PROXIMAL ROW CARPECTOMY

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Excision of the proximal carpal row has proven over the past 60 years to be an effective technique for certain disorders of the wrist, including degenerative sequelae of scapholunate ligament dissociation and scaphoid nonunions, Kienböck disease, Preissner disease, and other fracture-dislocations of the wrist. The durability of this procedure may be due to remodeling of the capitate head to the lunate fossa. Poor results have been noted in patients with rheumatoid arthritis and arthrogrypotic wrist deformities. Preservation of relatively normal cartilage of the capitate head as well as the lunate fossa is critical for success of this procedure. Average outcomes of this procedure include a wrist extension-flexion arc of 75° and grip strength of 60% of the uninvolved wrist. Revision to total wrist arthrodesis is required in 10% of patients. Approximately 90% have pain relief and can return to moderate use activity.

According to McLaughlin and Baab, excision of the proximal carpal row for carpal dislocations was recommended by Cotton in 1922. References to “proximal row carpectomy” before Stamm were, however, clearly descriptions of an entirely a different procedure. The technique referred to in these early works was excision of the entire carpus, leaving the metacarpal bases to articulate with the distal radius.

Stamm began performing excision of the proximal carpal row for late ununited scaphoid fractures in 1939 and should be credited for the first English citation of what we commonly refer to as proximal row carpectomy (PRC). He credits Gilford, Bolton, and Labrinudi’s work on the mechanics of the wrist joint as the basis for this procedure. His concept was that pain is related to either stretching or compression of sensitive tissues and that a gap would be formed by excision of the proximal carpal row, which when closed would relax the stress on these surrounding tissues. He noted that partial excision of the carpal row was destructive and would not relax the tissues as was possible with PRC. Stamm’s first report on this procedure in 1944, although lacking quantitative follow-up, was a concise and enlightening 2-page report. He believed an arthrodesis would lead to a strong and painless wrist, but certain occupations required mobility. Although the number of patients was not given, he reported that all patients had 50% to 70% normal range of motion and grip almost equal to the opposite side. His indications for PRC were ununited scaphoid fractures and avascular necrosis of the lunate; contraindications included articular damage to the distal radius and patients involved in heavy manual labor.

Stamm questioned the durability of his procedure and said, “It is not yet possible to say how long the
new joint will last.” He did mention, however, that a total wrist arthrodesis would be greatly facilitated by the previous PRC.

Numerous articles have been published on PRC for a wide variety of wrist deformities. The first large, well-documented series in the literature was in 1964 by Crabbe, who reported PRC in 24 patients whose diagnoses included scaphoid fractures, Kienböck’s disease, carpal dislocations, and carpal fracture-dislocations. Since Crabbe’s article, numerous surgeons have recommended PRC as a motion-preserving procedure of the wrist. Despite the number of different publications with variable lengths of follow-up, only a few large series exist in the literature. Comparison of results among studies is difficult because the methods of reporting differ, as well as other variables including severity of trauma, degree of deformity, cause of disorder, duration of symptoms, length of follow-up, and differences in rehabilitation. However, review of the larger series shows that moderate pain is persistent in only a small percentage of patients and that patient satisfaction is very high. Wrist motion has been shown to range from a modest decrease to the same as preoperative values. Grip strength has been reported to vary from 20% to 30% loss to 64% to 100% of the uninvolved side.

Surgical Considerations

Successful outcomes after PRC depend on relatively normal articular mating surfaces between the head of the capitate and the lunate fossa. Patients with midcarpal degenerative changes are not considered candidates for this procedure. The articular cartilage of this new “radiocapitate” joint should be supported by bone of reasonable quality. Multicystic carpal disease, which may weaken the capitate head subchondral support, and lunate facet or capitate head subchondral cysts, such as those in patients with rheumatoid arthritis, are relative contraindications to this technique.

Frequently, the condition of the articular surface of the head of the capitate cannot be determined from plain radiograph films and can only be evaluated by visual inspection. Therefore, an alternative procedure should be considered if significant degeneration of the capitate head is encountered intraoperatively.

The geometry of the lunate facet may affect the choice of surgical technique. Extension malunions of the distal radius or significantly increased radial inclination may predispose to dorsal and ulnar translation of the capitate, respectively, and should be factored into the surgical decision-making process. Pre-existing ulnar translation can potentially be increased with excision of the proximal carpal row.

Disease-Specific Results

Scapholunate Dissociation Wrist Deformity

Scapholunate advanced collapse (SLAC) is a common arthritic condition for which PRC is indicated. Watson and Ballet described the 3 progressive stages in this condition: The radial styloid and the adjacent scaphoid are involved in stage I, the proximal scaphoid pole and radial fossa degenerate in stage II, and capitolunate joint arthritis marks stage III. In SLAC deformities the radiolunate joint surfaces rarely are involved and are the basis for most wrist-motion-preserving procedures. Midcarpal degenerative changes usually preclude procedures relying on relatively normal capitate head cartilage such as PRC. Therefore, PRC has been mainly used for stage I and II SLAC wrist disorders.

Scaphoid Nonunion Advanced Collapse (SNAC) Wrist Deformity

Chronic scaphoid nonunions frequently result in radioscaphoid degeneration and can be treated with PRC in the absence of midcarpal degeneration. In fact, sequelae of scaphoid nonunions account for more than half of all cases reported in the literature. Many of the cited articles consider chronic scaphoid nonunions and wrist degeneration from scapholunate ligament disruption collectively as SLAC deformities. These two disorders (SLAC and SNAC) follow similar pathways of degeneration and have analogous treatment algorithms.

Kienböck Disease

Many publications on PRC include patients with Kienböck disease, but Kienböck disease has been the focus of only a few reports. Satisfactory results were reported by Begley and Engber (1994) for Lichtman stages IIIa and IIIb. Wrist motion did not decline, grip strength averaged 72% of the uninvolved side, and all patients returned to their previous jobs. The outcomes were noted to be inferior, however, when PRC was compared with lim-
ited wrist arthrodeses in a group of patients who had more advanced Kienböck disease. These surgeons suggested that the lunate fossa cartilage is different in Kienböck disease than in SLAC deformities. Despite this concern, Tomaino et al. reported that only minimal radiocapitate arthritis developed in 8 patients who had PRC for Kienböck disease with follow-up from 2 to 9 years. Moreover, wrist extension/flexion arc was 30° to 95° and grip strength, corrected for dominance, was 58% to 100% of the uninvolved side.

Wrist Fracture-Dislocations

Acute and subacute wrist fracture-dislocations can be satisfactorily managed by PRC. In the absence of osteochondral damage to the radiocapitate surfaces, PRC offers a simplified approach for motion preservation. McLaughlin and Baab in 1951 reported that at an average follow-up of 4.6 years (range, 1.5 to 7 years), all 4 of their patients treated by PRC for wrist fracture-dislocations were able to return to work without pain and with normal grip. No revisions were necessary.

Rettig and Raskin (1999) reviewed their results in 12 patients with unreduced and acute nonreconstructable wrist fracture-dislocations treated over a 7-year period. All were treated a minimum of 8 weeks after injury. Volar and dorsal incisions were routinely used, the volar for excision of the lunate and the dorsal for excision of the triquetrum and scaphoid. Marked pain relief was noted in these patients with stage III and IV perilunar dislocations at follow-up from 2 to 7 years. Inoue and Miura in 1990 found that patients with perilunar dislocations treated with PRC fared less favorably than did patients with Kienböck disease. The severity of the injury influenced the functional outcomes: patients with crush injuries had worse results than patients whose injuries stemmed from outstretched falls.

Scaphoid Osteonecrosis

Although osteoarthritic conditions secondary to radioscaphoid degeneration can be grouped together for treatment algorithms, scaphoid osteonecrosis is a rare condition that is readily treated by PRC. PRC for scaphoid osteonecrosis has rarely been reported. Jorgensen reported 8 patients with an average age at operation of 34 years who had osteonecrosis of the scaphoid. At 3 to 17 years after PRC, 6 patients reported no pain with heavy use, and 7 of 8 were rated as good to excellent results despite “some weakness of grasp” and 36% loss of motion. PRC also consistently relieved pain and improved motion in the small series of patients with Preiser disease, nontraumatic osteonecrosis of the scaphoid, reported by DeSmet et al.

Rheumatoid Arthritis

PRC for rheumatoid wrist deformities was first reported by Ferlic et al. in 1991. These surgeons did not recommend PRC for patients with rheumatoid arthritis, because only 2 of 8 rheumatoid arthritic patients had satisfactory outcomes. Reasons for failure included persistent pain, tendon imbalance, loss of grip strength, and the need for subsequent surgery. Culp et al. similarly reported failures in all 3 rheumatoid arthritis patients treated by PRC in a multicenter study. Therefore, alternative surgical procedures should be chosen for management of the painful rheumatoid arthritic wrist.

Wrist Contracture Deformity

Arthrogrypotic wrist deformities treated with PRC yield uncertain results according to Wenner and Sapiera (1987). Four of their 5 patients, aged 8 to 12 years at the time of surgery, needed subsequent surgery. However, in 1976 Omer and Capen found uniform satisfaction in patients with wrist flexion deformities secondary to spastic paralysis. Most of their 14 patients had cerebral palsy and had concomitant tendon transfers to the extensor surface of the forearm. They cautioned that the distal scaphoid should be left in place to reduce the likelihood of ulnar translation. It has been our experience that positional change of the wrist in the absence of additional procedures is unlikely to be long lasting with PRC alone.

Technical Considerations

Excision of the proximal carpal row is most commonly performed through a dorsal approach, although a palmar approach, a combined dorsal and volar approach, and an arthroscopic technique have been described. The dorsal wrist capsule can be accessed through a cosmetic incision oriented transversely in an extension crease just distal to Lister’s tubercle. More commonly, a straight longitudinal or curvilinear incision that allows extensile exposure is used, through which a total wrist or intercarpal arthrodesis can be
performed. The transverse or cosmetic procedure, however, can be safely used in patients in whom the condition of the articular surface of the head of the capitate is known either by previous arthroscopic examination or by radiographic evidence of stage I or stage II SLAC wrist deformity. Regardless of the incision chosen, after the skin is opened, blunt dissection is carried down to the extensor retinaculum. The extensor pollicis longus is located and unroofed along its ulnar margin, and dissection is carried down to the radiocarpal joint. The fourth dorsal compartment is located, and a self-retaining retractor is placed between the extensor pollicis longus and radial wrist extensor tendons radially and the common extensor tendons ulnarly. The dorsal wrist capsule is then exposed. The terminal branch of the posterior interosseous nerve in the radial floor of the fourth extensor tendon compartment can be dissected free, gently retracted distally, and electrocauterized to allow it to retract into the fourth dorsal compartment proximal to the radial carpal joint. The dorsal capsule is reflected away from the distal radius in an inverted T fashion (Fig 1A). This exposure allows clear inspection of the mating articular surfaces of the radioscapoid, radiolunate, scaphocapitate, and capitolunate joints. Healthy appearing articular surfaces of the head of the capitate are then removed. The transverse capsular incision is then closed with a single suture and skin staples are applied.

FIGURE 1. Technique for PRC through a dorsal approach. (A) Distally-based, inverted-T capsular dissection off dorsal rim of distal radius. (B) Exposure and morcelization of scaphoid and lunate between the second and fourth dorsal compartments. A radial styloidectomy (optional) may be performed. (C) Exposure of triquetrum between fourth and fifth extensor compartments for triquetrum excision.
capitate and lunate fossa are verified. Great care is taken to protect the head of the capitate and lunate fossa during excision of the scaphoid, lunate, and triquetrum. Excision can be aided by the use of a small osteotome and mallet to break the carpal bones into smaller pieces (Fig 1B). I prefer to excise the scaphoid first, followed by the lunate, and then the triquetrum. Retraction of the fourth dorsal compartment tendons radialward improves access to the triquetrum through the interval between the extensor digitorum communis and extensor digiti quinti proprius (Fig 1C). Small rongeurs assist in removing these small fragments and redundant synovium from the volar capsule. An assistant providing traction to the hand will open the radiocapitate articulation sufficiently to allow verification of complete proximal row carpal excision.

Impingement of the trapezium on the radial styloid is uncommon because the trapezium lies volar to the radial styloid. However, intraoperative assessment for impingement can be done by keeping the capitate head in the lunate fossa and placing the hand through a range of motion. If trapezium-radial styloid impingement occurs, a radial styloidectomy is performed. Subperiosteal dissection is performed carefully over the tip of the radial styloid to avoid injury to the first dorsal compartment tendons, which are held closely to the radial styloid. In general, the radial styloid can be removed flush with the lunate facet. A small osteotome and mallet, as well as sharp subperiosteal dissection, simplify this portion of the procedure.

The longitudinal portion of the capsule is closed with 2-0 braided absorbable suture. The transverse limbs of the capsule are not sutured to the dorsal rim of the radius. A one-eighth-inch suction drain is placed into the radiocarpal joint and brought out through the skin of the dorsum of the hand. The skin is approximated with 2-0 braided absorbable suture before skin closure with interrupted monofilament sutures. The wound is anesthetized with suitable, long-acting local anesthetic, and a soft compressive dressing and a sugar tong splint are applied.

**ALTERNATIVE SURGICAL PROCEDURES**

The presenting wrist deformity often influences both the surgical approach and the alternative procedure chosen. The condition of the capitate head may differ from what is indicated by radiographs, and the consent form should permit the surgeon to alter his surgical course (Fig 2). Techniques available for restoring the normal anatomy are beyond the scope of this article, and management of dynamic scapholunate dissociations or scaphoid fractures without radioscaphoid degeneration are not discussed. However, restoration of normal anatomy in static scapholunate ligament

![Figure 2](image-url)
disassociation is difficult, and a limited arthrodesis, such as a scaphotrapezial-trapezoid fusion, or PRC may be indicated even in the absence of radioscaphoid degeneration (Fig 3).

Four-Corner Fusion

Scaphoid excision and capitate-lunate-triquetrum-hamate arthrodesis (CLTH, or 4-corner arthrodesis) requires preservation of the lunate fossa cartilage. This technique is especially useful in SLAC wrists with degenerative midcarpal arthritis and is the most commonly used technique when significant capitate head articular defects are present. However, this operation can be used as an alternative to PRC in early-stage SLAC in which only radioscaphoid degeneration is present. After the description of the technique by Watson and Ballet in 1984, other surgeons have documented its efficacy. Ashmead et al reported an average extension/flexion arc of 72°, 12% impingement of the capitate on the dorsal radius rim, and 2% nonunion. Other surgeons reported nonunion rates ranging from 4.3% to 17.6%. Most of the problems with CLTH fusion have been from prominent hardware used for dorsal fixation in the 4-bone complex, especially staples. Colinear centering of the capitate over the lunate by whatever fixation means should reduce the frequency of this problem. In addition, newer recessed dorsal plates appear to avoid dorsal impingement.

PRC has compared favorably with the 4-corner arthrodesis for SLAC deformities. In a group of patients with PRC, the extension-flexion arc was reported to be 115° and grip strength 94% of the opposite hand, compared with 95° and grip strength of 74% in the CLTH group. Three failures were noted in the CLTH group, which were successfully converted to total wrist arthrodesis.

Capitolunate Arthrodesis

Fusion of the capitolunate joint is another motion-preserving alternative to PRC and to other limited wrist arthrodeses in the treatment of wrists with midcarpal degenerative arthritis and normal radiolunate joint articulation. High rates of nonunion were reported when fusion of the capitolunate joint was not combined with excision of the triquetrum. Despite a nonunion rate of 33%, Kirschenbaum et al reported good pain relief, a flexion/extension arc of 60°, good strength, and patient satisfaction in 12 of 18 patients who successfully obtained solid capitolunate fusion. Excision of the scaphoid and triquetrum and arthrodesis of the capitolunate joint with subchondral screws in a series of 14 patients lowered the pseudarthrosis rate to 14% (Fig 4). The average flexion/extension arc was 62°, with no significant pain and good strength in all patients.
extension arc was 53°, and grip strength was 71% of the opposite side. These values are similar to those reported after 4-corner arthrodesis but lower than those reported in some of the series on PRC.

**Distraction-Resection Arthroplasty**

When the capitate or lunate fossa has significant cartilage or bone destruction, some surgeons have recommended capsular resurfacing of the capitate head. In 1989, Fitzgerald et al described a technique they called distraction resection arthroplasty (DRA) in which the dorsal capsule is interposed between the cut surfaces of the capitate and hamate and distal radius (Fig 5). Distraction is maintained by a Kirschner wire for 6 to 8 weeks. A comparative study between DRA and PRC found that, despite conver-
ion to total wrist arthrodesis in 3 of 14 DRA wrists and 1 of 9 PRC wrists, the pain relief, wrist range of motion, and grip strength results were similar. Salo-
man and Eaton showed similar favorable clinical results in a small series of patients with their capsular interposition technique, which they attributed to the broader force distribution on the distal radius.

Partial Scaphoid Resection

Chronic scaphoid nonunions with degeneration between the distal scaphoid fragment and the radius can be treated by excision of the distal scaphoid segment (Fig 6). Although PRC would be possible in this disorder because of the absence of midcarpal degeneration, Malerich et al reported 13 of 19 patients with complete relief of pain after the procedure. Moreover, at an average follow-up of 49 months, range of motion improved 85% and grip 134%. All patients had preoperative carpal collapse, and only 1 patient was converted to a wrist arthrodesis, although there were 3 with progressive arthritic change.

Total Wrist Arthrodesis

Total wrist arthrodesis (TWA) is a reliable pain-relieving procedure and sometimes the only reasonable and predictable option for heavy demand use. Achieving a total fusion may be simplified by a previous PRC. Dorsal dynamic compression plates are most commonly used in non-osteopenic wrists. Fusion of the capitate-third metacarpal base frequently is done, and plate irritation may require hardware re-
moval. Clendenin and Green reported several wrist fusion techniques, with a nonunion rate of 17% and minor complications including transient nerve palsy and superficial skin necrosis in 23% of patients. Using compression plate fixation, however, a 93% rate of union can be expected.

Complications

Complications associated with PRC are infrequent. Sensory branch irritation, superficial or deep infection, hematoma, and reflex sympathetic dystrophy are very rare. Revision surgery after PRC is required in 5% to 10% of patients. Total wrist arthrodesis was the most common revision surgery in several large series, including those of Crabbe, Neviaser (1983), Nevi-
aser (1986), Green, Fitzgerald et al, Inoue and Miura, and Imbriglia et al. Successful wrist arthrodesis eliminated pain in most patients.

The use of radiocapitate Kirschner wire fixation may be associated with an increased complication rate. A review of 38 patients in our series indicated that complications occurred only in those patients who were treated with provisional radiocapitate Kirschner wire fixation. These complications included superficial pin track infection, transient sensory nerve irritation, and subchondral defects in the head of the capitate (Fig 7). Without the use of radiocapitate pin fixation, complications were infrequent.

Radial styloid impingement after PRC may require revision surgery for styloid excision. Intraopera-
tive evaluation for impingement may reduce the occurrence of this problem. Green advocated a limited radial styloidectomy in most patients, especially when there is foreshortening of the distal carpal row from instability, and he advised against an excessive styloidectomy because ulnar translation may occur.

Progressive Radiocapitate Degeneration

Many surgeons have noted no significant radiocapitate degeneration; however, a time-dependent change in the mating surfaces of the capitate head to the lunate fossa has been described by Imbriglia et
Comparison of preoperative and postoperative radiographs in their group of 27 patients followed up for 4 years showed remodeling of the capitate head to the lunate. The radius of curvature of the capitate head was approximately two thirds that of the lunate, and the radii of curvatures of the capitate head and lunate fossa more closely approximated each other with time. Reports of symptomatic progressive radiocapitate degeneration are rare. However, Fitzgerald et al. found radiocapitate degeneration in 5 of 9 patients, including subchondral cysts, marginal spurring, and small osteoarthritic cysts. None of these findings were of clinical significance. Plain radiographic and cineradiographic studies by Luchetti et al. also showed mild to moderate degenerative arthritis in most patients, but most also rated their outcomes as excellent. Our study of 38 patients also agreed with this finding: Although 40% had focal cystic changes in the capitate head, 86% were satisfied with their functional outcomes.

Moreover, cineradiographic evaluation of wrist motion after PRC shows that the head of the capitate is not always in contact with the distal radius. In extremes of wrist extension and flexion and radial and ulnar deviation the capitate head does not articulate with the lunate facet.

**Rehabilitation**

Rehabilitation after PRC has varied from progressive mobilization at 10 days after surgery to immobilization in a long-arm cast for 2 to 2 weeks, followed by a short arm cast for 3 to 4 weeks. We routinely use the early mobilization program, as originally outlined by Stamm and advocated by others.

PRC is performed on an outpatient basis, and instructions for rehabilitation are given before patient discharge. A suction drainage catheter is removed at 24 to 48 hours, depending on drainage output. Ele-
vation and ice are recommended for the first 48 to 72 hours after surgery. Before the first postoperative visit, hourly active and passive thumb and finger motions as permitted by the sugar tong splint are encouraged.

At the first postoperative follow-up visit, approximately 10 days to 2 weeks after surgery, the sugar tong splint is removed, and posteroanterior and lateral radiographs are obtained. Satisfactory positioning of the head of the capitate within the lunate fossa is to be expected and has been my experience with over 60 patients. Mild to moderate wrist, hand, and finger swelling is normal; however, sutures usually can be safely removed at this time. Wound reinforcement with skin adhesive and Steri-strips (3M Corp, St. Paul, MN) may be necessary. The patient continues an hourly home motion program emphasizing methods to reduce swelling and improve motion. Active and gentle passive wrist extension and flexion, radioulnar deviation, and circumduction exercises are added to the thumb and finger range of motion program.

A removable, commercially available canvas wrist splint is used between exercises. Wound massage is begun over the dorsal surgical scar to break up adhesions and promote tendon gliding. Rarely is formal physical therapy necessary during the first 6 weeks after surgery.

The second postoperative visit occurs at 6 weeks, when objective measurements are taken to evaluate wrist extension, flexion, and radial and ulnar deviation arcs. At this point, grip strengths and pinch strengths are measured to objectively compare progression from the preoperative state. Swelling may be increased in a few patients, and formal physical therapy may be required for edema control and further instruction on wrist, thumb, and finger motions. I have found anti-inflammatory and short-term parenteral steroid administration of benefit. The removable wrist splint is discontinued based on the patient’s level of comfort.

The patient is seen at 3 months for the third postoperative visit, when objective measurements are again obtained for wrist motion as well as grip and pinch strengths. Full activities are encouraged. The patient is seen at 6 and 12 months postoperatively for assessment of progressive return of wrist motion as well as strength achievement. Wrist motion and grip strengths slowly improve during the 3-to-12–month period. A 60% grip strength of the uninvolved side and 75° arc of motion are average goals for most patients.

CONCLUSION

The complex, intercalated human wrist joint is subject to numerous disease and injury patterns, resulting in disabling pain, stiffness, and subsequent loss of function. After failure of conservative measures, various surgical procedures have been devised to improve function by alleviating pain. Motion-preserving procedures have focused on the focal sites of cartilage loss as a basis for surgical reconstruction. PRC relies on capitate head and lunate fossa cartilage preservation. Numerous articles have documented the effectiveness of this procedure in reducing pain and preserving motion in a wide variety of wrist pathology. Osteoarthritic wrist disorders, as in stage II SLAC and scaphoid nonunion sequelae; some acute carpal fracture-dislocation patterns; and Kienböck and Preiser disease can be effectively managed by PRC. Alternative motion-preserving wrist procedures have clear literature documentation and usually are reserved for disease processes with midcarpal degeneration.

PRC is a simple operative technique, but iatrogenic damage to the capitate head and lunate fossa must be avoided. Green15 noted that PRC “is not an elegant operation” because the scaphoid, lunate, and triquetrum are removed piecemeal. Postoperative immobilization is minimal and accompanied by an uncomplicated postoperative course. Subjective and objective outcomes have compared favorably with more complex procedures and, added to the fact that complications and failures are few, this should make PRC, rather than a salvage operation, the preferred procedure in a variety of wrist disorders.

REFERENCES