Using Ultrasound to Prevent Screw Penetration

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Ultrasound is a readily available, inexpensive, easy-to-use, and rapid diagnostic tool. Physicians can use ultrasound to identify excessively long screws or screw penetration into joints. This article illustrates ultrasound identification of problem screws. *(J Hand Surg Am. 2016;41(3):453–456. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Ultrasound, fractures, distal radius, screw complications.

ULTRASOUND IS NOW READILY AVAILABLE in most operating facilities. It is a quick, easy-to-use, and inexpensive diagnostic tool. This article demonstrates how to identify problems of screw placement with ultrasound.

INDICATIONS

Ultrasound is useful to identify excessive screw length, detect joint penetration, or avoid tendon impingement. For example, after the internal fixation of the distal radius or after the internal fixation of fingers, a brief examination with ultrasound can help avoid problem screws.

CONTRAINDICATIONS

Ultrasound is a noninvasive diagnostic tool. There are no harmful effects due to the ultrasound signal. It may identify problem screws. A positive ultrasound scan gives the surgeon the opportunity to change a screw length while still in the operating room.

Screw penetration through the dorsal cortex after distal radius fracture fixation can cause extensor tendon irritation and ruptures.[1] Peg penetration into the radial carpal joint will cause wrist pain and cartilage abrasion. Similarly, long screws can impinge on digital flexor tendons after phalangeal fracture fixation.

Lateral radiographs of the distal radius looking for long screws are easily misinterpreted because of the radius' trapezoidal shape. A surgeon may believe that he or she has the screws appropriately deep, below the dorsal cortex, after volar plate application, when, in fact, he or she has mistakenly placed the screw through the dorsal cortex, but below the tip of Lister's tubercle. Therefore, screws may appear to be of the appropriate length on lateral radiographs, when they are not. There are several published studies describing methods to avoid these problems. Some surgeons leave the screws a few extra millimeters short. Other surgeons rely on intraoperative fluoroscopy. Several studies describe a variety of special radiographic views to detect prominent screws.[2-6]

The ultrasound signal does not penetrate the cortical bone. Any structure or screw, deep, inside, or behind a bony cortical surface is invisible to ultrasound imaging. This is referred to as being in the shadow of the cortex. Metal is highly echoic and appears bright on ultrasound. Metal inside a bone is in the cortex's ultrasound shadow and, therefore, is not seen. On a brief ultrasound scan, an examiner can easily see any screw or peg that penetrates the bony cortex. If a screw is visible, it is through the cortex and, therefore, a possible problem. If no screw is seen, none are through the cortex and unlikely to cause problems of tendon or joint irritation.

Most operating rooms have ultrasound machines readily available. Our anesthesia colleagues use ultrasound for guided regional blocks. It takes only a few minutes to set up these machines for use in surgery. Most of these available machines are designed for

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FIGURE 1: The ultrasound transducer is positioned parallel to the articular surface of the distal radius.

FIGURE 3: Plain radiographs suggest peg penetration into the wrist joint.

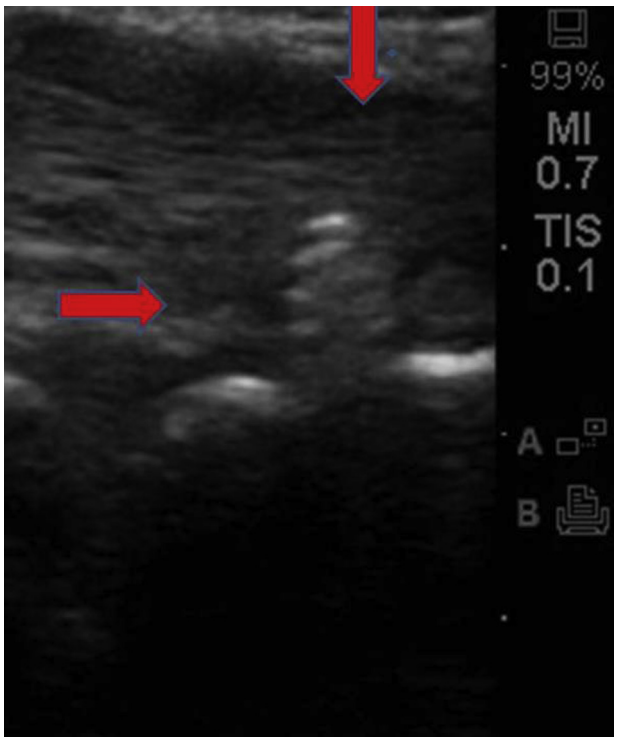

FIGURE 2: Screw is penetrated 5 turns of threads out of the cortex. The arrows point to the tendon irritation.

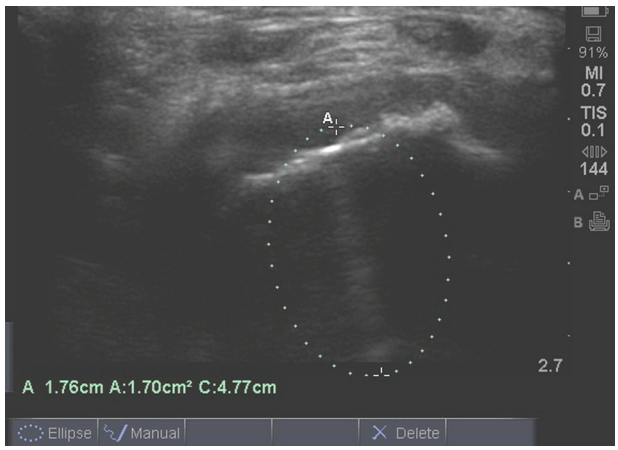

FIGURE 4: Ultrasound images document peg penetration.

musculoskeletal use and the default settings work well for the use described here. Magnetic resonance and computed tomography accomplish the same thing but are not readily available in the operating room.

TECHNIQUE

Figure 1 shows an ultrasound transducer aligned along the articular surface of the radius. This position best demonstrates pegs penetrated through the radius joint surface. To scan for dorsal radius screw penetration, position the transducer at 90° to the cortex. Place the transducers in sterile, commercially available sleeves and apply a small amount of unsterile gel inside the sleeve. Then, apply some sterile gel directly on to the skin.

Place the transducer on the palmar surface of the finger or the hand at 90° to the finger surface to scan for screws penetrated into digital flexor tendons. Ultrasound is very sensitive to the transducer-receiver position. The examiner will need to try various transducer positions during the examination (Fig. 1).

ILLUSTRATIVE CASES

The first case shows a screw prominent on the dorsal cortex, eroding an extensor tendon. This female patient had a distal radius fracture treated by another

FIGURE 5: Computed tomography scan images documenting peg penetration into the wrist joint.

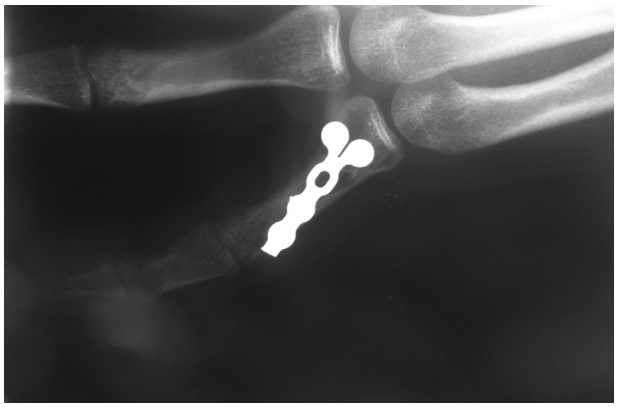

FIGURE 6: Anteroposterior radiographs of the plate on the proximal phalanx.

surgeon. Her complaint was continuing dorsal forearm pain. It is easy to identify the screw protruding out of the dorsal cortex. One can count the threads and see the hypoechoic inflammation about the screw. There is partial tendon erosion. Her symptoms rapidly resolved after removal of the screws and plate (Fig. 2).

The second case shows a threaded peg penetrated into the wrist joint. Plain radiographs did not clearly show that penetration (Fig. 3). Ultrasound, however,

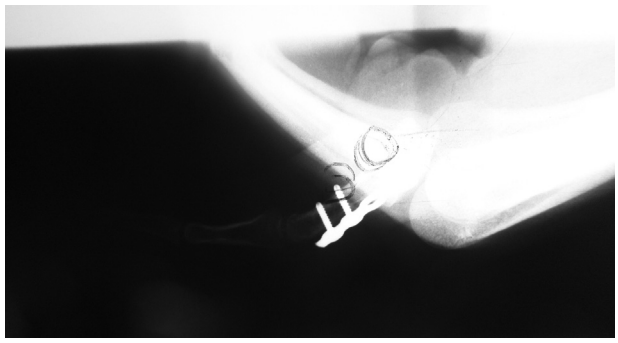

FIGURE 7: Lateral radiographs of the plate demonstrating the long screw tip.

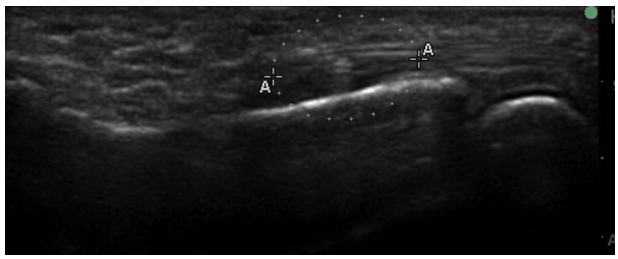

FIGURE 8: Ultrasound image demonstrating flexor tendon erosion about the penetrated screw tip.

does, and provided computed tomography images reinforce the point (Figs. 4, 5).

In 2 patients presenting with diminished finger motion after internal fixation of finger fractures, ultrasound demonstrated the penetration of screws into the flexor tendons. This was not apparent on plain radiographs.

One of these 2 patients had poor finger motion after plate and screw treatment of a phalangeal fracture. Her treating physician advised a flexor tenolysis to restore active finger flexion. Screw removal was the better solution.

The third illustrative case describes another patient who had a proximal phalangeal fracture treated with a dorsal plate and screws. He was unable to flex either his proximal distal interphalangeal joints for 4 years after his surgical treatment. On the lateral radiographs, the screws appear a little long. On ultrasound, it is clear that the screw has penetrated the digital flexor tendon. There are hypoechoic inflammatory changes in the body of the flexor tendon about the screw (Figs. 6–8). The patient regained flexion of the finger after removal of the plate and screws.

REFERENCES

1. White BD, Nydick JA, Karsky D, Williams BD, Hess AV, Stone JD. Incidence and clinical outcomes of tendon rupture following distal radius fracture. *J Hand Surg Am.* 2012;37(10):2035–2040.

2. Thomas AD, Greenberg JA. Use of fluoroscopy in determining screw overshoot in the dorsal distal radius: a cadaveric study. *J Hand Surg Am*. 2009;34(2):258–261.
3. Boyer MJ, Korcek KJ, Gelberman RH, Gilula LA, Dirsios K, Evanoff BA. Anatomic tilt x-rays of the distal radius: an *ex vivo* analysis of surgical fixation. *J Hand Surg Am*. 2004;29(1):116–122.
4. Tweet ML, Calfee RP, Stern PJ. Rotational fluoroscopy assists in detection of intra-articular screw penetration during volar plating of the distal radius. *J Hand Surg Am*. 2010;35(4):619–627.
5. Pace A, Cresswell T. Use of articular wrist views to assess intra-articular screw penetration in surgical fixation of distal radius fractures. *J Hand Surg Am*. 2010;35(6):1015–1018.
6. Sügün TS, Ozaksar K, Gürbüz Y. Screw prominence of locking plating in distal radius fractures. *J Hand Surg Am*. 2012;37(12):2646–2647.