Scaphocapitolunate Arthrodesis and Radial Styloidectomy for Posttraumatic Degenerative Wrist Disease

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Abstract

Long-standing scaphoid nonunion, scaphoid malunion, and chronic scapholunate dissociation result in malalignment of the carpal bones, progressive carpal collapse, instability, and osteoarthritis of the wrist. The most commonly used procedures to treat scaphoid nonunion advanced collapse (SNAC) and scapholunate advanced collapse (SLAC) wrists are the four-corner fusion (4CF) and the proximal row carpectomy (PRC). The purpose of this study was to evaluate the clinical outcome of a different treatment modality: radial styloidectomy and scaphocapitolunate (SCL) arthrodesis. This treatment option is chosen in an effort to maintain the joint contact surface and load transmission across the radiocarpal joint. We conducted a retrospective review of 20 patients (average age 62 years, range: 27 to 75 years) treated from 1994 to 2010. Seven patients were treated for SNAC, 12 patients for SLAC wrists, and 1 for degenerative joint disease following a transscapho-transcapitate perilunar dislocation. Sixteen patients had Herbert screw fixation, and four had Spider plate fixation. All patients had autologous bone graft used for the arthrodesis. The mean follow-up was 4.6 years (range: 2 to 9.6 years). Patients were evaluated clinically and radiographically. Nineteen of 20 arthrodeses healed on an average of 9.6 weeks. One patient was reoperated 8 months after the initial operation with salvage of the SCL arthrodesis with a spider plate with an adequate result. The mean active flexion–extension arc was 70 degrees and the radioulnar deviation arc was 23 degrees. Pain decreased in all patients, 13 of whom were pain free postoperatively. The average postoperative disabilities of arm, shoulder, and hand score was 24. Radiographically, neither radiolunate nor radio-scaphoid arthritis was noted on follow-up. SCL arthrodesis with radial styloidectomy resulted in an adequate residual range of motion and pain relief. This method preserves the normal ulnar sided joints of the carpus and maintains a more physiologic joint surface for radiocarpal load sharing.

Keywords

- scaphocapitolunate
- wrist arthrodesis
- SNAC
- SLAC

Treatment of advanced osteoarthritis after long-standing scaphoid nonunion (scaphoid nonunion advanced collapse, SNAC) or chronically destabilized wrists from scapholunate dissociation (scapholunate advanced collapse, SLAC) is most

commonly treated with four-corner fusion (4CF) or proximal row carpectomy (PRC).^{1–4} In each, the scaphoid is excised, reducing the cartilage contact area at the radiocarpal joint. This leads to an increased load across the lunate fossa, as the

scaphoid fossa is no longer articulating with the carpus.⁵ Therefore, osteoarthritis is a risk, particularly in PRC.⁶ The rates of osteoarthritis in 4CF were recently reported at 1% by a meta-analysis,³ but three of the eight studies used for this data had less than a 3-year follow-up, and only one study had more than 5-year follow-up. In addition, two long-term studies of 4CF^{7,8} only followed clinical data and did not review radiologic data or reported on the risk of developing progressive osteoarthritis. Therefore, the rate of osteoarthritis, particularly long term, may be underestimated.

The scaphocapitolunate (SCL) arthrodesis is an alternate treatment option in which most of the scaphoid is maintained to maximize physiological loading across the radiocarpal joint, while the unaffected intact ulnar joints of the carpus remain mobile. This partial carpal fusion is performed with a radial styloidectomy as well as a partial resection of the distal scaphoid to address radial-sided osteoarthritic changes and painful radioscapoid impingement. Although the clinical significance of progressive osteoarthritis is unknown, conceptually this procedure may be advantageous because it maintains a more physiologic joint surface area. It is therefore an appealing treatment option, particularly in the young patient.

Methods

Patients

Twenty patients were treated with SCL arthrodesis performed by the senior author (D.L.F.) from 1994 to 2010. Nine patients were men and 11 patients were women. The average age of the patients was 62 years (range: 27 to 75 years). In 12 patients, the dominant wrist was affected, and in 8 patients, the nondominant wrist. The average follow-up was 4.6 years (range: 2 to 9.6 years). Seven patients were treated for SNAC wrists (1 patient in stage I, 1 patient in stage II, and 5 patients in stage III); 12 patients were treated for SLAC wrists (2 patients in stage II and 10 patients in stage III), and 1 for degenerative joint disease following a transscapho-transcapitate perilunar dislocation.

Preoperative radiographic assessment showed dorsal intercalated segmental instability (DISI) deformity in all patients with an average capitolunate angle of 22 degrees (range: 19 to 28 degrees). Patients were considered surgical candidates when they had a significant pain and functional impairment in activities of daily living and during work after failing conservative modalities including nonsteroidal anti-inflammatory drugs, temporary immobilization, and intra-articular steroid injections. Patients also needed to have radiographic evidence of SLAC or SNAC degenerative changes with a well-preserved proximal and central area of the scaphoid fossa in the radiocarpal joint (—Fig. 1). Exclusion criteria included significant cartilage loss of the scaphoid fossa with complete loss of the joint space, in which a 4CF was performed.

Four patients had previous surgeries: one open reduction internal fixation of a perilunar fracture dislocation, one styloidectomy for scaphoid nonunion, one scapholunate ligament repair and scapholunate joint screw fixation, and one

Figure 1 Posteroanterior and lateral views of a patient presented with a stage I SLAC wrist after a failed ligament reconstruction. The DISI deformity is evident on the lateral view. SLAC, scaphoid lunate advance collapse; DISI, dorsal intercalated segment instability.

ligament reconstruction for midcarpal instability. The other 16 patients did not receive adequate primary treatment of the scaphoid fracture or scapholunate ligament disruption.

Surgical Technique

The wrists were approached through a longitudinal 6- to 8-cm dorsal incision centered over Lister's tubercle. The wrist capsule was exposed in the interval between the third and fourth dorsal compartments mobilizing the extensor pollicis longus radially. Following transection of the posterior interosseous nerve, the dorsal capsule was incised longitudinally in line with the skin incision at the level of the scapholunate interval extending distally to the carpometacarpal joint. Radial and ulnar capsular flaps were developed by incising the capsule transversely in an inverted "T" fashion, close to its radial attachment.

The cartilage of the scaphoid and radius was then inspected. If 90% of the cartilage of the scaphoid fossa was well preserved, we chose to keep the scaphoid in SLAC and SNAC wrists and proceed with the SCL arthrodesis. Otherwise, a 4CF or PRC was considered. Although arthritic changes involved the radioscapoid joint, the changes were localized to the dorsal aspect of the radius and the palmar aspect of the flexed scaphoid. In SLAC and SNAC degenerative patterns, the normal joint surface of the scaphoid is not in contact with the scaphoid fossa. Thus, by reducing the scaphoid into the sound part of the scaphoid fossa, we expect to have two surfaces of relatively normal cartilage contacting one another.

After inspection of the cartilage, the same incision was used to address the osteophytes in three areas: the radial styloid, the dorsal distal radius, and the scaphoid. Osteophytes of the radial styloid were exposed and excised to prevent further impingement. The debridement of the radial

Figure 2 Intraoperative view of the same patient as ►Fig. 1. Here, a 2-mm K-wire is placed in the lunate (left) and rotated as a “joy-stick” to reduce the lunate (right).

styloid was limited to the area of osteophyte formation and bare bone at the level of the joint surface radially. Dorsal osteophytes of the distal radius, if present, were also removed. The scaphoid osteophytes were located at the volar and radial surface of the distal scaphoid abutting radial styloid and were excised. The amount of resection depended on the magnitude of the osteophyte formation and the degenerative changes at the radial styloid and the most radial cartilage lining the scaphoid fossa. In cases of scaphoid nonunion, the distal portion of the scaphoid was removed in two cases; otherwise, it was preserved and included in the arthrodesis.

Next, the carpal alignment was restored, correcting lunate and scaphoid rotation and the dorsally subluxed capitate. To achieve this, a 2-mm Kirschner wire (K-wire) was placed in the lunate and used as a “joystick” to correct this alignment (►Fig. 2). Additional K-wires were then used to temporarily maintain the reduction by first using a 1.6-mm K-wire through the most ulnar and dorsal corner of the radius then through the lunate into the capitate to maintain the

alignment of the central carpal column. Next, the scaphoid was extended of its flexed deformity and pinned transversely to the capitate with two K-wires (►Fig. 3). The articular cartilage and subchondral bone of the adjacent surfaces of the scaphoid, lunate, and capitate were then removed. The articular spaces were filled with cancellous bone graft. The graft was obtained from the distal radius in 6 patients and from the iliac crest in 14 patients. The arthrodesis was then stabilized with either Herbert screws (Zimmer, Warsaw, IN) or a “hub-cap” plate, (a locking spider-type plate, Acumed Hillsboro, OR) (►Fig. 4). Specifically, in SLAC cases and the cases of SNAC where the distal scaphoid was removed, three Herbert screws were placed in a triangular configuration to stabilize the arthrodesis site: one spanning the scaphoid and capitate, a second one spanning the capitate and lunate, and a third one spanning the scaphoid and lunate. In the SNAC cases where the distal scaphoid was preserved, the three Herbert screws were again used in a slightly different configuration: one spanning the capitate and lunate, a second one spanning the capitate and distal scaphoid, and a third one spanning the

Figure 3 Intraoperative and fluoroscopic views of the temporary K-wire stabilization of the same patient as ►Figs. 1 and 2. The alignment of the central carpal column is maintained by driving a 1.6-mm K-wire through the most ulnar and dorsal corner of the radius through the lunate and into the capitate. Then, the scaphoid is reduced out of its flexed deformity and pinned transversely across with two K-wires to the capitate.

Figure 4 Intraoperative view and immediate postoperative posteroanterior and lateral radiographs of the same patient as ►Figs. 1–3. Distal radius bone graft was used for the SCL arthrodesis. The plate is placed after reducing and stabilizing the carpus (left). Postoperative radiographs demonstrate correction of the DISI deformity (right).

proximal and distal scaphoid (►Figs. 5 and 6). In four patients, spider-type plate was used for stabilization (►Figs. 7 and 8).

Postoperative Protocol

Postoperatively, the patients were immobilized in a dorsal splint for 2 weeks, and after suture removal, a short arm cast was applied for 5 weeks. After radiographic evidence of bony healing, range of motion and strengthening exercises were started under physiotherapy supervision.

Evaluation

The patients were assessed both clinically and radiographically pre- and postoperatively by the senior author. No patient was lost to follow-up. Radiographically, the patients were examined with four X-ray projections (posteroanterior, lateral, supinated oblique at 45 degrees, and pronated oblique at 45 degrees) and evaluated for union, lunocapitate angle, and progression of osteoarthritis. Clinical evaluation consisted of determining range of motion in flexion–extension and radial

Figure 6 Posteroanterior and lateral radiographs 6.5 years after SCL arthrodesis and styloidectomy on same patient as ►Fig. 5. Three Herbert screws were used for fixation. In addition to the capitulate and scaphocapitate screws, the third screw spans the site of previous nonunion. The patient's radiocarpal joint space is maintained, and no progression of osteoarthritis is noted.

Figure 5 Preoperative posteroanterior and lateral radiographs of a patient with stage II SNAC wrist. This patient did not receive any previous treatment for his scaphoid fracture. SNAC, scaphoid non-union advance collapse.

Figure 7 Posteroanterior and lateral radiographs of a patient presenting 25 years after a Matti-Russe procedure with a stage III wrist.

Figure 8 Radiographs 4.5 years after SCL arthrodesis and radial styloidectomy in the same patient as in ►Fig. 7. A Spider-type plate was used for fixation. The patient's radiocarpal joint space is maintained, and no progression of osteoarthritis is noted.

and ulnar deviation. Grip strength was measured with a Jamar dynamometer. In addition, the patients answered the disabilities of arm, shoulder, and hand (DASH) questionnaire⁹ and pain was assessed with the Fernandez wrist pain scales¹⁰ (►Table 1). The data were evaluated retrospectively.

Results

Clinical Evaluation

The results are summarized in ►Table 2. The average grip strength reflected as a percentage of strength of the uninjured hand improved from 40% preoperatively to 65% postoperatively. The average range of motion for flexion–extension was 81 degrees preoperatively and 70 degrees postoperatively. For radial and ulnar deviation, the average arc was 33 degrees preoperatively and 23 degrees postoperatively.

According to the Fernandez pain rating scale¹⁰ (►Table 2), 11 patients had severe pain and 9 patients had moderate pain preoperatively. Postoperatively, 13 patients had no pain, 5 patients had mild pain, and 2 patients had moderate pain. Average DASH scores were 44 preoperatively and 24 postoperatively. Fifteen patients returned to their original occupation, four returned to work but changed occupation to one with lighter demands. One patient, whose course was complicated by the nonunion, was still disabled at late follow-up.

Table 1 Fernandez Pain Scale

Pain Scale
– = No pain
+ = mild (present at extremes of active wrist ROM but the patient is neither physically nor psychologically disturbed)
++ = moderate (occurs during heavy manual labor and the patient is physically and psychologically disturbed)
+++ = severe (present with daily activities and even at rest)

ROM, range of motion.

Table 2 Clinical and Radiographic Results of SCL Arthrodesis

	Preoperative	Postoperative
Flexion,°	39	33
Extension,°	42	37
Flexion–extension arc,°	81	70
Radial deviation,°	13	8
Ulnar deviation,°	20	15
Radioulnar deviation arc,°	33	23
Capitolunate angle,°	22	2
Grip strength, % opposite wrist	40	65
Pain score (Fernandez)	3.2	0.45
DASH score	44	24

SCL, scaphocapitolunate; DASH, disabilities of arm, shoulder, and hand.

Eighteen patients were satisfied with the procedure and would repeat it if necessary on the opposite hand, two were not.

Radiological Evaluation

Nineteen of twenty arthrodeses healed uneventfully after the index procedure (95%). The average time to healing was 9.6 weeks (range: 8.1 to 12.3 weeks). The arthrodesis was evaluated radiographically and considered united when bony bridging trabeculae were seen at the level of the fused surfaces as well as no sign of loosening of internal fixation material. The postoperative capitolunate angle averaged 2 degrees (range: 0 to 5 degrees). One patient was reoperated for persistent pain and nonunion of the SCL arthrodesis. In this patient, the capitolunate and scapholunate surfaces failed to unite whereas the scaphocapitate surface healed as seen on computed tomography (CT) scans. This patient had developed degenerative changes 8 years following ligament reconstruction for midcarpal instability. The nonunion was regrafted and stabilized with a locking spider plate and subsequently healed in 8 weeks. We now recommend that the SCL arthrodesis be performed with a locking spider-type plate.

Progression of osteoarthritis such as joint space narrowing or increased subchondral sclerosis or osteophyte formation was not observed in any case. Although occasionally there was a slight incongruity of the SCL arthrodesis with the distal radius, no osteoarthritis was noted. In particular, four patients were followed more than 6 years with no progression of osteoarthritis of the wrist (►Fig. 6).

Complications and Reoperations

In addition to the aforementioned salvage procedure for nonunion, five patients underwent hardware removal; each of these five patients had screw fixation. Three of the patients insisted on having their screws removed (“foreign body phobia”). Two of these five patients had screw removal and combined arthrolysis with release of the dorsal wrist capsule to improve wrist flexion. In each of these cases, the flexion improved from 15 to 30 and 35 degrees, respectively.

Two patients had distal radius dorsal rim osteophytes resected for residual painful dorsal wrist impingement. These osteophytes were resected 12 and 14 months after the index procedure and were considered to be due to the initial pathology. In both of these patients, the fusion was stabilized with a spider plate. Direct contact with the plate and the osteophytes under passive wrist extension was not present, but removal of the osteophytes did improve wrist extension.

Discussion

Degenerative osteoarthritis of the wrist secondary to SNAC or SLAC is most commonly treated with 4CF or PRC. These procedures excise the scaphoid to address arthritic degeneration and stabilize the wrist with either fusion of the midcarpal joint or excision of the remaining proximal row. SCL fusion with radial styloidectomy as described here involves a more limited excision of only the distal portion of the scaphoid and radial styloid, thus preserving the proximal scaphoid joint surface.

We recommend SCL arthrodesis for patients with SNAC or SLAC II-III wrists in which the proximal radioscaphoid joint is preserved or has minimal arthritic changes. If the proximal pole of the scaphoid is small and avascular, we would recommend resecting the proximal scaphoid and maintaining the distal pole by fusing it to the capitate, although we did not have any of these cases in this series. As compared with 4CF and PRC, this procedure results in a more physiologic radiocarpal joint and decreases load across the joint, thus preventing further arthritic changes across the joint.

One patient who presented with SNAC stage I was staged on the basis of radiographic studies; however, intraoperatively, it was discovered that the patient had cartilage erosion of the distal scaphoid and the head of the capitate. Therefore, this patient underwent the SCL fusion. In general, this technique is reserved for more advanced cases (i.e., SNAC/SLAC stage II-III).

Watson's initial description of patterns of arthritic changes in SLAC wrists described degenerative arthritis in specific patterns, specifically at the distal radioscaphoid joint (SLAC I), the proximal radioscaphoid joint (SLAC II), and the capitolunate joint (SLAC III).¹¹ In our experience, often the proximal scaphoid can be maintained because of limited arthritic changes in the proximal radioscaphoid joint. Consistent with Watson's description, the worst degenerative changes are found at the distal radioscaphoid joint, which is addressed by radial styloidectomy and partial distal pole resection in this series. In addition, arthritic changes at the capitolunate joint (SLAC III) are addressed in the SCL arthrodesis. In the radioscaphoid joint, arthritic changes were localized to the palmar radial aspect of the scaphoid and the radial styloid. The scaphoid fossa of the radius has cartilage degeneration in the most dorsal ulnar area due to pressure of the dorsally "subluxed" scaphoid, which is in a flexed position, whereas the central and palmar surface of the scaphoid fossa has well-preserved cartilage. Thus, after reduction of the scaphoid, the articulating portions of both the scaphoid and radius have preserved cartilage.

The description by Vender et al of degenerative changes in SNAC wrists describes preservation of the proximal pole of the scaphoid as it is tethered to the lunate via the intact scapholunate ligament.¹² Thus, degenerative changes are not seen in the proximal scaphoid. Indeed, Morimoto et al confirmed preservation of the proximal radioscaphoid joint surface in SNAC wrists using three-dimensional CT scans.¹³ Regardless of the location of the scaphoid fracture, the radiocarpal joint at the proximal scaphoid and lunate did not change significantly. The distal fragment of the scaphoid had degenerative changes with either the radial styloid or the dorsal lip of the radius depending on the fracture pattern. This supports the ability to preserve the scaphoid when treating SNAC wrists.

Excision of the entire scaphoid as performed in the PRC or 4CF may unnecessarily sacrifice the proximal scaphoid joint surface, particularly in SNAC wrists. From a strictly biomechanical point of view, scaphoid excision in the 4CF or PRC reduces the cartilage contact area. This may lead to focal cartilage overload and, with time, development of osteoarthritis of the residual radiocarpal joint at the lunate fossa. A cadaveric wrists study confirmed an increase in the mean total force for the lunate fossa after scaphoid excision and 4CF with no difference in the load across the triangular fibrocartilage complex area.⁵ In contrast, an SCL fusion model demonstrated an increase in scaphoid contact areas (pressure divided by total available joint surface) by 42% accompanied by a slight decrease in the lunate contact area by 12%.¹⁴ By preserving the proximal scaphoid, a more physiologic radiocarpal joint is maintained in SCL arthrodesis.

In addition, with respect to PRC, not only is the load increased across the lunate fossa as the only radiocarpal articulation but also the capitate articulation with the lunate fossa is incongruous. X-ray analysis estimated the capitate to be 60 and 64% of the lunate fossa on AP and lateral views, respectively.¹⁵ Magnetic resonance imaging evaluation of the capitate found the radius of curvature to be 37% of the lunate fossa in the coronal plane and 57% in the sagittal plane.¹⁶ Biomechanical evaluation of cadaveric wrists after PRC found the load to increase from 23.2 N/cm² in a normal wrist at the radiolunate joint to 136.4 N/cm² at the radiocapitate joint with an associated decrease in contact area from 2.08 to 0.30 cm².¹⁴ Although the capitate is approximately 60% of the diameter of the lunate fossa, the contact area was found to be only 14% of the lunate contact area. This may be a result of the four subfacets of the capitate, thus the capitate articular surface is not as smooth as the lunate.¹⁷

Few studies exist with long-term follow-up after PRC or 4CF.^{6,18-20} Of 17 patients after PRC, Di Donna et al found three patients with no loss of radiocapitate joint space, seven patients with reduction in the joint space, and complete loss in seven patients.¹⁸ In addition, they report failure in patients who had this procedure at less than 35 years of age. The 10-year follow-up of PRC patients by Jebson et al found flattening of the proximal capitate in 6 of 18 patients and moderate to severe arthrosis in 4 of 18 patients.⁶ It is important to note that the radiographic changes did not correlate with degree of wrist pain in that series. Proponents

Table 3 Comparison of SCL Arthrodesis Results

	No. of Cases	Healed, %	Follow-Up, Mo	Pain	ROM Flexion/Extension	Strength, % Contralateral
Rotman et al ²³	21	81	28	Reduced-80%	65°	70
Simmen et al ²⁴	21	100	19	Reduced-100% Pain free-81%	57°	–
Viegas et al ²⁵	6	100	18	Reduced-100%	50% contralateral side	50

SCL, scaphocapitolunate; ROM, range of motion.

of the 4CF cite a more congruent joint when the lunate is preserved as compared with capitate articulating with the lunate fossa. However, the increased load across this joint can also lead to arthritic changes. In one study of 37 patients after 4CF with an average of 97-month follow-up, 27% of patients showed arthrosis of the radiolunate joint and/or ulnar translocation.¹⁹ Investigation of patients with an 8- to 12-year follow-up after a more limited lunocapitate fusion with scaphoid excision resulted in 25% of patients developing radiolunate arthrosis.²⁰ In addition, deformation of the dorsal lunate and radiocarpal osteophytes were often observed. In contrast, of the 20 patients treated here with SCL arthrodesis, 4 patients are followed with more than 6 years without progression of osteoarthritis.

The postoperative range of motion of our patients (37-degree extension, 33-degree flexion, 8-degree radial deviation, and 15-degree ulnar deviation) decreased from preoperative values of 42-degree extension, 39-degree flexion, 13-degree radial deviation, and 20-degrees ulnar deviation. Overall, the flexion–extension arc was 70-degree post-op and the radioulnar deviation was 23-degree post-op. These values are similar to ranges given in a recent meta-analysis of PRC versus 4CF wrists. The PRC wrists had 75- to 76-degree flexion–extension arc and 9- to 32-degree radioulnar deviation arc whereas the 4CF wrists had a 64- to 76-degree flexion arc and a 13- to 30-degree radioulnar deviation arc.³ Palmer et al reported on the wrist range of motion needed for completion of activities of daily living: 30-degree extension, 5-degrees flexion, 10-degree radial deviation, 15-degree ulnar deviation.²¹ The postoperative range of motion of our patients exceeded these values in the flexion extension arc and was near to the values of radioulnar deviation. The grip strength of our patients increased postoperatively from 40% of the contralateral side to 65%. This is comparable with the 70 to 75% grip strength found in PRC and 4CF patients found in the meta-analysis by Mulford et al.³

This procedure sacrifices some range of motion for a reduction in pain. Indeed, patients will have a better functioning wrist if pain is controlled rather than restoring better wrist motion. The average pain improved 2.75 points with 13 patients being pain free postoperatively. Arthritic changes between the scaphoid and capitate, when present, are addressed with the arthrodesis. However, most of the arthritic changes in SNAC and SLAC wrists are at the distal radio-scaphoid joint with impingement particularly on radial deviation. Because a portion of the distal scaphoid and the radial styloid are resected, this impingement is eliminated. A limit-

ed excision of the radial styloid has been advocated to avoid detachment of the radiocarpal ligaments and destabilization of the wrist.²² Postoperative destabilization has not been observed in these patients despite a radial styloidectomy.

Our midterm results with this procedure have shown well-maintained joint space in cases followed-up for more than 6 years (►Fig. 2). Few studies have reported SCL fusion as a treatment for SLAC and SNAC wrists (►Table 3).^{23–25} Overall, flexion–extension range of motion and grip strength was similar to the results obtained in this publication. Pain was decreased in all series; however, it is important to note that differences exist between the operative technique of these authors; Viegas excises the entire distal scaphoid, and unlike our technique, none of the authors describe systematic radial styloid excision, which may further decrease postoperative pain.

One downside of this operation is the need for an additional source of bone graft because the scaphoid itself cannot be used for this purpose. Although 14 patients in this series had iliac crest bone grafting without complication, iliac crest donor site is a known source of morbidity.²⁶ To minimize this, a minimal incision and small curette were used to obtain the graft. The six patients who had distal radius bone grafting healed without incident.

The authors are aware that they cannot demonstrate a clear advantage of this operation over a 4CF, which is a procedure that has been widely utilized and has long-term follow-up and reliability as demonstrated in the literature. The early and midterm results in this smaller series have shown acceptable relief of pain and residual motion. In addition, the senior author did not have to revise or convert any patient into a wrist fusion or a total wrist arthroplasty, suggesting that longer survival rate of this procedure may be possible. However, longer follow-up is needed to validate this series. This study serves to propose this technique as an alternative that maintains a more physiologic wrist load. This procedure may be of particular use in the young patient with significant wrist demands.

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