SURGICAL TECHNIQUES

TRANSTRAPEZIAL APPROACH FOR FIXATION OF
ACUTE SCAPHOID FRACTURES

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Introduction

The transtrapezial approach for fixation of acute scaphoid fractures facilitates precise percutaneous placement of a screw along the central axis of the scaphoid, which has been shown to be biomechanically superior to a more eccentric screw position^{1,2}.

The transtrapezial approach provides access to the central axis of the scaphoid and turns a technically demanding procedure into a straightforward operation if all steps are followed. Correct positioning of the patient, surgeon, and fluoroscopy equipment is essential before starting the procedure. The central axis of the scaphoid is marked on the skin, both in the frontal and the lateral plane. A volar stab incision is made over the distal part of the trapezium, and a guidewire is inserted through the trapezium along the central axis of the scaphoid (parallel to the skin markings) under visual control and fluoroscopic control. The trapezium and the distal cortex of the scaphoid are drilled. The length of the scaphoid is measured, and the appropriate screw is selected and inserted.

Step 1: Position the Patient, Surgeon, and
Fluoroscopy Equipment

Correctly position the patient, surgeon, and fluoroscopy equipment before starting the procedure.

- Position the patient supine with the affected arm on an arm table.
- Assuming that the surgeon is right-handed, he or she sits in the axilla of the patient for a left scaphoid procedure (Fig. 1) or at the shoulder and head of the patient for a right scaphoid procedure. This facilitates insertion of the guidewire and more intuitive handling of the other instruments.
- Place the fluoroscopy tube (mini C-arm or dedicated C-arm) on the opposite side of the surgeon. Position the monitor in front of the surgeon or on the opposite side of the patient and so that it is easily visible to the surgeon (Fig. 1).
- Adjust the fluoroscopy image on the monitor (rotation and mirroring) so that it is oriented exactly as the limb of the patient is oriented in front of the surgeon.

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Fig. 1

Fig. 1 Operating-room setup.

Step 2: Mark the Skin

Mark the central axis of the scaphoid on the skin along the frontal and lateral (optional) planes as the markings allow visual control for insertion of the guidewire.

- Position a guidewire on the skin of the patient along the central axis of the scaphoid in the frontal and lateral (optional) planes (Fig. 2).
- Mark the position of the guidewire on the skin to provide a visual mark for guidewire insertion (Fig. 3, Video 1).

Fig. 2

Fig. 3

Fig. 2 A guidewire is positioned on the skin of the patient along the central axis of the scaphoid.

Fig. 3 The position of the guidewire is marked on the skin.

Video 1 The central axis of the scaphoid is marked on the skin.

Step 3: Stab Incision

Make a volar stab incision over the distal half of the trapezium.

- Make a volar stab incision on the longitudinal line, over the distal half of the trapezium (Fig. 4, Video 2).

Fig. 4

Fig. 4 A volar stab incision is made over the distal half of the trapezium.

Video 2 A stab incision is made over the distal half of the trapezium.

Step 4: Insert the Guidewire

Insert the guidewire through the trapezium along the central axis of the scaphoid, which is the critical step of the procedure.

- The preferred starting point for guidewire insertion is the center of the volar cortex of the trapezium. Insert a 1.1-mm guidewire (for later placement of a 2.0-mm headless bone screw) into the trapezium using the skin markings as a visual guide.
- Use fluoroscopy control to confirm the good position of the guidewire.
- As long as the guidewire is not advanced into the scaphoid, adjust the direction of the guidewire further, if needed, by changing the position of the wrist (radial and ulnar deviation or flexion and extension). This helps to position the guidewire exactly along the central axis of the scaphoid (Figs. 5-A through 5-F).
- Advance the guidewire further until it abuts on the proximal cortex of the scaphoid (Fig. 6).

Fig. 5-A

Fig. 5-B

Fig. 5-C

Fig. 5-D

Fig. 5-E

Fig. 5-F

Fig. 6

Fig. 5 Figs. 5-A through 5-F As long as the guidewire is not advanced into the scaphoid, the direction of the guidewire can be adjusted by changing the position of the wrist. **Figs. 5-A, 5-B, and 5-C** Anteroposterior fluoroscopic images showing the wrist in neutral position (**Fig. 5-A**), radial deviation (**Fig. 5-B**), and ulnar deviation (**Fig. 5-C**). **Figs. 5-D, 5-E, and 5-F** Lateral fluoroscopic images showing the wrist in neutral position (**Fig. 5-E**), flexion (**Fig. 5-F**), and extension (**Fig. 5-F**).

Fig. 6 The guidewire is further advanced until it abuts on the proximal cortex of the scaphoid.

- It is advisable to use a smooth, rather than a threaded, guidewire as this allows the surgeon to feel resistance when the wire abuts on the proximal cortex of the scaphoid.
- Carefully check the correct position of the guidewire under fluoroscopy in all planes (Figs. 7-A and 7-B, Video 3).

Fig. 7-A

Fig. 7-B

Figs. 7-A and 7-B The position of the guidewire on a lateral view (**Fig. 7-A**) and oblique view (**Fig. 7-B**).

Video 3 The guidewire is inserted through the trapezium along the central axis of the scaphoid.

Step 5: Drilling

Drill the trapezium and the distal cortex of the scaphoid to allow easy insertion of the screw.

- With a 2.0-mm cannulated drill-bit, drill the trapezium and the distal cortex of the scaphoid (Figs. 8-A and 8-B, Video 4).
- When a self-drilling is used, it is unnecessary to drill the whole scaphoid. This will avoid “backing out” of the guidewire when the drill is retracted.

Fig. 8-A

Fig. 8-B

Figs. 8-A and 8-B Anteroposterior (**Fig. 8-A**) and lateral (**Fig. 8-B**) intraoperative photographs showing drilling of the trapezium and distal cortex of the scaphoid with the appropriately sized drill-bit.

Video 4 The trapezium and distal cortex of the scaphoid are drilled.

Step 6: Length Measurement

Precisely measure the scaphoid length to determine the appropriate screw length.

- Determine the correct length of the screw to be inserted by sliding a length-measurement device with a narrow tip over the guidewire until it reaches the distal cortex of the scaphoid (Fig. 9, Video 5).
- Check the position of the length-measurement device tip under fluoroscopic control and decide on the appropriate screw length (Fig. 10).
- If the appropriate length-measurement device is not available, the correct length can also be determined by an alternative technique. Pass a second guidewire of similar length in the predrilled trajectory along the first guidewire until it reaches the distal cortex of the scaphoid. Measure the difference in length between the two guidewires, which is the length of the screw to be inserted.
- Insert a screw of maximum length with purchase of the screw threads into the strong subchondral bone, as this provides the most rigid fixation, which is the goal. However, protrusion of the screw definitely needs to be avoided³. It is therefore advisable to subtract 2 to 4 mm of the total measured scaphoid length when deciding on the length of the screw.
- It is advisable to use screws that are available in 1-mm-length increments, as this facilitates the insertion of a screw with the ideal length⁴.

Fig. 9

Fig. 10

Fig. 9 The correct length of the screw to be inserted is determined by sliding a length-measurement device with a narrow tip over the guidewire until it reaches the distal cortex of the scaphoid.

Video 5 The correct length of the screw to be inserted is determined.

Fig. 10 The position of the length-measurement device tip is checked under fluoroscopic control and the appropriate screw length is decided.

Step 7: Insert the Screw

Insert the selected screw over the guidewire.

- Insert the selected screw over the guidewire into the correct position, along the central axis of the scaphoid (Fig. 11, Video 6).
- Use careful fluoroscopic control, which is necessary to avoid protrusion of the screw both proximally at the radiocarpal joint and distally at the scaphotrapezial joint.
- Protrusion of the screw into the scaphotrapezial joint is best checked on a 45° pronated oblique view with the wrist in slight flexion and ulnar deviation (Fig. 12).
- When the screw protrudes outside the scaphoid, a grinding sensation can often be felt when the wrist is mobilized.
- The technique allows exact central placement of the screw into the scaphoid (Fig. 13).

Fig. 11

Fig. 12

Fig. 13

Fig. 11 The selected screw is inserted over the guidewire into the correct position.

Video 6 The screw is inserted and its final position is checked under fluoroscopy.

Fig. 12 Protrusion of the screw into the scaphotrapezial joint is best checked on a 45° pronated oblique view with the wrist in slight flexion and ulnar deviation.

Fig. 13 Postoperative posteroanterior, oblique, and lateral radiographs confirm exact central placement of the screw into the scaphoid.

Results

In our report on the first results of this technique in forty-one patients with an acute nondisplaced scaphoid waist fracture, all fractures united within ten weeks (mean, 6.4 weeks) and the modified Mayo wrist score was good (four patients) or excellent (thirty-seven patients) at a mean follow-up of thirty-six months (range, fourteen to sixty-eight months)^{5,6}.

A study with longer follow-up was done to look specifically for clinical and radiographic degenerative changes at the scaphotrapezial joint⁷. A total of thirty-four patients were available for follow-up at a mean of 6.1 years (minimum, 3.7 years). Standard posteroanterior and lateral radiographs and a 45° pronated oblique radiograph to evaluate the scaphotrapezial joint of both wrists were made. No clinically important changes at the scaphotrapezial joint were seen in comparison with the contralateral side. In twenty-nine of the thirty-four patients, the screw was positioned exactly along the central axis of the scaphoid in all three views.

The same surgical technique was used in a selected group of eighteen patients with a delayed union or nonunion of the scaphoid⁸. Only patients without marked cyst formation (<5 mm), sclerosis, or deformity at the nonunion site were included. The mean time between injury and surgery was four months (range, two to ten months). Seventeen of the eighteen scaphoids united after a mean of three months (range, one to nine months).

What to Watch For

Indications

- An acute undisplaced scaphoid waist fracture in a young active patient is the primary indication for this procedure as an alternative to cast immobilization.
- Delayed union or nonunion of the scaphoid waist, when no marked cyst formation (<5 mm), sclerosis, or deformity is present on radiographs or computed tomography scans.
- Displaced waist fractures need to be reduced first, before a percutaneous screw can be inserted. The distal fragment is most commonly displaced into flexion and pronation in relation to the proximal fragment. Manipulating the wrist into extension and supination often corrects minor displacement or gap formation. If necessary, Kirschner wires can be used as joysticks in the distal fragment (inserted from a volar approach) and/or proximal fragment (inserted from a dorsal approach) to help reduce the displaced fragment. Arthroscopy is the ideal modality to confirm accurate reduction of the fracture fragments when necessary.

Contraindications

- Fractures in the very proximal part of the scaphoid can more accurately be reduced and fixed using a dorsal approach.
- Displaced fractures that cannot be reduced into a satisfactory position, often part of a perilunate injury pattern, need to be managed through an open approach.
- A long-standing nonunion with sclerosis and/or deformity is better addressed through an open approach with bone-grafting and correction of the deformity.

Pitfalls & Challenges

- To allow early mobilization and return to function, it is essential that the screw is correctly positioned into the scaphoid, which is technically challenging but facilitated by the transtrapezial technique.
- Protrusion of the screw at the radiocarpal or scaphotrapezial joint needs to be avoided at all times, as it may cause pain, loss of function, and degenerative changes at longer term. Choosing a screw of appropriate length and careful fluoroscopic evaluation of the radiocarpal and scaphotrapezial joint in all planes are necessary. Therefore, we routinely use the 45° pronated oblique view to evaluate the scaphotrapezial joint.

- In the unlikely event that a screw needs to be removed, a guidewire is redrilled through the trapezium, into the screw. In most cases, the previous drill-hole in the trapezium will have consolidated, and a new trajectory needs to be drilled under fluoroscopic control. The screw path is redrilled over the guidewire, and the screw is removed. If this is not possible, the wrist is flexed and the guidewire is advanced dorsally through the skin. An angiocath needle of appropriate size is passed over the guidewire and used to push on the screw in a retrograde direction to assist with removal of the screw. If this still does not allow removal of the screw, it is removed in an antegrade direction, advancing it through the proximal cortex of the scaphoid.
- It is advisable to insert a small-diameter screw. This minimizes the impact on the scaphotrapezial joint cartilage, and if a nonunion should occur, the screw can be replaced by one with a larger diameter.

Clinical Comments

- Undisplaced scaphoid waist fractures have a high union rate with cast immobilization, and the risks and benefits of percutaneous fixation need to be discussed with the patient.
- We believe that the transtapezial technique is technically easier than conventional techniques of percutaneous scaphoid fixation and is associated with a lower risk of complications. (No manipulation of the wrist or scaphoid is necessary to insert the guidewire, there is access to the central axis of the scaphoid, less fluoroscopy time is needed, and there is less risk of soft-tissue damage around the scaphoid⁹.)
- When rigid fixation with exact central placement of the screw is obtained, no formal immobilization is necessary and an early return to function is allowed.
- With this technique, a 2.0-mm drill-hole is made at the scaphotrapezial joint. Although a radiographic follow-up study (with a mean follow-up of 6.1 years) did not show degenerative changes at this joint⁷, longer follow-up is necessary to confirm this finding.

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