Chapter 5
Arthroscopic-Assisted Management of Acute Scaphoid Fractures

William B. Geissler and Jared L. Burkett

Case Presentation

The patient was a 29-year-old male laborer status after a high-speed motor cycle injury. He presented to the emergency room with severe pain and swelling to his left wrist. He related that he was thrown off his motorcycle landing on his outstretched hyper-extended wrist. Physical examination in the emergency room demonstrated a markedly deformed wrist with a moderate amount of swelling. He complained of paresthesias over the median nerve. Radiographs obtained in the emergency room revealed a displaced trans-scaphoid perilunate fracture dislocation of the left wrist (Fig. 5.1). At that point, under Bier block, a closed reduction was performed reducing the wrist.

The patient presented to the orthopedic clinic 1 week later with continued complaints of pain and swelling of the left wrist. There was less clinical deformity. He still had complaints of mild pares-

W. B. Geissler (✉)
Division of Hand and Upper Extremity Surgery, Department of Orthopaedic Surgery and Rehabilitation, University of Mississippi Medical Center, Jackson, MS, USA
e-mail: 3doghill@msn.com

J. L. Burkett
Department of Orthopaedic Surgery and Rehabilitation, University of Mississippi Medical Center, Jackson, MS, USA

J. Yao (ed.), *Scaphoid Fractures and Nonunions*,
DOI 10.1007/978-3-319-18977-2_5

Fig. 5.1 Posterior Anterior (PA) radiograph of a trans-scaphoid perilunate dislocation. (Published with kind permission of © William B. Geissler and Jared L. Burkett, 2015. All rights reserved)

thesias over the median nerve which had significantly improved since the reduction.

Physical Assessment

Physical examination revealed moderate swelling of the wrist. He was point tender to palpation over the anatomic snuff box and the dorsal aspect of the scaphoid. He was also very point tender over the lunotriquetral (LT) interval. He had pain with a LT shuck maneuver. Sensation was grossly intact, including in the median nerve distribution. Digital range of motion was intact, but wrist range of motion was very limited due to pain.

Diagnostic Studies

Radiographs obtained in the clinic revealed the reduced trans-scaphoid perilunate dislocation. There was some widening of the LT interval, and the fracture line of the scaphoid was apparent on all views.

Diagnosis

Trans-scaphoid perilunate dislocation

Management Options

Traditional management would include open reduction and internal fixation of the scaphoid LT ligament repair and stabilization of the LT interval with Kirschner wires (K-wires) [1].The K-wires would be at risk for infection as they would be exiting the skin and would hamper rehabilitation. Other options besides open reduction were discussed including arthroscopic fixation of the fracture of the scaphoid and stabilization of the LT interval with a scapholunate intracarpal (SLIC) screw [2].

Management Chosen

Arthroscopic fixation of the scaphoid and percutaneous stabilization of the LT interval allows for earlier range of motion as compared to K-wire fixation and may also lead to decreased scarring for potentially increased range of motion. The SLIC screw (Acumed, Hillsboro, OR) is a screw that freely rotates at its midsection (Fig. 5.2). In addition, it has approximately 20° of toggle between the proximal and distal ends. When the screw is inserted, it allows a more normal rotation between the involved carpal bones. This allows the screw to be placed for a prolonged period of time,

Fig. 5.2 View of the SLIC screw (Acumed, Hillsboro, OR). (Published with kind permission of © William B. Geissler and Jared L. Burkett, 2015. All rights reserved)

while the interosseous ligament heals allowing near-normal motion of the carpal bones with range of motion of the wrist. The screw can be taken out at approximately 6–9 months if the patient is symptomatic.

Surgical Technique

After general anesthesia is obtained, the patient is placed in supine position with the left arm outstretched on a hand table. A sterile tourniquet is applied at the level of the upper arm just proximal to the elbow crease. By placing the tourniquet more distal than normal at the level of the elbow crease allows better support of the upper extremity in the traction tower. The Acumed traction tower (Acumed, Hillsboro, OR) is set up on the hand table with the forearm plate in the dorsal position for easier removal later (Fig. 5.3). Traditionally, the forearm plate is placed on the volar aspect of the forearm for stability of the wrist which is slightly flexed in the traction tower. However, by placing the forearm plate dorsally, this allows for easier removal when the arm is flexed during the operative procedure. All bony prominences are well padded about the arm and forearm, and the skin does not touch the traction tower itself. The joint of the tower arm is set at the same level of the wrist joint, and the wrist is flexed approximately 30°. Finger traps are

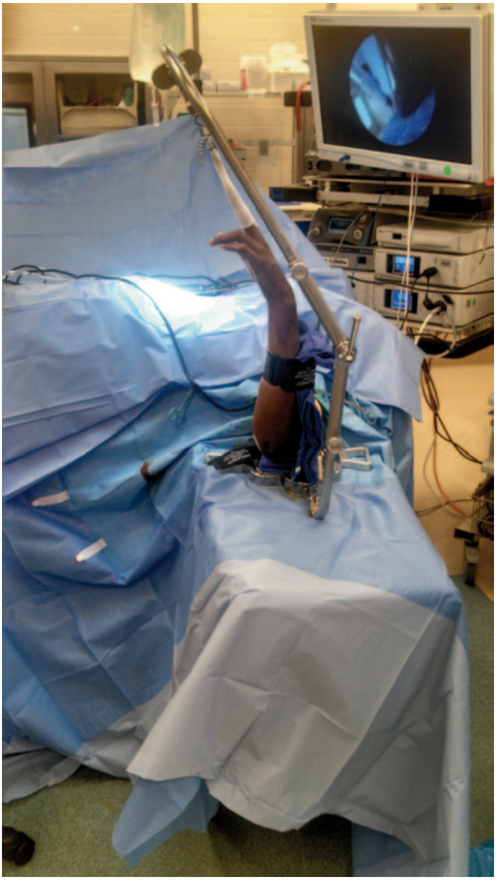

Fig. 5.3 Fluoroscopic view of placing the cannulated SLIC screw (Acumed, Hillsboro, OR) across the LT interval. (Published with kind permission of © William B. Geissler and Jared L. Burkett, 2015. All rights reserved)

placed along the index and long fingers, and the wrist is suspended with approximately 10–15 lb of traction. It is important that the bend of the tower is at the level of the wrist to allow wrist flexion in this procedure.

An 18-gauge needle is then initially placed in the 6U portal for inflow, and approximately 5–10 ccs of sterile lactated Ringers is injected into the radial carpal joint. An 18-gauge needle is then inserted into the radial carpal joint at the 3–4 portal (between the third and the fourth dorsal compartments) 1 cm distal to Lister's tubercle. It is important to place the needle at approximately 10° of angulation and volarly to match the volar tilt of the distal radius. The 3–4 portal is located down the radial border of the long metacarpal. Once the ideal location of the 3–4 portal is identified, the skin is incised by pulling the skin against the tip of a no. 11 blade and blunt dissection is carried down with a hemostat to the level of the joint capsule. The 2.7-mm arthroscope with a blunt trocar is then introduced into the 3–4 portal.

Evaluation of this patient's radiocarpal space with the arthroscope in the 3–4 portal showed pristine articular cartilage to the scaphoid, lunate, and the distal radius. The scapholunate interosseous ligament was completely intact. Under direct visualization with the arthroscope in the 3–4 portal, an 18-gauge needle is placed to localize the 6R portal. This enters the joint just distal to the articular disk of the triangular fibrocartilage complex. The arthroscope with a blunt trocar is introduced into the 6R portal. Evaluation of the LT interval revealed a Geissler Grade IV tear of the LT interosseous ligament. Evaluation of the articular disk showed it to be intact with no tear.

The arthroscope was then introduced into the radial midcarpal space to evaluate the midcarpal joint. Evaluation of the radial midcarpal space revealed the fracture at the waist of the scaphoid. It was displaced. Evaluation of the scapholunate interval with the arthroscope in the midcarpal space showed it to be tight and congruent with no step-off. Continued evaluation of the ulnar side of the wrist again showed widening and separation of the LT interval consistent with a Geissler Grade IV injury of the LT interosseous ligament.

Carpal instability is best arthroscopically reduced by looking across the wrist to evaluate the rotation of the carpal bones. In this instance, the arthroscope was in the 3–4 portal. Joysticks were placed percutaneously into the lunate and triquetrum. Once the interval was anatomically reduced, a guide wire was placed in oscillation mode percutaneously through the triquetrum into the lunate. Using the oscillation mode helps protect the dorsal sensory branch of the ulnar nerve. The wrist tower is then flexed, confirming the ideal location of the guide wire in the LT interval with fluoroscopy. The guide wire is aimed toward the radial proximal corner of the

Fig. 5.4 In arthroscopic management of scaphoid fractures, it is best to set the forearm plate on the dorsal aspect of the forearm rather than the normal volar position with the arc traction tower (Acumed, Hillsboro, OR). In this manner, it makes it easier to flex the tower down to confirm position of the guide wire. (Published with kind permission of © William B. Geissler and Jared L. Burkett, 2015. All rights reserved)

lunate. Following confirmation of the ideal position of the guide wire, a 1-cm skin incision was made around it. A cannula with a blunt trocar is introduced to the level of the joint capsule to protect the dorsal sensory branch of the ulnar nerve. The SLIC cannulated drill was then placed over the guide wire and advanced between the triquetrum and the lunate, so the step of the drill is between the lunate and the triquetrum as confirmed under fluoroscopy. The length of the proximal portion of the screw was then measured directly by the drill under fluoroscopy. There are three optional lengths of the proximal portion of the screw. In this manner, the length of the portion is determined so that it will be flushed with the carpal bones to aid in its removal in the future. In this instance, a 25-mm SLIC screw was measured from the drill. This screw was inserted over the guide wire so that the interval of the screw would be exactly between the lunate and the triquetrum (Fig. 5.4). This will allow for near-normal carpal motion of the bones with range of motion of the wrist.

The traction tower was then placed back in the vertical position. The arthroscope was introduced into the radial midcarpal space to evaluate reduction to the LT interval. Evaluation of the LT interval with the arthroscope in the radial midcarpal space showed good stability and a congruent reduction between the lunate and the triquetrum.

The arthroscope was then transferred into the 6R portal and the scapholunate interval was identified. A probe was placed into the 3–4 portal to palpate the scapholunate interosseous ligament and the proximal pole of the scaphoid (Fig. 5.5). Following this, a 14-gauge needle is then introduced into the 3–4 portal into the radial carpal space. It is vital that the 14-gauge needle passes easily through the 3–4 portal without any resistance so as not to impale an extensor tendon. If there is any question, a hemostat can be used to spread the 3–4 portal and the needle placed over the hemostat

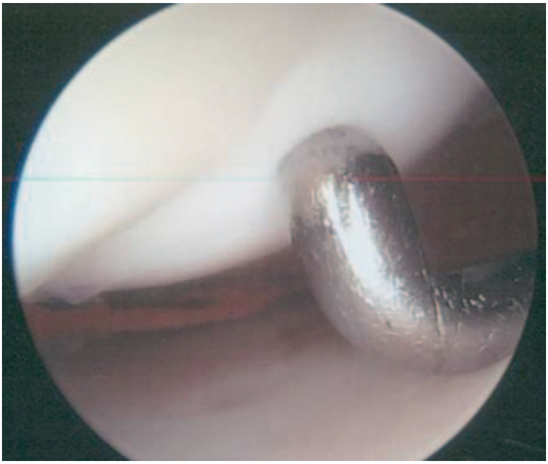

Fig. 5.5 Arthroscopic view with the arthroscope in the 6R portal. The junction of the scapholunate interosseous ligament and the proximal pole of the scaphoid is identified. This location is impaled with a 14-gauge needle. (Published with kind permission of © William B. Geissler and Jared L. Burkett, 2015. All rights reserved)

into the radial carpal space. The 14-gauge needle is then placed just radial to the scapholunate interosseous ligament into the proximal pole of the scaphoid. It is then impaled into the proximal pole under direct visualization with the arthroscope. In this manner, there is absolutely no guess work [3]–[4]. The exact location of the guide wire and eventually the position of the cannulated screw are directly visualized with the arthroscope under bright well-lit magnified conditions. Following placement of the guide wire, the arthroscope is placed in the midcarpal space to evaluate the reduction of the scaphoid fracture. Particularly, arthroscopy is very sensitive to detect malrotation of the fracture fragments as compared to fluoroscopy. A fracture of the waist is best seen with the arthroscope in the radial midcarpal space, and a fracture of the proximal pole is best seen with the arthroscope in the ulnar midcarpal space. If the fracture is not anatomically reduced as viewed with the arthroscope in the midcarpal space, the guide wire is advanced out distally from the proximal fragment while still being maintained in the distal scaphoid fracture fragment. Usually, manipulation of the tower and further extension and radial deviation will help anatomically reduce the scaphoid fracture. If this does not reduce it, the guide wire in the distal pole of the fragment can be used to manipulate and further reduce the fracture. Once the fracture is anatomically reduced, the guide wire is then advanced proximally into the proximal scaphoid fracture fragment.

The forearm strap is then removed along with the dorsally placed forearm plate, and the traction tower is flexed to be parallel to the floor (Fig. 5.6). The starting point at the most proximal pole of the scaphoid is then verified under fluoroscopy (Fig. 5.7). The ARC wrist traction tower is very fluoroscopy-friendly in that the traction bar is placed to the side of the forearm so as not to block the X-ray beam. Once the ideal starting point for the guide wire is confirmed under fluoroscopy, the needle is simply aimed toward the thumb. A guide wire for the mini Acutrak compression screw (Acumed, Hillsboro, OR) is then placed through the 14-gauge needle and aimed toward the thumb. Prior to advancing the guide wire under fluoroscopy, the appropriate trajectory and angulation of the guide wire is determined prior to its advancement into the scaphoid. The guide wire is then advanced under fluoroscopy to the far

Fig. 5.6 The ARC traction tower (Acumed, Hillsboro, OR) is then flexed down to fluoroscopically confirm the ideal position of the needle. (Published with kind permission of © William B. Geissler and Jared L. Burkett, 2015. All rights reserved)

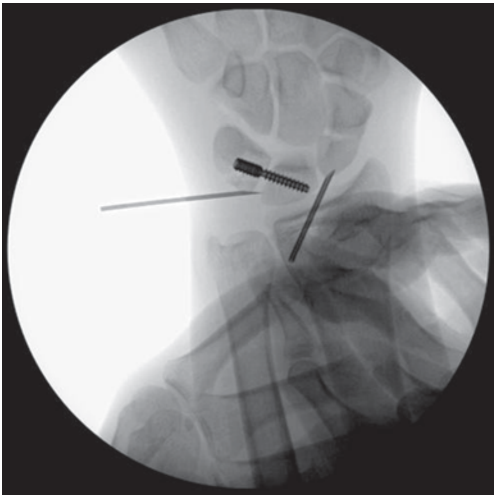

Fig. 5.7 Fluoroscopic view demonstrating precise placement of a 14-gauge needle on the proximal pole of the scaphoid. (Published with kind permission of © William B. Geissler and Jared L. Burkett, 2015. All rights reserved)

Fig. 5.8 Fluoroscopic view confirming placement of the guide wire down the central axis of the scaphoid. It is imperative to use a headless screw approximately 4 mm shorter than is measured. (Published with kind permission of © William B. Geissler and Jared L. Burkett, 2015. All rights reserved)

cortex of the distal pole of the scaphoid on the posteroanterior view under fluoroscopy. Ideal guide wire placement is then assessed on the posteroanterior oblique and lateral views under fluoroscopy to insure appropriate positioning of the guide wire down the center of the scaphoid (Fig. 5.8).This has been shown by McCallister et al. to be the optimum position biomechanically. The length of the screw is then determined by one of the two manners. Either the measuring guide is then used or an exact same length guide wire can be used. In this instance, a second guide wire was placed against the proximal pole of the scaphoid as viewed arthroscopically, and the difference in length between the two guide wires was measured. It is extremely important to use a screw at least 4 mm shorter than when using a headless compression screw [5–6]. A 24-mm headless compression screw was selected by measurement.

Prior to drilling and placing the screw, the guide wire is then advanced out the volar aspect of the hand and clamped with a hemostat to prevent pull of the wire during drilling as well as for easy retrieval in case the wire is broken during drilling and insertion.

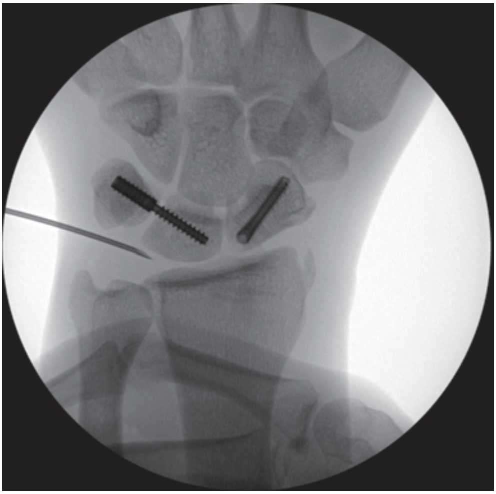

Fig. 5.9 Anteroposterior fluoroscopic view following stabilization of the trans-scaphoid perilunate dislocation. (Published with kind permission of © William B. Geissler and Jared L. Burkett, 2015. All rights reserved)

The scaphoid was then drilled through a soft tissue protector sleeve with the near-and-far reamers. A 24-mm Acumed mini Acutrak screw was inserted over the guide wire leading to compression at the fracture site (Figs. 5.9 and 5.10). Following screw placement, the arm is brought back into the vertical position in the traction tower. It is very important to view screw placement with the arthroscope in the radial carpal space to insure that the screw is countersunk into the scaphoid and not protruding proximally.

Clinical Course and Outcome

Postoperatively, the patient was placed in a volar splint for approximately 2 weeks in 30° of extension with the thumb not included in the splint. Range of motion exercises were continued for 4 weeks.

Radiographs at 6 weeks postoperatively showed no loosening of the hardware. At that point, a range of motion and strengthening program through hand therapy was initiated. The patient was seen

Fig. 5.10 Lateral fluoroscopic view confirming reduction of the trans-scaphoid perilunate dislocation. (Published with kind permission of © William B. Geissler and Jared L. Burkett, 2015. All rights reserved)

in approximately 3 months postoperatively. Range of motion of the wrist at that point showed 45° of extension, 30° of flexion, 10° of radial deviation, and 20° of ulnar deviation. The patient could make a full fist with good strength of 4/5. The patient clinically had no pain and was quite pleased. Radiographs showed bony consolidation of the scaphoid fracture and no loosening of the SLIC screw. The patient was then discharged to a home strengthening program.

Clinical Pearls/Pitfalls

- Clear arthroscopic visualization of the proximal pole of the scaphoid is mandatory. Any dorsal synovitis that may obscure visualization should be removed with a shaver.
- The starting point for the guide wire is the junction of the scapholunate interosseous ligament at the proximal pole of the scaphoid.

- Reduction of the scaphoid fracture should be visualized with the arthroscope in the midcarpal space.
- The position of the guide wire must be checked in posteroanterior, oblique, and lateral planes before reaming and insertion of the headless screw.
- A second guide wire may help to protect against rotation of the fracture fragments as the headless cannulated screw is being inserted.
- The position of the screw inserted in the scaphoid must be checked with the arthroscope in the radiocarpal space to ensure that it is not prominent.
- Final reduction of the scaphoid after screw insertion should be checked with the arthroscope in the midcarpal space.

Literature Review and Discussion

Haddad and Goddard reported their results in a pilot study of 15 patients with acute scaphoid fractures that were stabilized percutaneously through the volar approach [1]. Union was achieved in all patients in an average of 57 days, and range of motion at union was equal to that of the contralateral limb with their percutaneous technique. Grip strength averaged 90 % at 3 months.

Slade reported in a consecutive series of 27 fractures (17 waist fractures and 10 proximal pole fractures) treated with arthroscopic-assisted dorsal percutaneous approach [2, 3]. All patients underwent CT scans postoperatively which confirmed 100 % union rate in an average of 12 weeks. Of all the fractures, 18 of the fractures were treated within 1 month of injury.

Geissler reported on 13 patients with perilunate dislocations that were stabilized without K-wire fixation [4, 5]. Six of those patients had trans-scaphoid perilunate dislocations that were managed all arthroscopically. In the trans-scaphoid perilunate group, the arc of motion at 3 months was between 70 and 120°. Five patients had no pain. Stabilization of perilunate dislocations without Kirschner wires allows patients to participate in physical therapy at an earlier stage, resulting in a very functional range of motion at only 3 months postoperatively.

References

1. Haddad FS, Goddard NJ. Acute percutaneous scaphoid fixation using a cannulated screw. Chir Main. 1998;17(2):119–26.
2. Slade JF, Merrell GA, Geissler WB. Fixation of acute and selected non-union scaphoid fractures. In: Geissler WB, editor. Wrist arthroscopy. New York: Springer; 2005. pp 112–24.
3. Slade JF III, Grauer JN, Mahoney JD. Arthroscopic reduction and percutaneous fixation of scaphoid fractures with a novel dorsal technique. Orthop Clin North Am. 2000;30:247–61.
4. Geissler WB. Arthroscopic assisted fixation of fractures of the scaphoid. Atlas Hand Clin. 2003;8:37–56.
5. Geissler WB, Hammit MD. Arthroscopic aided fixation of scaphoid fractures. Hand Clin. 2001;17:575–88.

Suggested Readings

Kamineni S, Lavy CBD. Percutaneous fixation of scaphoid fractures: an anatomic study. J Hand Surg. 1999;24:85–8.

Whipple TL. The role of arthroscopy in the treatment of intraarticular wrist fractures. Hand Clin. 1995;11:13–8.