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Percutaneous Kirschner Wire Fixation Through the Snuff Box: an Anatomic Study

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We undertook this study to better define the anatomy of the radial aspect of the wrist and to establish a zone of safety for the placement of Kirschner wires, cannulated screws, and arthroscopes within the anatomic snuff box. Twenty fresh frozen cadaver upper extremities underwent placement of three percutaneous Kirschner wires under fluoroscopic guidance through the anatomic snuff box. In each extremity, one Kirschner wire was placed into the radial styloid, one across the scaphocapitate joint, and one across the scapholunate joint. A safe zone of mean 0.68 sq cm was found deep to the subcutaneous tissue bordered by the radial styloid, the first dorsal compartment, the radial artery, and the superficial radial nerve. Kirschner wires placed distal, dorsal, or palmar to the borders of the safe zone were at great risk of injuring neurovascular structures. To minimize the risk of injury to adjacent structures, we advise a limited incision in the safe zone with blunt dissection to the wrist capsule. Though improved anatomic understanding, we established a new location for the arthroscopic 1,2 portal within the snuff box. (J Hand Surg 1995; 20A:57–62.)

Although the anatomy of the radial aspect of the forearm, wrist and hand is well described,[1–6] complications from percutaneous hardware placement within this region are common. Injury to the superficial branch of the radial nerve (SBRN) and the lateral antebrachial cutaneous nerve (LABCN); causing pain, numbness and dysesthesias, are well documented.[7–14] Injury of the radial artery, causing false aneurysm formation, has been also reported.[15] The present study focuses on the anatomic snuff box,[3,4] establishing a window of safety and technique for the placement of percutaneous hardware.

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Methods

Twenty fresh cadaver upper extremities, without evidence of disease or trauma to the hand, underwent placement of three percutaneous Kirschner wires (K-wires) (0.045 in or 0.054 in, Onyx Medical, Memphis, TN) through the anatomic snuff box under fluoroscopic guidance (Fluorescan unit, Healthmate, Northbrook, IL). The anatomic snuff box is defined as the area bounded by the radial styloid, extensor pollicis longus tendon, extensor pollicis brevis/abductor pollicis longus tendons, and the base of the thumb metacarpal. The K-wires were first pushed through the skin and soft tissues and then drilled into the anatomic snuff box, close to the midaxis of the wrist. In each extremity, the first K-wire was placed across the scapholunate joint, the second across the scaphocapitate joint and the third into the radial styloid. Plain x-ray films were then obtained, confirming K-wire placement (Fig. 1).

The SBRN, the LABCN, the cephalic vein, and the radial artery were dissected from proximal to distal under 3.5× loupe magnification. The radial styloid, Lister's tubercle, and the first dorsal com-

Figure 1. (**A**) Plain anteroposterior and (**B**) lateral x-ray films confirm placement of K-wires across the scapholunate joint, the scaphocapitate joint, and in the radial styloid.

partment were selected as anatomic landmarks. Measurements of the SBRN, the LABCN, the cephalic vein, and the radial artery to the anatomic landmarks, as well as the three K-wires, were obtained using analog vernier calipers (Dial Caliper, Starret, Athol, MA) calibrated to 0.05 mm. Sketches and photographs were obtained for each specimen. Mean and standard deviations of the measurements were calculated.

Results

The LABCN was present within the anatomic snuff box in 9 of 20 (45%) of the specimens. It consistently traveled with the cephalic vein and was at risk of injury in eight of nine specimens. In five specimens, the LABCN was found touching a K-wire, while in three, the nerve was speared by a K-wire. The cephalic vein was present in 19 of 20 (95%) of specimens and was at risk of injury in 16 of the 19. In 12, the vein was touching a K-wire, while in 4, the vessel was speared by a K-wire.

The SBRN was found to bifurcate a mean distance of 4.2 cm proximal to Lister's tubercle. The dorsal branch coursed distally and bifurcated, again a mean distance of 0.4 cm proximal to Lister's tubercle. These three branches of the SBRN were labeled from dorsal to palmar as superficial radial (SR) 1, SR 2, and SR 3 (Fig. 2). SR 1 was not in danger of injury except in one specimen in which the K-wires were placed dorsally in the anatomic snuff box and were found touching the SR 1 branch. SR 2 was a mean distance of 8.1 mm (range, 4.5–14.1 mm; SD, 2.3) dorsal to the extensor pollicis brevis tendon and was found touching the K-wires of 6 of 20 specimens and speared by a dorsally placed scaphocapitate pin in one specimen. SR 3 was on the border or palmar to the anatomic snuff box in all specimens (mean distance, 7.9 mm from the radial styloid; range, 4.2–18.6 mm; SD, 4.9). The SR 3 nerve was found touching palmarly placed K-wires in 2 of 20 specimens and injured in one specimen secondary to poor K-wire placement technique. In this particular specimen (Fig. 3), the SR 3 branch was speared by the radiostyloid pin. This probably occurred when the K-wire was placed through the skin, spearing the SR 3 branch and then tenting the nerve when the K-wire was advanced into the radius.

The radial artery, which is a mean distance of 7.5 mm distal to the radial styloid (range, 4.5–10.5 mm; SD, 1.5) was at risk of injury when the K-wires were placed close to the scaphotrapezial joint. The sca-

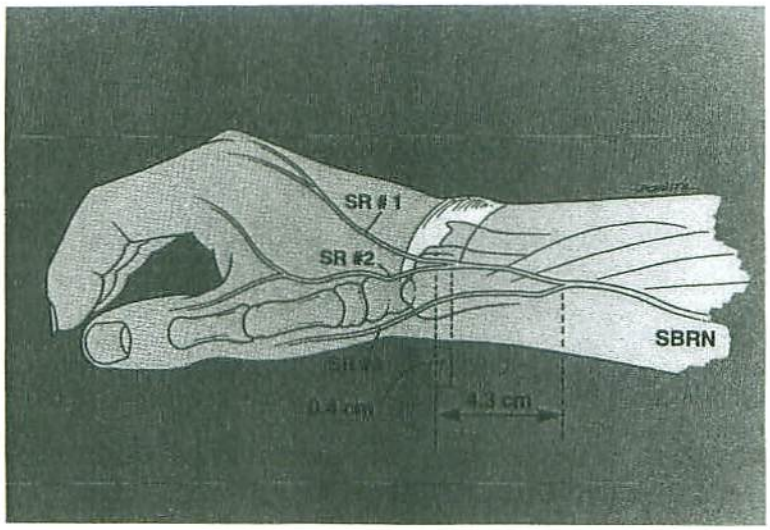

Figure 2. The superficial branch of the radial nerve has three main branches labeled SR 1, SR 2, and SR 3.

phocapitate K-wire was touching the artery in 8 of 20 specimens and speared the artery (Fig. 4) in 2 of 20 specimens. In one specimen, a hole was found in the radial artery, representing a poorly placed K-wire, which was removed after fluoroscopic assessment. The scapholunate K-wire was found touching the radial artery in 7 of 20 specimens when the K-wire was placed distal in the scaphoid.

Overall, in 5 of the 20 specimens (20%), deep structures were injured by direct K-wire spearing of the radial artery (3) and the SBRN (2). In 7 of 20 specimens, superficial sutures were injured by direct K-wire spearing of the cephalic vein (4) and the LABCN (3).

Safe Zone

The area bounded by the first dorsal compartment, the radial artery, the SR 2 branch, and the radial styloid was calculated for each specimen by using the formula for a trapezoid $\frac{1}{2}$ (A + B) × H (Fig. 5): where H is the distance from the radial styloid to the radial artery; A is the distance of the extensor pollicis brevis to the SR 2 branch at the radial artery; and B is the distance from the extensor pollicis brevis to the SR 2 branch at the radial styloid. The mean square area was 0.68 sq cm (range, 0.31–1.10^2 cm; SD, 0.25). This area, deep to the cephalic vein and the LABCN, formed a small but

Figure 3. The small palmar arrow denotes the first dorsal compartment. The dorsal arrow points to a speared and tented SR 3 branch. The freer elevator is proximal while the forceps are distal.

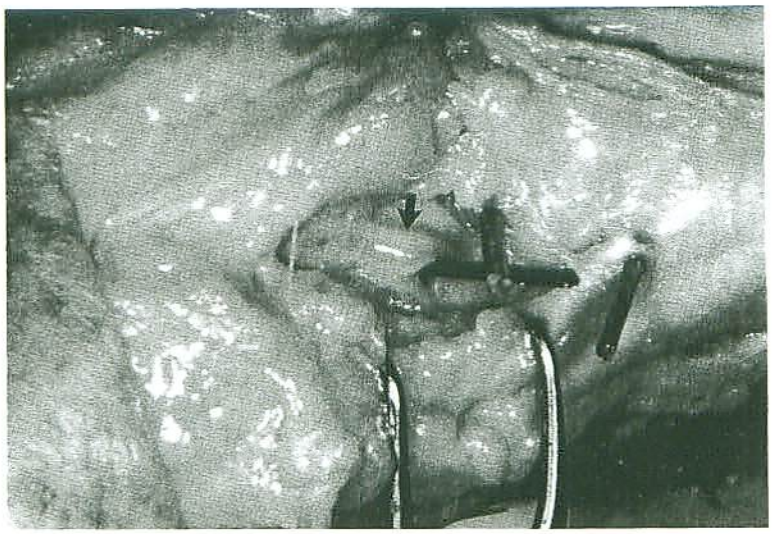

Figure 4. The arrow points to a radial artery speared by a scaphocapitate K-wire.

consistent safe zone within the anatomic snuff box. The value of H was a mean distance 7.5 mm (range, 4.5–10.5 mm; SD, 1.5), while A was a mean distance 9.8 mm (range, 6.1–15.1 mm; SD, 2.3), and B was 8.1 mm (range, 4.5–14.1 mm; SD, 2.3).

Discussion

This study of 20 fresh cadaver specimens, that underwent placement of three percutaneous K-wires within the anatomic snuff box confirms the high risk of injury to the structures in this complex region.[7–15] Despite the notion that neurovascular structures can be safely pushed out of the way of percutaneously placed, non-spinning K-wires,[16] we found a high incidence of nerve and vessel injury. Deep structures were injured by direct K-wire spearing of the radial artery and SBRN in 20% of specimens. In 35% of specimens, superficial structures were injured by direct K-wire spearing of the cephalic vein and LABCN. Percutaneously placed non-spinning K-wires, however, may protect

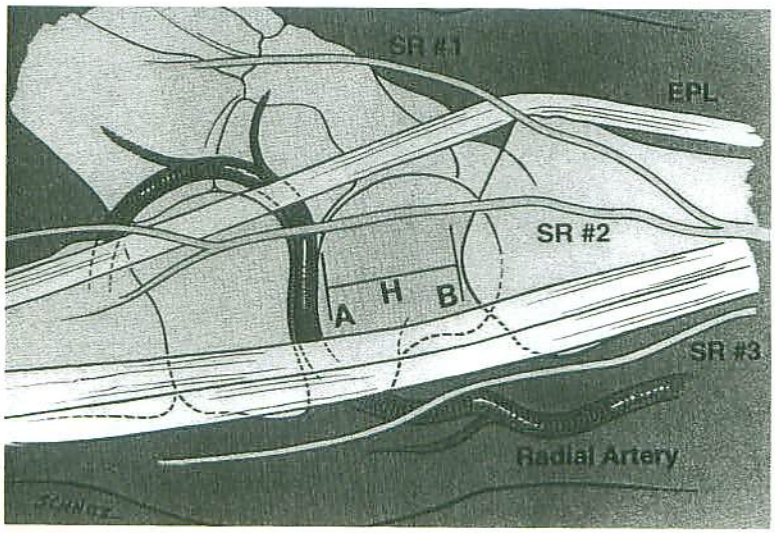

Figure 5. The formula for a trapezoid, ½ (A + B) × H, was used to calculate the safe zone bounded by the radial artery, the SR 2 branch, the first dorsal compartment, and the radial styloid, where H is the distance from the radial styloid to the radial artery; A is the distance of the extensor pollicus brevis to the SR 2 branch at the radial artery; and B is the distance from the EPB to the SR 2 branch at the radial styloid.

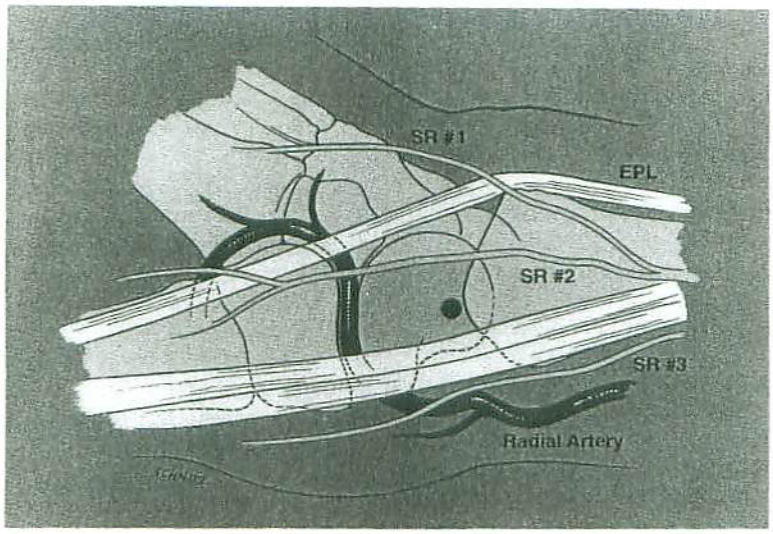

Figure 6. Based on our anatomic findings, our recommended arthroscopic 1–2 portal is the proximal, palmar aspect of the snuff box.

against wrapping of neurovascular structures. Although we found a high incidence of K-wires touching a vessel or a nerve (20 of 20 specimens), there was no evidence of any structure wrapped or twisted around a K-wire.

The most common pattern of the SBRN, found in this study (Fig. 2), closely corresponds to the configuration reported by Abrams, et al.[17] In addition, we found a small but consistent safe zone bounded by the SR 2 branch, the first dorsal compartment, the radial artery, and the radial styloid, which had a mean area of 0.68^2 cm. Neurovascular structures were at risk of injury when the K-wires were placed at the distal, dorsal, or palmar borders of the safe zone. When scapholunate or scaphocapitate K-wires were placed distally in the snuff box, close to the scaphotrapezial joint, the radial artery was at greatest risk of injury. K-wires placed palmar or dorsal to the safe zone were at risk of injuring the branches of the superficial radial nerve.

Based on the above anatomic findings, our recommended technique for the placement of percutaneous hardware within the anatomic snuff box is: first, careful palpation of the first dorsal compartment and the radial styloid while ulnarly deviating the wrist. Second, a longitudinal stab incision is made just dorsal to the palpable extensor pollicis brevis and abductor pollicis longus tendons. Avoid placing the incision more than 4.5 mm dorsal to the first compartment or 4.5 mm distal to the radial styloid. Third, blunt spreading dissection retracts the mobile cephalic vein and LABN. Fourth, a K-wire or an arthroscopic trocar, protected by a drill guide or sheath, can then be safely advanced to joint capsule or bone. This technique was applied to five additional cadaver specimens, placing the three K-wires in the anatomic snuff box under fluoroscopic guidance. No structure was found speared by a K-wire. The LABCN and cephalic vein were found touching a K-wire in one specimen.

This technique differs from the arthroscopic 1–2 portal most commonly used by hand surgeons.[14] Whipple[14] recommends the dorsal aspect of the snuff box at the intersection of the extensor carpi radialis longus and extensor pollicus longus tendons for access to the radioscaphoid joint. The rationale for this particular placement is protection of the radial artery.[14] However, we have found that the radial artery crosses the snuff box at the scaphotrapezial joint, a mean distance of 7.5 mm distal to the radial styloid. In addition, the SR 2 branch crosses the snuff box at a mean distance of 8.1 mm dorsal to the abductor pollicis longus tendon close to the ECRL and EPL intersection. The palmar, proximal aspect of the snuff box is a safer portal, protecting both the radial artery and the SR 2 branch (Fig. 6).

We have shown that the anatomic snuff box is a dangerous region for percutaneous hardware placement. Through improved anatomic understanding of this area, we have devised a technique to help avoid unnecessary neurovascular injury.

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