Chapter 24
Scaphoid Nonunion Advanced Collapse: Capitolunate Arthrodesis

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Case Presentation

A 45-year-old right-hand-dominant male laborer was referred to the hand center with long-standing right wrist pain. The patient's past medical history was unremarkable, but he did admit to near-daily alcohol use and was a smoker. The patient initially injured his right wrist ~ 15 years prior to presentation while playing recreational volleyball. He was told he had a "hairline" fracture of the scaphoid and surgical intervention was recommended. The patient initially elected for nonoperative management. The pain in his right wrist continued to progress over the years to the point where presented with difficulty in grasping or reaching for objects. His pain was rated as an 8/10 on a visual analog scale, and he was unable to identify any alleviating factors.

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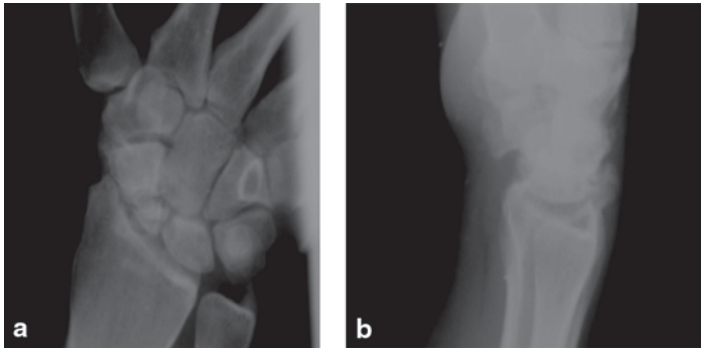

Fig. 24.1 **a** Postero-anterior (PA) image demonstrating stage 2 SNAC wrist. **b** Lateral image of the same patient. DISI deformity noted as well. (Published with kind permission of ©R. Glenn Gaston, 2015. All Rights Reserved). *PA* Postero-anterior, *SNAC* scaphoid nonunion advanced collapse, *DISI* dorsal intercalary segmental instability

Physical Assessment

Examination of the right wrist yielded significant tenderness to palpation over the scaphoid in the anatomic snuffbox. There was visible swelling noted as well over the dorsal–radial aspect of the wrist. His range of motion in the sagittal plane was limited to 55° of flexion and 30° of extension, but with relatively preserved pronosupination measuring 75° of supination and 90° pronation. He was able to achieve pulp-to-palm contact, but was unable to make a full composite fist. There was normal light touch sensation of the fingers and brisk capillary refill.

Diagnostic Studies

The patient was presented to clinic with X-rays from his referring provider (Fig. 24.1a, b). The radiographs demonstrated a proximal third scaphoid nonunion with beaking of the radial styloid and significant radioscaphoid and scaphocapitate arthrosis. His radiolunate and capitolunate joints appeared well preserved. A very small separate facet on the lunate for the hamate was noted.

Diagnosis

Watson and colleagues described the evolution of arthritis in the wrist, but Vender and colleagues established the term scaphoid nonunion advanced collapse (SNAC) [1]. They described the stages as follows: stage I is characterized by arthrosis at the radial styloid–distal scaphoid articulation; stage II is characterized by involvement progressing to scaphocapitate arthrosis followed by stage III which is denoted by degenerative changes in the midcarpal joint—specifically, the capitolunate joint. Notably, the interface between the proximal pole of the fractured scaphoid and the radius is often spared. Based on the patient's history, physical examination, and diagnostic studies, the patient was diagnosed with stage II SNAC.

Management Options

- *Proximal row carpectomy (PRC)*: Proximal row carpectomy is a well-described method of managing scapholunate advanced collapse (SLAC) and SNAC wrist. Critical to its success is preservation of the articular surfaces of the lunate fossa and head of the capitate. Midcarpal arthrosis is a relative contraindication for this procedure. If PRC were selected, in that setting it would require either capsular interposition or an osteo-articular transfer system (OATS)-type procedure to be done concomitantly. PRC done for younger and higher demand patients is still controversial with advocates for and against its use in this patient cohort. Stern et al. have reported poorer outcomes in patients under 35 years of age but good results even in longer term studies of patients older than 35.
- *Midcarpal fusion*: There are many described techniques for scaphoid excision and midcarpal fusion including four-corner fusion (lunate, triquetrum, capitate, and hamate), three-corner fusion (fusing all except lunotriquetral (LT) joint), two-column fusion (sparing LT and capitohamate (CH) joints), and isolated capitolunate fusion. In principle, all are identical in that the scaphoid is removed and the midcarpal joint is stabilized with a

fusion. Proponents of the four-corner fusion cite a larger surface area for fusion as the main advantage. Studies have shown no difference in fusion rates, range of motion, and functional outcomes between the four-corner and isolated capitolunate techniques [2]. Advantages of an isolated capitolunate (CL) fusion include lower risk of subsequent pisotriquetral (PT) arthritis, less bone graft needs, less surgical time, and equal outcomes and union rates. In principle, the fewer number of joints necessary for fusion to be achieved assuming the other joints are free of degenerative change makes the most sense. Combined, these factors have led us to favor scaphoid excision and isolated capitolunate fusion with triquetral retention.

- *Malerich Arthroplasty*: This technique involves removal of the distal pole of the scaphoid (the portion distal to the nonunion). Long-term studies have shown very good results, and we do like this technique for some patients. The presence of midcarpal arthritis makes this technique less desirable, but it can work well in isolated stylo-scaphoid degeneration (SLAC I). It should be noted that preexisting DISI deformity often worsens after this procedure though it has not been correlated with worse outcomes in studies till date.
- *Denervation/Styloidectomy*: We use this procedure selectively in patients not wanting to undergo a larger procedure. Often, older or lower demand individuals do not want larger scale reconstructive procedures, and we will offer arthroscopic radial styloidectomy and anterior interosseous nerve (AIN)/posterior interosseous nerve (PIN) neurectomy.
- *Wrist arthrodesis*: For pancarpal arthritis, this is our procedure of choice. We also offer this if the patient has very poor pre-op read-only memory(ROM) (if less than roughly 30° arc of flexion/extension) as salvaging this small amount of motion and assuming the risk of possible additional future surgery does not seem worthwhile. Also patients with gout often present with apparent SLAC wrist that have had attenuation of the scapholunate (SL) over time and intraoperatively are found to have pancarpal arthritic change despite some radiographic joint preservation. These patients are counseled before surgery that midcarpal verses total wrist fusion may be needed depending on surgical findings.

- *Wrist Arthroplasty*: There are reports of successful management of wrist osteoarthritis using wrist arthroplasty. At our institution, we have abandoned wrist arthroplasty for osteoarthritis after poor outcomes were achieved, but still use it routinely for rheumatoid arthritis.

Management Chosen

Scaphoid excision and isolated capitolunate fusion with triquetral retention was chosen and is our procedure of choice for the majority of these patients. Critical factors in the decision include patient age/level of demand/comorbidities, preoperative ROM, and stage of disease. In lower demand patients, physiologically older patients, and those at higher risk of nonunion due to comorbidities, PRC is selected more often. Patients with pancarpal arthritis or very limited preoperative ROM are more often recommended total wrist fusion. Patients with very early degenerative changes (stage I), especially those who do not want to undergo a larger procedure, often undergo either Malerich arthroplasty +/− denervation (early SNAC) or arthroscopic radial styloidectomy with denervation (early SLAC). As mentioned above, we prefer isolated CL fusion with triquetral retention over four-corner fusion because of the lessened need for bone graft, lower risk of subsequent PT arthritis, shorter surgery time, and equivalent outcomes [2]. We now maintain the triquetrum as opposed to excising it, given the biomechanical data of increased load across the lunate associated with triquetral excision [3].

Clinical Course and Outcome

The patient underwent scaphoid excision and capitolunate arthrodesis approximately 1 month from the time of his initial evaluation. At his first postoperative visit, his surgical dressing was taken down and his sutures were removed. Active and passive range of motion of the wrist demonstrated smooth flexion, extension, ulnar, and

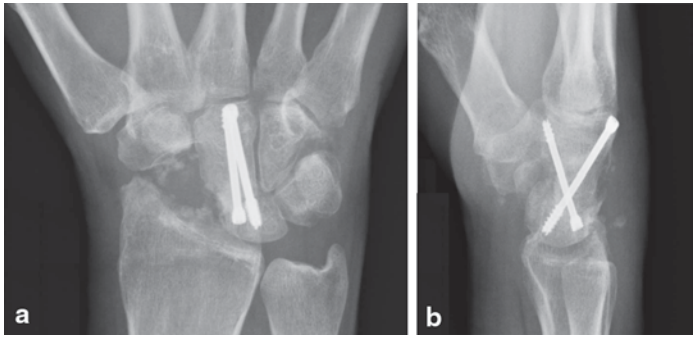

Fig. 24.2 **a** PA X-ray showing healing of the CL fusion without hardware migration. **b** Lateral X-ray showing healing of the CL fusion without hardware migration. (Published with kind permission of ©R. Glenn Gaston, 2015. All Rights Reserved)

radial deviation. He was placed into a short-arm cast and instructed to work on active range of motion exercises for the digits. He was counseled on smoking cessation. He returned to clinic at 6 weeks. At this visit, the patient admitted to performing repetitive heavy lifting and other vigorous activities with his operative extremity in spite of his ongoing restrictions. Radiographs were obtained and demonstrated intact hardware with a healing arthrodesis of the capitolunate joint (Fig. 24.2). The patient was placed into a removable splint, which he was instructed to use for all activities. A CT scan was ordered 3 months postoperatively to assess the arthrodesis site. The CT scan demonstrated intact hardware with bony bridging across the arthrodesis site between the capitate and lunate (Fig. 24.3). At the time of his final follow-up visit, the patient was no longer requiring narcotic pain medication, was able to perform all activities of daily living with minimal discomfort, and was anxious to return to work without restrictions. On examination, the patient's incision was well healed without signs of infection, he had full and supple range of motion of his digits, and his wrist range of motion measured 15° of extension, 45° of flexion, 80° of pronation, and 80° of supination. The patient was released to full duty at 4 months postoperatively.

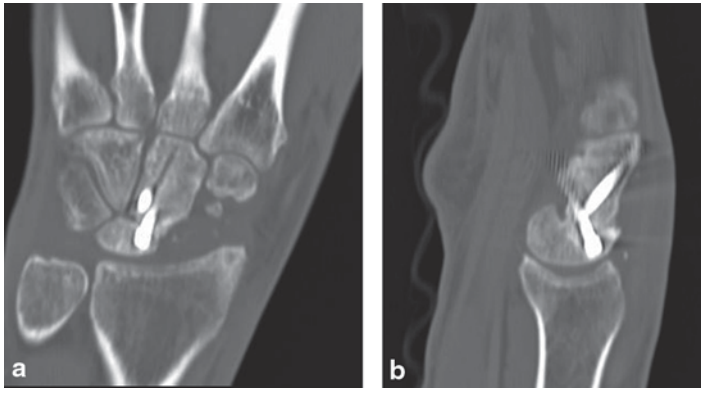

Fig. 24.3 **a** Coronal CT scan image showing bridging bone across the CL joint. **b** Sagittal CT scan image showing bridging bone across the CL joint. (Published with kind permission of ©R. Glenn Gaston, 2015. All Rights Reserved)

Clinical Pearls/Pitfalls

1. Reduce the lunate: Attaining colinearity of the lunate and capitate is critical and can be difficult at times. The DISI deformity can be challenging to reduce. Threaded K-wires into the lunate to use as joysticks followed by a single capitolunate pin is typically all that is needed. Also maximal passive wrist flexion, then driving a K-wire across the radiolunate joint with subsequent extension of the wrist and then advancing the wire across the midcarpal joint can work as well in difficult cases (Fig. 24.4).
2. Avoid hardware complications: K-wires alone for CL fusion have had an unacceptably high nonunion rate. Cannulated compression screws have a higher union rate but have been reported in multiple studies to back out and require repeat surgery for removal. When possible, retrograde screw placement is preferred so that the radiocarpal joint is not damaged with screw backout if this complication does arise (Fig. 24.5). Some patients have a very flat dorsal capitate head/neck morphology which makes retrograde screws very hard to place because of the difficult angle, and we do not prefer violating the 3rd carpometacarpal (CMC) as other authors have reported. Also getting two screws side by

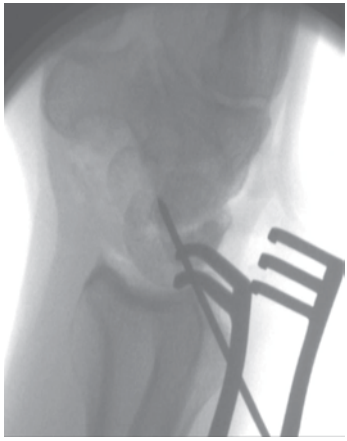

Fig. 24.4 Lateral X-ray demonstrating a K-wire having been advanced across the radiolunate and midcarpal joint to attain and maintain proper lunocapitate angle. (Published with kind permission of ©R. Glenn Gaston, 2015. All Rights Reserved)

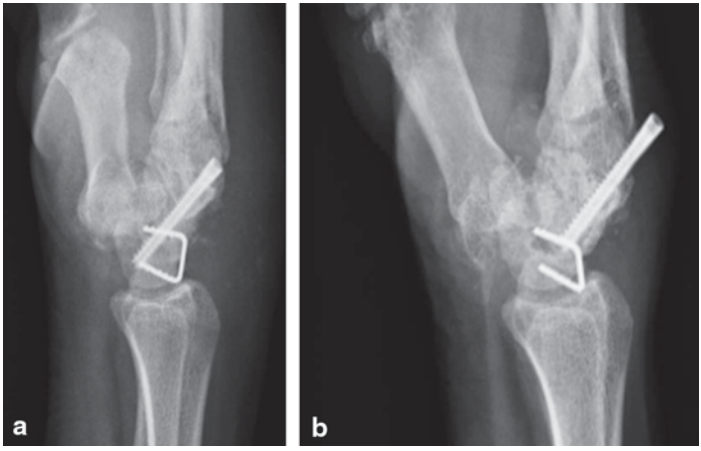

Fig. 24.5 **a** Lateral post-op X-ray with a staple and retrograde screw placed. **b** Lateral X-ray demonstrating back out of the retrograde screw. (Published with kind permission of ©Glenn Gaston, 2015. All Rights Reserved)

Fig. 24.6 Lateral X-ray showing well-seated staples in a small trough therefore not impinging on the dorsal rim of the distal radius. (Published with kind permission of ©R. Glenn Gaston, 2015. All Rights Reserved)

side can risk fracturing out the dorsal capitate cortex if the starting points are too close in more narrow capitate morphologies. In these cases, we will place antegrade screws (one or both) as needed. In patients who have a more deep, concave capitate head/neck, retrograde screws are easier to insert. We have more recently moved to nitinol memory staples for fixation. Making a small trough to bury the staple helps prevent dorsal impingement of the staple on the rim of the radius (Fig. 24.6).

3. Managing type 2 lunates: Type 1 lunates only articulate with the capitate and make this technique much easier. Some type 2 lunates have larger hamate facets making room for hardware in the capitate alone difficult. We have managed this with both excision of the proximal hamate and inclusion of the proximal hamate into the arthrodesis with no difference in outcome or complications noted till date (Fig. 24.7).
4. Bone graft: For isolated CL fusion, we have never required anything more than scaphoid cancellous bone for graft. The surfaces match well and do not require much grafting.
5. Joint preparation: We prefer to only use rongeurs and curettes for the joint preparation. We use no power in this part of the case as burrs often "polish" the surface and create unwanted heat even when copiously irrigated. Removing all subchondral bone

Fig. 24.7 PA wrist radiograph showing management of a type 2 lunate using one staple across the lunate–hamate joint. (Published with kind permission of ©R. Glenn Gaston, 2015. All Rights Reserved)

down to good cancellous bone is the key for attaining union. Typically, the lunate is more difficult to prepare given its concave shape and more often sclerotic bone.

Literature Review and Discussion

Four-corner fusion has been the traditional limited wrist fusion for SLAC and SNAC wrist based on the large surface area available for fusion and proven track record in published series. Interestingly, in Watson's original article on the management of SLAC wrist, three of his sixteen patients who underwent limited wrist fusions had a capitolunate fusion with results similar to the cohort having undergone four-corner fusion [4]. One of Watsons' first CL fusion patients was reported to have "rode 4753 miles on a bike with hand brakes" [5]. Isolated capitolunate fusion was first reported in 1966 for the management of Kienbocks [6] though early applications of this technique to the SLAC wrist were met with poor outcomes secondary to a high nonunion rate [7, 8]. The current four-corner fusion technique advocated by Watson arose from the desire to

increase the surface area for fusion when compared to the isolated CL fusion. Refinements of the CL fusion technique (specifically changing fixation from K-wires to compression screws or compression staples) have greatly decreased the incidence of nonunion, and the technique offers the advantages of a lessened or even eliminated need for bone graft, and elimination of pisotriquetral arthritis as a complication [2, 9, 10]. While newer techniques continue to be reported, such as two-column fusions and other modifications to the traditional four-corner fusion, all require fusion of the triquetral–hamate joint. In our experience, this joint is rarely arthritic and fusing it has been shown to dramatically alter pisotriquetral mechanics as clinically evidenced by the late pisiform excision rates reported up to 33 % [2, 11]. This coupled with the success, and simplicity of an isolated capitolunate fusion with triquetral retention has reinforced our decision to continue this procedure as our procedure of choice for most SLAC and SNAC wrists.

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