Chapter 20
Recalcitrant Proximal Pole Nonunions Reconstructed with Medial Femoral Condyle Osteoarticular Graft

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Case Presentation

A 27-year-old right-hand dominant male presented to the office with pain in the anatomic snuffbox and limitation in the range of motion and grip strength of the right hand. The patient was identified as having a proximal pole scaphoid fracture 2.5 years prior to presentation. He initially underwent 8 weeks of casting at the time of injury and was thought to have healed his fracture. Fourteen months later, he was found to have a nonunited fracture and underwent 1,2 intracompartmental supraretinacular pedicled vascularized bone grafting from the distal radius via a dorsal approach and screw fixation.

Six months later, CT scan images demonstrated a persistent nonunion with cystic changes at the nonunion site. The patient was referred for the revision treatment of the scaphoid nonunion or salvage procedures.

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J. Yao (ed.), *Scaphoid Fractures and Nonunions,*
DOI 10.1007/978-3-319-18977-2_20

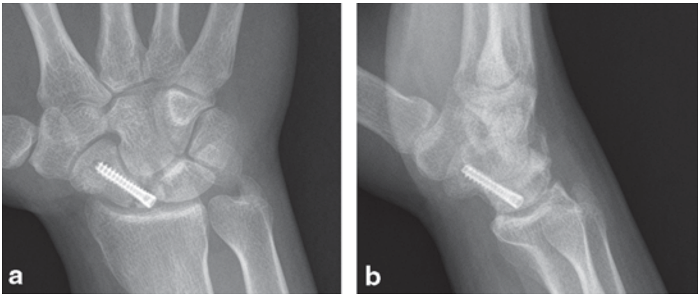

Fig. 20.1 **a** and **b** Preoperative anteroposterior and lateral radiographs. (Published with kind permission of © James Higgins, 2015. All Rights Reserved.)

Physical Assessment

On examination, the patient demonstrated a well-healed scar on the dorsal aspect of his wrist. He had full digital range of motion. His wrist extension was limited to 30°, flexion to 20°, ulnar deviation to 25°, and radial deviation to 0°. He demonstrated full forearm pronosupination. His grip strength was diminished as compared to his contralateral uninvolved side.

Diagnostic Studies

X-rays demonstrated a dorsal headless bone screw traversing a very small proximal pole nonunion fragment. The nonunion site exhibited cystic formation and bone loss. There was no evidence of arthritic changes in the radial carpal or midcarpal joint. (Fig. 20.1)

CT scan images demonstrated with greater clarity the small dimensions of the small proximal pole segment and a humpback flexion deformity at the nonunion site (Fig. 20.2). The lunate is positioned in a neutral posture.

Diagnosis

Recalcitrant proximal pole scaphoid nonunion following failure of a previous vascularized bone graft procedure from the distal radius.

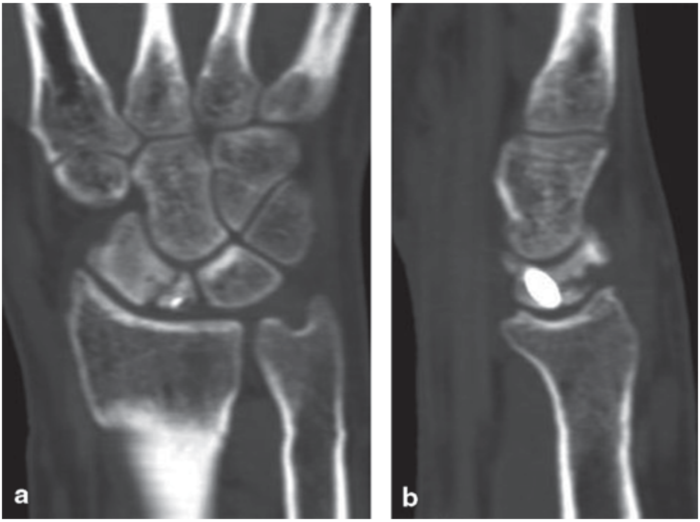

Fig. 20.2 **a** and **b** Preoperative coronal and sagittal CT scans revealing a small proximal pole fragment and humpback deformity. (Published with kind permission of © James Higgins, 2015. All Rights Reserved.)

Management Options

Given the failure of a previous well-performed treatment with a vascularized distal radius bone graft, revision vascularized bone grafting from the radius does not offer any advantages in achieving scaphoid healing. The very small proximal pole fragment presents a particular challenge in achieving fixation with subsequent nonunion surgery particularly given the osseous changes from the previous screw fixation.

Options for reconstruction of the scaphoid include revision ORIF with a vascularized corticocancellous bone flap from another site such as the medial femoral condyle (MFC), or proximal pole excision and replacement with vascularized osteochondral reconstruction from the medial femoral trochlea (MFT). Options for salvage procedures would include scaphoid excision and midcarpal fusion or proximal row carpectomy.

Management Chosen

Due to the patient's young age and lack of arthritic changes, the patient was deemed a candidate for revision ORIF of the scaphoid nonunion. Because of the failure of previous vascularized cortico-cancellous grafting, the small size of the proximal pole fragment, and the poor quality of the proximal pole fragment after previous screw fixation, the patient was felt to be an ideal candidate for proximal pole scaphoid excision and medial femoral trochlea vascularized osteochondral reconstruction.

Surgical Technique

The MFT osteochondral flap, provides a convex cartilaginous segment of bone with an arc of curvature very similar to that of the greater curvature of the proximal scaphoid. A segment of osteochondral bone is harvested in continuity with the transverse branch of the descending geniculate artery. The source vessel is the same as the conventional MFC corticoperiosteal flap (Fig. 20.3). However, the MFT's terminal branch (transverse branch) is distinct from the longitudinal branch typically used for the MFC flap. The osteochondral segment is harvested to mimic the deficit created after resection of the proximal pole fragment and additional portions of the proximal scaphoid beyond the nonunion site (Fig. 20.4).

This resection of additional scaphoid distal to the nonunion site converts the proximal pole nonunion conceptually into a waist-level osteosynthesis site. During resection of the proximal scaphoid, cartilage on the lesser curvature that articulates with the midcarpal joint is preserved. Additionally, the distal-most segments of the dorsal and volar scapholunate interosseous ligament are likewise preserved if possible. Preservation of the thin cartilage layer and distal scapholunate ligament is facilitated by maintaining the capsular integrity of the midcarpal joint. The resection is completed with the goal of opening only the radicarpal joint. The only cartilage-bearing surface of the medial femoral trochlea flap is oriented to articulate solely with the scaphoid fossa of the radius (Fig. 20.5).

The flap is inserted such that the vascular pedicle and periosteum are oriented dorsal in the wrist (Fig. 20.6). The pedicle is

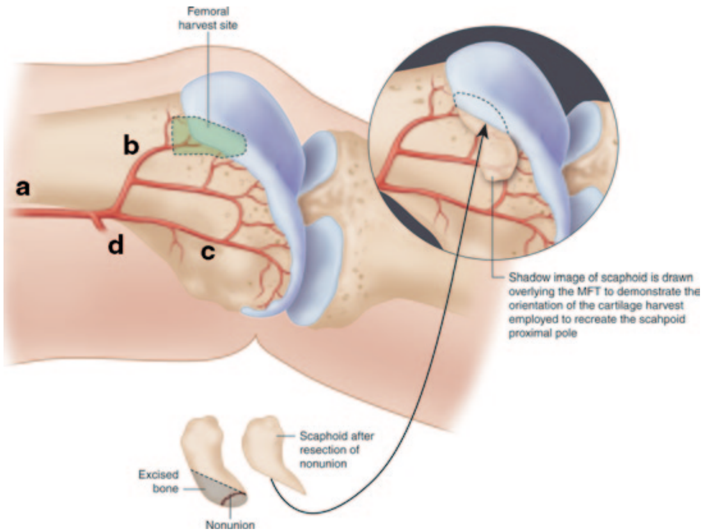

Fig. 20.3 Diagram of the vascular tree of the descending geniculate artery. Note the course of the transverse branch and its relationship to the proximal trochlea. Also demonstrated is the area of typical harvest and its orientation in the reconstructed scaphoid. (Published with kind permission of © The Curtis National Hand Center. All Rights Reserved.)

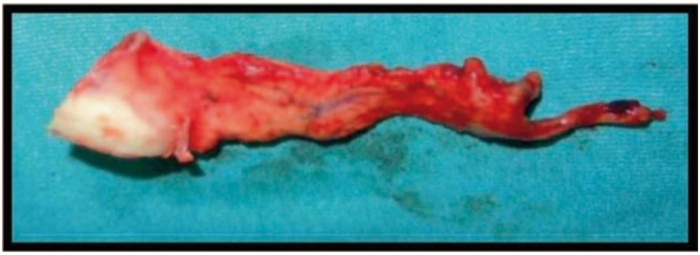

Fig. 20.4 The harvested osteochondral graft with pedicle. (Published with kind permission of © James Higgins, 2015. All Rights Reserved.)

draped in a distal direction and is gently routed into the snuffbox for microvascular anastomosis end-to-side into the radial artery and associated veins.

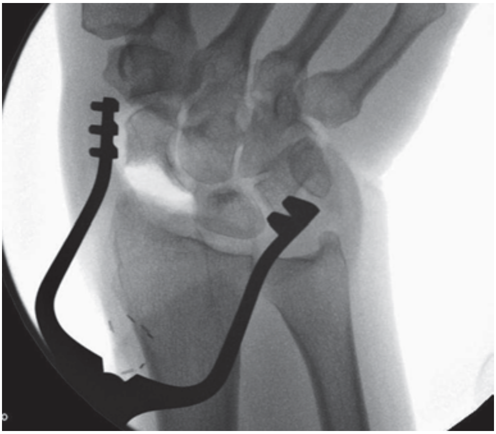

Fig. 20.5 Intraoperative fluoroscopic view of the scaphoid after generous resection of the nonunion fragment and an additional portion of native scaphoid distal to the nonunion site. Note the preservation of the convex cartilage segment that articulates with the midcarpal joint. By preparing the scaphoid resection in this manner, the proximal pole nonunion is converted to a less-challenging waist-level osteosynthesis site. Additionally, this preparation allows the only cartilage-bearing surface of the MFT osteochondral segment to articulate with the scaphoid fossa, while preserved native scaphoid cartilage articulates with the midcarpal joint. (Published with kind permission of © James Higgins, 2015. All Rights Reserved.)

The conversion of a poor-quality small proximal pole nonunion fragment to a considerably larger dense osteochondral flap greatly facilitates fixation. Headless cannulated screw fixation is directed through the cartilage surface of the flap across the waist-level osteosynthesis site and into the distal pole. This screw is often directed in a more longitudinal orientation than conventional scaphoid screw placement in order to achieve a good interface with the distal pole bone fragment and avoid the pathway of the previously failed screw fixation.

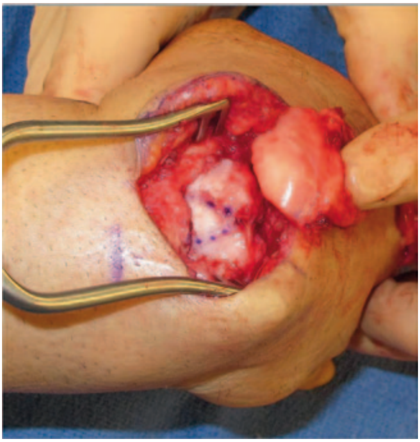

Fig. 20.6 Sizing the graft compared to the native scaphoid. The pedicle is draped into the anatomic snuffbox. (Published with kind permission of © James Higgins, 2015. All Rights Reserved.)

Clinical Course and Outcome

The patient demonstrated a healed scaphoid reconstruction confirmed with CT scan obtained 12 weeks after surgery. He achieved complete resolution of pain and tenderness. His digital range of motion and pronosupination remained full. His wrist extension in 12 weeks was 35 °, flexion was 55 °, ulnar deviation was 25 °, and radial deviation was 5 °.

Postoperative knee discomfort created a gait disturbance for approximately 6 weeks. No immobilization or gait assistance (i.e., crutch, cane) were required. Twelve weeks after surgery, his knee became pain-free with full range of motion. He was able to participate in his routine athletic endeavors which include running, soccer, and biking. Follow-up radiographs 1 year after the surgery demonstrated no development of arthritic changes and a well preserved and normal SL angle and interval. (Fig. 20.7)

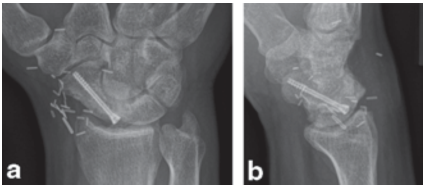

Fig. 20.7 **a** and **b** Postoperative AP and lateral radiographs 1 year after reconstruction. (Published with kind permission of © James Higgins, 2015. All Rights Reserved.)

Clinical Pearls/Pitfalls

- A segment of osteochondral bone is harvested in continuity with the transverse branch of the descending geniculate artery.
- The osteochondral segment is harvested to mimic the deficit created after resection of the proximal pole fragment and additional portions of the proximal scaphoid beyond the nonunion site.
- Resection of additional scaphoid distal to the nonunion site converts the proximal pole nonunion conceptually into a waist-level osteosynthesis site.
- Preservation of the thin cartilage layer and distal scapholunate ligament is facilitated by maintaining the capsular integrity of the midcarpal joint.
- The screw is often directed in a more longitudinal orientation than conventional scaphoid screw placement to achieve a good interface with the distal pole bone fragment and avoid the pathway of the previously failed screw fixation.

Literature Review and Discussion

The descending genicular artery system has demonstrated value as a donor for microvascular reconstruction. In upper extremity surgery, it has been shown to be of use as a pliable corticoperiosteal flap, a corticocancellous semi-structural flap, and a skin-bearing flap. Its transverse branch has been well studied and demonstrated to supply a periosteal filigree of vessels to the cartilage-bearing area of the proximal aspect of the medial trochlea of the patellofemoral joint. This convex surface has been demonstrated to be of similar contour to the greater curvature of the scaphoid as well as the mirror–image scaphoid fossa.

These qualities have made the MFT flap a useful tool in treating recalcitrant proximal pole scaphoid nonunions. The sole series reporting its use reported on 16 patients with a minimum of 6-month follow-up (average follow-up was 14 months with a range from 6 to 72 months) [1]. The median age of the patients was 30 years with the range of 18–47. The average number of previous operations was 1 with the range of 0–3. Seven of 16 patients were smokers. The authors reported healed scaphoid reconstructions confirmed by CT scan in 15/16 patients. In one patient, healing was not achieved and the patient is considering salvage operations. Most (12 of 16) patients reported complete pain relief while 4 of 16 reported improvement without complete pain relief. Pronosupination and digital range of motion were unaffected when comparing preoperative to postoperative values. Preoperative extension averaged 45.7 ° and postoperative extension averaged 46 °. Preoperative flexion averaged 43 ° and postoperative flexion averaged 43.8 °. Radiographically the analysis of the intercarpal relationships demonstrated relatively unchanged scapholunate angles with an average of 51.6 ° preoperatively and 48.6 ° postoperatively.

MFT scaphoid reconstruction is indicated in young patients with scaphoid nonunions demonstrating a very small proximal pole fracture fragment that has failed previous attempts of reconstruction, or less commonly, in young patients with extremely small proximal scaphoid nonunion without prior surgeries. In these situations, conventional reconstructive techniques, likely, will not provide both improved vascularity and rigid internal fixation. When the proximal fragment is extremely small and particularly when it has been previously damaged by single or multiple attempts at screw fixation, it is difficult to achieve adequate fixation. Conventional vascularized or nonvascularized correction procedures require preservation of this small damaged cartilage shell. Often, however, this shell is unsalvageable. The medial femoral trochlea flap provides the surgeon the ability to widely resect this damaged fragment and resect distally into the normal scaphoid fragment enlarging the nonunion site and converting the proximal pole fracture to a waist level defect. This larger defect can be filled because of the ability to transfer this morphologically similar convex osteocartilaginous flap. The larger size of the flap enables the surgeon to easily achieve rigid internal fixation on both proximal and distal fragments. These attributes enable the surgeon to deliver both improved vascularity and fixation to difficult nonunion cases and achieve union despite previous failures. It also enables the surgeon to make a challenging technical case somewhat more feasible by supplying fixation and not feeling compelled to preserve a damaged and compromised proximal cartilaginous shell.

In order to maintain intercarpal relationships after resecting the majority of the scapholunate ligament and proximal pole, additional care is required. The distal-most cartilaginous shell of the native scaphoid that effaces the midcarpal joint as well as the distal-most aspects of the dorsal scapholunate ligament is preserved if possible. In addition to the stability afforded by the distal scapholunate ligament segment, biomechanical evidence has demonstrated that the replacement of the resected proximal pole (often with bone loss and humpback deformity) with a larger osteochondral graft may provide correction of scapholunate alignment, even in the absence of primary and secondary soft tissue stabilizers [2]. These data would suggest that oversized osteochondral flaps ("scaphoid overstuffing") may permit complete resection of the proximal pole segment and scapholunate ligament in these difficult cases without resultant rotary subluxation of the scaphoid.

A concern with osteochondral flap harvest is that of donor site morbidity. These patients will typically report transient discomfort in the knee after medial femoral trochlea harvest for approximately 3 months. Thereafter, they are routinely able to return to normal ambulation as well as sporting activities without difficulty.

While these findings are quite promising for addressing this very difficult problem of recalcitrant proximal pole scaphoid nonunions, there are many unaddressed questions. Long-term radiographic and subjective outcomes are needed to determine the value of this reconstructive option and its ability to preserve function and avoid arthritic changes. Further basic research is also warranted on determining the relative value of periosteal and subchondral vascular supply to cartilage in relation to that of synovial perfusion.

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Suggested Readings

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