses of US in rheumatology are expanding, particularly for guidance of procedures formerly performed using the traditional palpation method. In light of these advances, several cases of US-guided injections and aspirations in office practice highlight the capabilities of the technology to improve the comfort, diagnosis, treatment, and outcomes for patients afflicted with painful disorders. (The SonoSite M-Turbo 6-13 MHz transducer was used for all cases.)

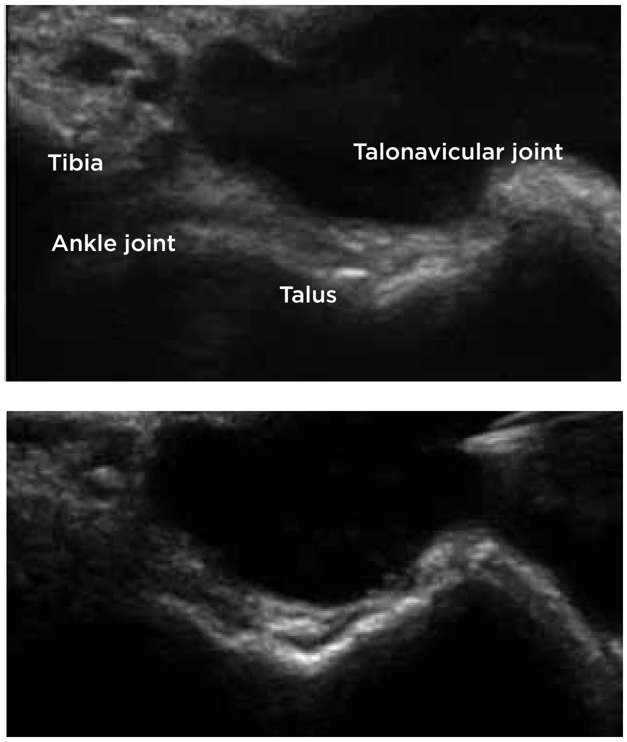


**Figure 2. Talonavicular joint.**

**Effusion of the talonavicular joint extending in front of the ankle joint was clinically mistaken for effusion of the ankle joint. Ultrasound helped define the lesion and accurate aspiration of the talonavicular joint. Analysis of the joint fluid under polarized light microscopy showed needle-shaped negatively birefringent crystals, establishing the diagnosis of gout. Palpation without ultrasound may have led to the insertion of the needle into the ankle joint, thereby missing the fluid.**

### Case 1

A 67-year-old woman presented with sudden onset of pain in her left hip. She was treated with 200 mg of celecoxib (Celebrex, Pfizer) twice daily for 2 months with minimal relief. She was evaluated by an orthopedic physician and sent for a hip x-ray, which revealed mild osteoarthritis. The patient received 50 mg of diclofenac sodium and misoprostol (Arthrotec, Pfizer) twice daily and was referred for physical therapy, again with minimal relief. After 3 months of worsening pain, the patient began to experience severe difficulty ambulating. She was seen by another orthopedic physician and evaluated with MRI. The imaging study showed left iliopsoas bursitis. The patient was prescribed 500 mg of naproxen twice daily, again with poor control of symptoms.

Under US performed in-office, the patient's left hip showed iliopsoas bursitis consistent with the MRI diagnosis (Figure 1). She received an injection into her iliopsoas bursa of 40 mg of methylprednisone and 1 mL of 1% lidocaine under US guidance. The patient was completely symptom-free within 3 days of the treatment and has remained without pain since.

***Clinical Pearls***

Iliopsoas bursa injection performed under US guidance offers a safe and effective method to inject the bursa, often providing substantial therapeutic benefits to patients,[11] including long-term pain relief in the majority of cases.[12]

US guidance helps avoid injury to vessels and nerves in the area by planning the needle path before injection by accurately defining the anatomy of the region.

## Case 2

A 50-year-old man with known history of tophaceous gout presented with swelling of his left foot and ankle. Examination with US revealed a large effusion in the talonavicular (TN) joint (Figure 2). After aspiration of the joint, analysis of the fluid under a polarized light microscope showed negatively birefringent, needle-shaped crystals consistent with monosodium urate (MSU), establishing the diagnosis of gout as the cause of his joint effusion. The patient's joint was injected with 40 mg of methylprednisone and 1 mL of 1% lidocaine.

Upon physical examination, the effusion of the TN joint extending in front of the ankle joint was clinically mistaken for ankle joint effusion, which is the more common cause of ankle swelling. Reliance on the traditional palpation-guided method would have mistakenly led to insertion of the needle into the ankle joint to attempt aspiration, thus missing the fluid. Doing so would have caused unnecessary trauma and discomfort to the patient, without clinical benefit.

***Clinical Pearls***

Use of US to localize joint fluid collection greatly improves the success of diagnostic joint fluid aspiration in rheumatology practice. One study found a 97% success rate in joints aspirated under US guidance, compared with a 32% success rate for aspirations performed without the technology.[13]

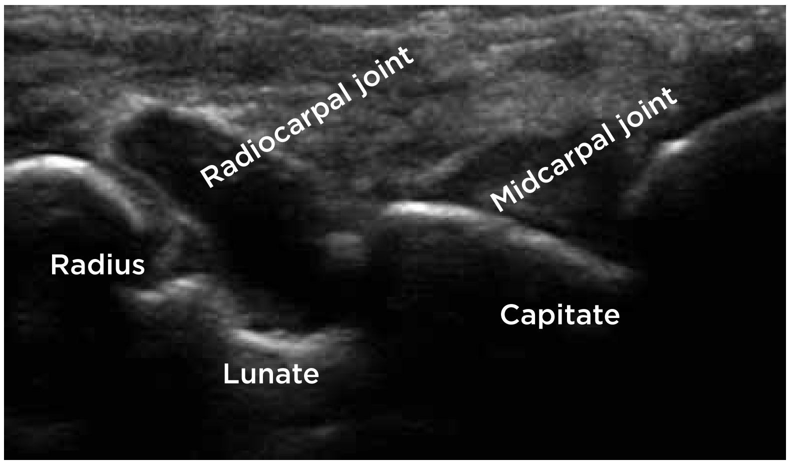


**Figure 4. Midcarpal joint aspiration.**

**The patient presented with painful swelling of the wrist. An ultrasound examination showed effusion in the midcarpal joint and synovial proliferation of radiocarpal joint. Two mL of cloudy fluid was aspirated from the midcarpal joint under ultrasound guidance. Analysis of the fluid showed rhomboid positively birefringent crystals, making the diagnosis of pseudogout. Blind palpation might have led to the targeting of the radiocarpal joint, missing the fluid and the diagnosis.**

Specific diagnostic sonographic features that have been proposed as indicators of gout, but not other arthropathies, include the "double contour sign"—a hyperechoic band over the superficial margin of the articular cartilage suggestive of MSU deposits (Figure 3). In a study of 37 joints of 23 patients with MSU-proven gout, the double contour sign was found in 92% of gouty joints but none of the joints examined in 23 control patients with other rheumatic disorders.[14]

Another diagnostic feature proposed in the same study was hypoechoic to hyperechoic, inhomogeneous material surrounded by a small anechoic rim (representing tophaceous material) observed in all of the gouty metatarsophalangeal and MCP joints examined, but none of the controls.[14] However, analysis of the aspirate under the polarized light microscope remains the gold standard for accurate diagnosis of both gout and pseudogout.

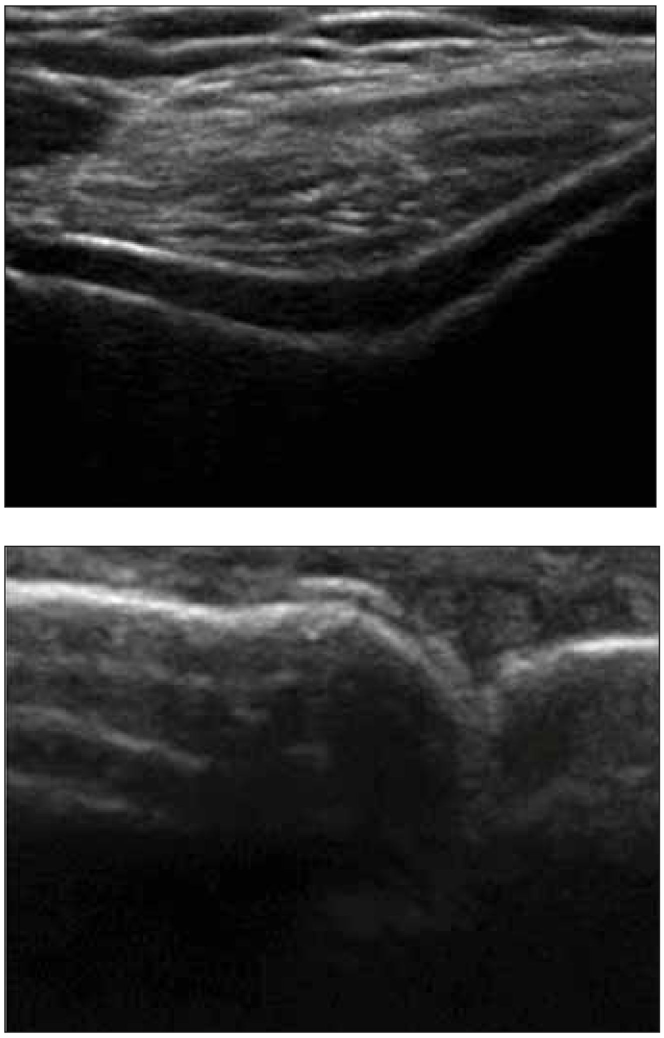

**Figure 3. "Double contour" sign indicative of gout.**

**Gout as seen in the knee (top) and foot (bottom).**

## Case 3

A 62-year-old man presented for evaluation of acute pain in the left wrist. Examination under US showed an isolated effusion in the midcarpal joint, with no involvement of the radiocarpal joint. The differential diagnosis included infection, gout, and calcium pyrophosphate dihydrate (CPPD) deposition disease (pseudogout). Although the most frequent target of CPPD disease is the knee, it also can develop in the elbows, ankles, or wrists.

The intercarpal joint was successfully aspirated under US guidance and an analysis of the joint fluid was performed in the office with a polarized light microscope. Positively birefringent rhomboid crystals were identified consistent with CPPD, establishing the diagnosis of pseudogout, a frequent cause of acute-onset, single-joint arthritis in older adults. Post-aspiration, the intercarpal joint was injected with 20 mg of methylprednisone and 0.5 mL of 1% lidocaine, with an excellent clinical response. Aspirating the radiocarpal joint without US guidance could have resulted in dry tap, unnecessary trauma to the patient, and lack of clinical response.

***Clinical Pearls***

US has a demonstrated high sensitivity in the detection of joint effusions, including detection of volumes of effusion as small as 7.4 mL in the knee.[15] Aspiration of even a few drops and analysis under the polarized light microscope facilitates immediate diagnosis and proper management of both CPPD disease and gout. US also is a valuable tool for detecting CPPD deposits in cartilage, even in patients without radiographic evidence of cartilage calcifications.[16]

## Case 4

A 35-year-old man with left wrist pain was seen for isolated synovial proliferation of the extensor carpi ulnaris tendon sheath. He had previously consulted 2 orthopedic physicians, and was referred to physical therapy twice. An x-ray failed to reveal pathology, but MRI showed synovial proliferation of extensor carpi ulnaris tendon sheath with tendinopathy and partial tear of extensor carpi ulnaris.

Examination using US found synovial proliferation of extensor carpi ulnaris tendon sheath consistent with the MRI (Figures 4 and 5). No tear was apparent on the MRI; however, tendon thickness consistent with tendinopathy was evident. The patient received an US-guided injection of 10 mg of methylprednisone into the extensor carpi ulnaris tendon sheath, with an excellent clinical response.

***Clinical Pearls***

US offers in-office diagnosis of soft tissue pathology that is not visible on x-ray. Furthermore, it can provide immediate diagnosis at a fraction of the cost of MRI. Moreover, isolating and injecting the sheath of the extensor carpi ulnaris tendon under US guidance is easier than doing so blindly.

### Case 5

A 72-year-old woman presented with bilateral shoulder pain, with the right side worse than the left. Examination of the shoulders with US showed hypoechoic widening of glenohumeral joints indicative of glenohumeral arthritis. Her right shoulder joint was injected with 40 mg of methylprednisolone acetate and 1 mL of 1% lidocaine under aseptic precautions and US guidance, with an excellent clinical response. Because of deep location of the joint, employment of Advanced Needle Visualization (SonoSite; Figure 6) technology was helpful in accurately placing the needle in the glenohumeral joint.

***Clinical Pearls***

The degree of pain relief and functional improvement is greater when the injection is documented to be in the intended target. For shoulder injections, both injection-site selection and use of US improve accuracy. A systematic review concluded that rates of accuracy for glenohumeral joint injections are significantly higher for the posterior approach, compared with the anterior approach. Use of imaging also significantly increased injection accuracy (95% vs 79% without imaging). Accuracy is also higher when imaging is used for injection of the subacromial space, acromioclavicular joint, and knee.[17]

US-guided shoulder injections provide greater pain relief than blind injections.[18] In a randomized comparative study of 41 consecutive patients with painful shoulders, the group treated with sonography-guided local corticosteroid injections experienced significantly greater improvements in the Shoulder Function Assessment scale and the VAS for pain 6 weeks after injection than did patients injected with the traditional blind technique.[18]

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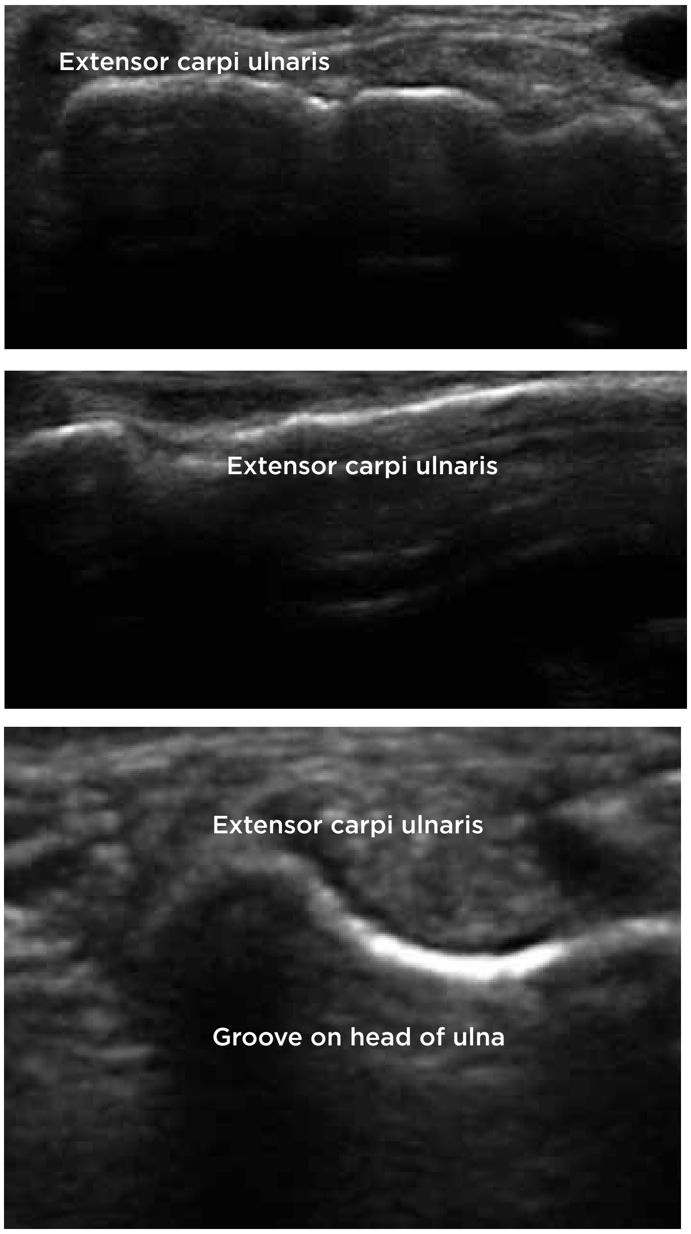


**Figure 5. Extensor carpi ulnaris.**

**The sheath of the extensor carpi ulnaris tendon is accurately injected under ultrasound guidance.**

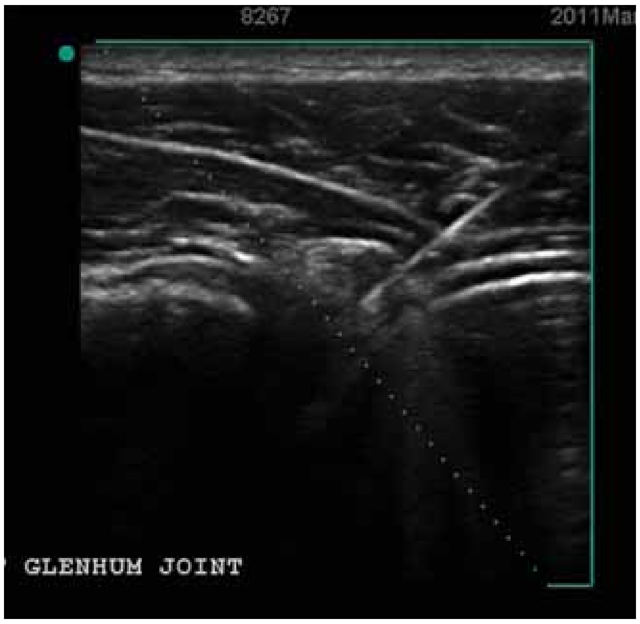


**Figure 6. Glenohumeral joint injection.**

**On follow-up visit 1 week later, the patient was completely pain-free and had marked improvement in range of motion of the shoulder joint.**

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