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PERCUTANEOUS RETROGRADE SCREW FIXATION OF NON-DISPLACED FRACTURES OF THE SCAPHOID WAIST: AN ANTIROTATION WIRE MAY NOT BE NECESSARY

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Some authors recommend using an antirotation wire when performing percutaneous screw fixation of acute non-displaced scaphoid waist fractures. The aim of this study of 21 cadaveric wrists was to assess the usefulness of such a wire in Herbert's B2-type fractures. A B2-type fracture was created experimentally on each scaphoid. An antirotation wire was inserted in eight wrists. Retrograde percutaneous fixation using a double-threaded headless cannulated screw was performed on all wrists. Computed tomography was used to measure interfragmentary rotation. No interfragmentary rotation was noted in either group. Our study suggests that using an antirotation wire may be unnecessary when performing retrograde percutaneous screw fixation of isolated B2-type scaphoid fractures.

Keywords: scaphoid fracture, percutaneous screw fixation, malunion, fracture displacement, experimental study

INTRODUCTION

Acute B2-type (Herbert and Fisher, 1984) scaphoid fractures can be treated with either cast immobilization or percutaneous screw fixation under fluoroscopic guidance (Merrell and Slade, 2008; Slade and Jaskwhich, 2001). Some authors like Dias et al. (2008) identified no medium-term difference in function or radiological outcome between the two treatments. However, others authors found that in comparison with cast immobilization, percutaneous screw fixation may be associated with earlier mobilization of the wrist and elbow, faster return to work (McQueen et al., 2008), and comparable healing times and rates (Arora et al., 2007; Bond et al., 2001; Davis et al., 2006; Haisman et al., 2006; 2007; Inoue and Shionoya, 1997; McQueen et al., 2008; Vinnars et al., 2007).

The use of an antirotation wire has been advocated to avoid interfragmentary rotation when performing percutaneous screw fixation of acute B2-type fractures (Adolfsson et al., 2001; Bond et al., 2001; Haisman et al., 2006; Jeon et al., 2003). Most surgeons use cannulated screws, which require the preliminary insertion of a guidewire (Barton, 1996; Beadel et al., 2004). Correct guidewire insertion is technically difficult given the small size and complex shape of the scaphoid (Bushnell et al., 2007; Ceri et al., 2004; Compson et al., 1994; 1997; ~~Merrell et al., 2008~~). Having to also insert an antirotation wire increases the difficulty. If the gap between the guidewire and the antirotation wire is insufficient insertion of both the drill and the screw could be impeded; faulty placement of the antirotation wire outside the scaphoid could damage adjacent cartilage and soft tissues. Using an antirotation wire could also increase the duration of the procedure, and the radiation dose received by the patient and surgeon. We assessed the usefulness of an antirotation wire when percutaneously fixing an acute B2-type scaphoid fracture in cadaver wrists.

METHOD

Our study used the forearm, wrist, and hand of fresh frozen cadavers and was approved by the ethics committee of the Saint Pères School of Medicine, Paris, France. Each specimen was thawed 24 hours before the experiment and was examined clinically and radiologically to assess whether the forearm could be rotated and the wrist extended and flexed. No specimen demonstrated evidence of previous trauma, surgery, or malformations involving the forearm or wrist and so none were excluded. We recorded the side of each specimen, as well as the gender and age of the donor.

The protocol involved five steps. A Kirschner wire 1 mm in diameter was inserted into the scaphoid tubercle and advanced into the centre of the proximal pole using the Kremlin Guide (Arex®, Palaiseau, France) device (Soubeyrand et al., 2009) to ensure appropriate wire orientation in the anteroposterior and lateral fluoroscopic views (Fig 1). The steps used to create an

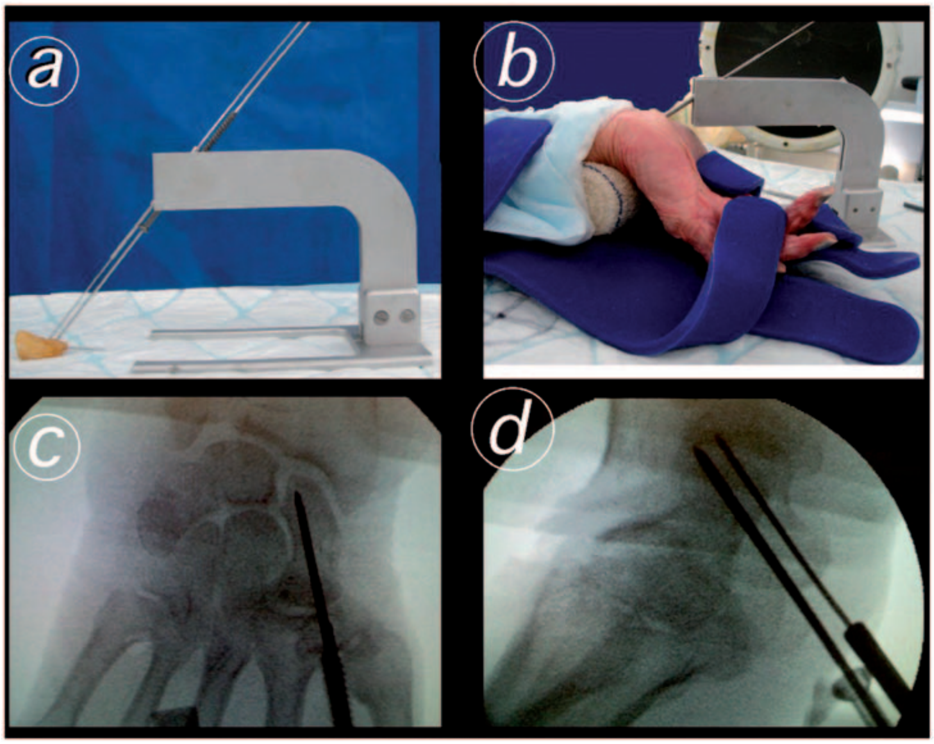

Fig 1 (a) The guidewire device permitted percutaneous insertion of two parallel wires into the scaphoid. (b) The hand was secured in a radiolucent lead hand and the wires were inserted under fluoroscopic guidance. (c) Anteroposterior view of the scaphoid with both wires. (d) Lateral view of the scaphoid with both wires. The two wires are parallel to each other. The anterior wire is 1 mm in diameter and served to guide the screw. The other wire is 1.5 mm in diameter and served as the antirotation wire.

undisplaced non-comminuted fracture of the scaphoid waist are detailed in Fig 2.

The wrist was immobilized in extension in a radiolucent lead hand (Chirobloc, Arex, Palaiseau, France). The 1.5 mm Kirschner wire was withdrawn to its entry point in the distal pole, which left a 1.5 mm tunnel in the bone. The 1 mm wire was left in the scaphoid and the first CT scan (Somatom Sensation 64, Siemens Medical Solutions, Munich, Germany) was performed. The slice thickness was 0.4 mm. Multiplanar reconstructions were obtained using Carestream PACS 10.1 software (Kodak Carestream Health, Rochester, NY, USA) and read by an independent experienced hand surgeon, who assessed the fracture pattern and fracture reduction. The fracture pattern was classified as B2 if the fracture line was transverse and non-comminuted through the scaphoid waist. Satisfactory fracture reduction was defined as aligned scaphoid edges at the fracture and absence of a rotatory gap between the proximal and distal parts of the 1.5 mm tunnel. Specimens with non-B2-type fractures or unsatisfactory reduction were excluded from the study.

Retrograde percutaneous screw fixation was performed after the first CT scan. In one group of eight specimens, the 1.5 mm Kirschner wire was pushed back into its tunnel in the distal-to-proximal direction and served as the antirotation wire. In the other group of 14, the 1.5 mm Kirschner wire was not reintroduced. In both groups, a 24 mm cannulated double-threaded headless screw (HCS, Synthes Inc., West Chester, PA, USA) was fully inserted along the 1 mm wire. In the antirotation-wire group, the 1.5 mm Kirschner wire was then removed, leaving a 1.5 mm tunnel in the bone.

A second CT scan was done to determine whether screw insertion had induced rotatory displacement of the scaphoid fragments. Each scaphoid had a 1.5 mm tunnel along its central axis and contained a screw. Two parallel slices perpendicular to the screw axis and passing 0.5 cm proximal and 0.5 cm distal to the fracture line were obtained by reconstruction (Fig 3). On each slice, the lines linking the centre of the screw to the centre of the 1.5 mm tunnel were drawn using the ‘line’ tool of the Carestream PACS software. The two slices were merged and the angle between these two lines (alpha) was measured using the ‘compass’ tool of Carestream PACS. In the absence of interfragmentary rotation, alpha was 0.

The alpha angles measured in the specimens with and without an antirotation wire were compared using a

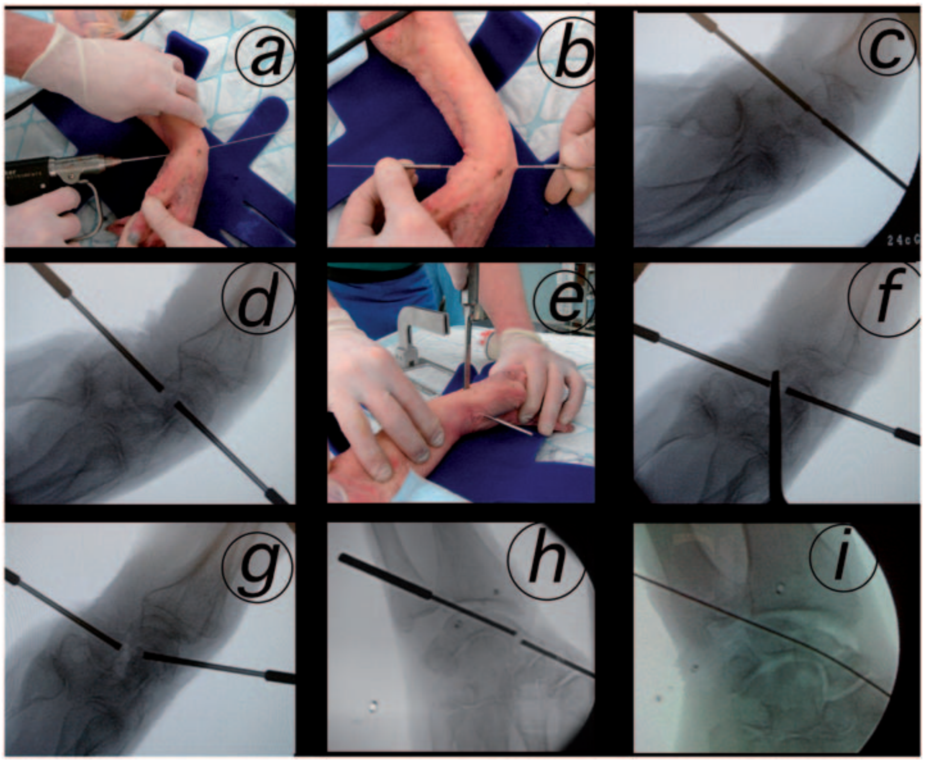

Fig 2 Description of the steps used to create an undisplaced non-comminuted fracture of the scaphoid waist. (a) A 1 mm wire was inserted into the scaphoid and pushed through the dorsal skin under image intensifier guidance (Siremobil, Siemens, Munich, Germany). (b,c) Two drill bits were introduced through the proximal and distal pole, respectively, until separated by 5 mm at the level of the waist. (d) Both wires were partially withdrawn to permit the osteotomy. (e) A 10 mm incision was made through the skin at the level of the anatomical snuffbox and through the underlying wrist joint capsule. A 10 mm osteotome was introduced and placed in contact with the scaphoid waist. (f) The osteotome was positioned perpendicular to the lateral edge of the scaphoid waist on the anteroposterior view and perpendicular to the long axis of the bone on the lateral view. (g) The osteotome was used to fracture the bone. (h) The bone was then fractured with the osteotome with the two drill bits steadying the scaphoid. (i) The drill bits were removed and the wire was manually reintroduced into its initial pathway along the entire scaphoid to reduce the fracture.

Wilcoxon rank sum paired test for the data before and after screw insertion. The level of significance was 5%.

RESULTS

We used 22 specimens, from 13 male and 9 female cadavers whose mean age was 73 years (range, 65–85). There were 11 right wrists and 11 left wrists. We assigned eight specimens to the antirotation-wire group and 14 to the control group. We excluded one control specimen because the fracture was comminuted on the first CT scan and was not a B2-type fracture. In none of the specimens did we identify any rotation.

DISCUSSION

Our cadaveric study suggests that an antirotation wire is not needed for percutaneous screw fixation of B2-type scaphoid fractures. Three factors may explain the stability of the fracture site during screw fixation. First, the proximal and distal fragments are congruent: the absence of displacement implies good interfragmentary contact. Second, the scaphoid is tightly lodged in a small space located between the radius and the distal carpal row. Third, the distal ligament complex stabilizes the distal fragment and the scapholunate ligament the proximal fragment (Boabighi et al., 1993). However, recent in vivo arthroscopy studies showed that ligament damage was more common in scaphoid fractures than previously thought (Cheng et al., 2004; Kozin, 2001; McAdams and Srivastava, 2004). We did not create ligament lesions and our results do not apply to B2-type fractures with ligament damage.

In previous experimental studies of scaphoid waist fractures (Beadel et al., 2004; Bocquet et al., 2001), the scaphoid bones were removed from the wrist and the fractures were assessed by naked-eye inspection. In contrast, we studied the scaphoid bone in situ,

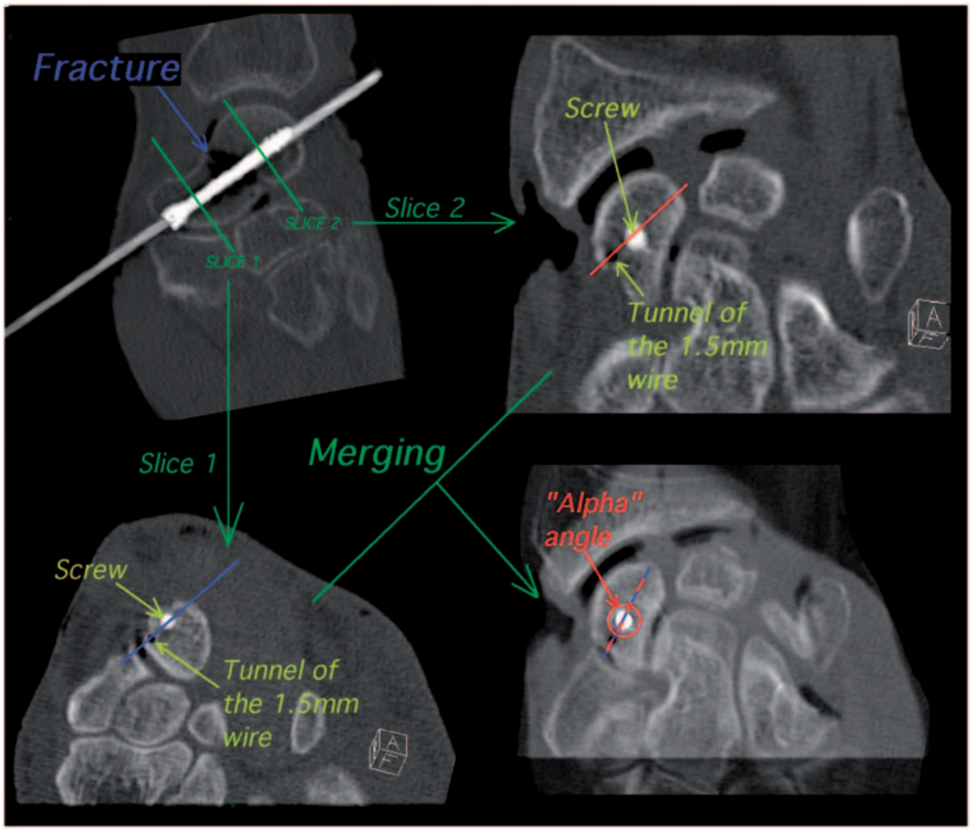

Fig 3 After screw insertion, two computed tomography slices were obtained, perpendicular to the screw and bone tunnel, above and below the fracture site. A line joining the centre of the screw and the tunnel of the 1.5 mm wire was drawn on both slices. Then, the two slices were merged, and the angle formed by the two lines (alpha angle) was measured. The angle was 0 in 21 cases.

which might theoretically have led us to miss fracture displacements and therefore to underestimate the usefulness of the antirotation wire. To obtain a sensitive assessment of interfragmentary displacement, we used well-defined landmarks that were easily identified on CT scans. Displacements in the coronal and sagittal planes were noted by following the edges of the scaphoid at the level of the fracture and rotational displacement by following the 1.5 mm tunnel created in the bone. Our results indicate that for B2-type fractures without associated ligament lesions percutaneous screw fixation can be performed without using an antirotation wire.

Conflict of interests

None declared.

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