Technique: Osteochondral Grafting of Capitate Chondrosis in PRC

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Abstract

Background Proximal row carpectomy (PRC) is a useful treatment option for wrist arthritis, but the operation is contraindicated when there is arthritis of the capitate head. We describe a technique that involves resurfacing of a capitate that has focal chondrosis, using an osteochondral graft harvested from the resected carpal bones.

Materials and Methods PRC patients who had a focal area of capitate chondrosis underwent osteochondral grafting of the capitate. Pre- and postoperative pain level, employment status, motion, grip strength, and Modified Mayo Wrist Scores (MMWS) were assessed. Postoperative Disability of the Arm, Shoulder, and Hand (DASH) scores were also calculated.

Description of Technique The articular surface of the capitate is assessed for need for grafting. The proximal row is resected with the lunate removed intact. The arthritic area is prepared. The graft is taken from the lunate and placed in the prepared site of the capitate.

Results Eight patients (average age of 53 years) were followed for 18 months. Pain: Preoperatively, moderate to severe in 7 patients; postoperatively, mild to no pain in 7 patients. Motion: Preoperative, 84° (74% of the contralateral side); postoperative 75° (66%). Grip Strength: Preoperative, 29 kg (62%); postoperative, 34 kg (71%). Mayo Wrist Score: Preoperative, 51 (poor); postoperative, 68 (fair). Average postoperative DASH score was 19.5. Follow-up radiographs showed that 75% of patients had mild to no degeneration.

Conclusions Osteochondral grafting in PRC offers satisfactory results in terms of pain relief, return to work, motion, and grip strength.

Keywords
► osteochondral graft
► proximal row carpectomy

Proximal row carpectomy (PRC) has been shown in multiple studies to be an effective motion-preserving procedure for wrist arthritis. The operation consists of resection of the scaphoid, lunate, and triquetrum.1 The proximal capitate and lunate fossa of the radius form the new wrist articulation, which makes the ideal patient free of degenerative changes at those articular surfaces.2–8 Various authors, as well as the senior author, have maintained that when there is mild degeneration of these articular surfaces, PRC can still provide good to excellent results.2–6,9

However, as wrist arthritis progresses, as in stage III scapholunate advanced collapse (SLAC) wrist or stage II/III scaphoid nonunion advanced collapse (SNAC) wrist, the proximal capitate becomes arthritic. With advanced degeneration, alternative surgical procedures include scaphoid excision, four-bone fusion, and wrist fusion. However, there...
may be reasons to favor a PRC despite capitate arthritis, including a shorter surgical time (poor patient health status), shorter immobilization time (patient with baseline difficulties with activities of daily living), increased wrist motion (vocational or sport need), and lack of need to achieve bony union (patient may have risk factors for nonunion such as smoking). Imbriglia et al documented that a significant remodeling of the radiocapitate interface occurs following the standard PRC, which produces a “hinge-and-roll” rather than a ball-and-socket motion. In an effort to provide a broader interface to distribute radiocarpal compressive forces more evenly, Salomon and Eaton recommended resecting the proximal capitare regardless of arthritis or pristine cartilage, with or without placement of a capsular interposition. Their approach obviated any regard for the status of the capitare cartilage. Our approach respects cartilage and seeks to improve the status of the capitare cartilage if there is a focal defect.

There are few reports in the literature of this type of approach. Salon and Hémon described using an osteochondral graft from resected carpal bones in two cases of Kienböck disease; these grafts were used to resurface areas of chondral damage over the capitare and the lunate fossa of the radius. Langer et al described an osteochondral transfer of a scaphoid segment into the lunate fossa in PRC in two patients with stage IV of Kienböck disease. Our technique expands the indications for a PRC. In this paper we describe the technique and review the outcomes we have previously published.

Patients and Methods

Between 2004 and 2005, the articular surface of the capitare was evaluated in all patients having a PRC. Prior to surgery, informed consent was obtained for each patient to include possible osteochondral grafting. The status of the capitare articular cartilage was graded using a modified Outerbridge classification: grade I: softening of the articular cartilage; II: fibrillation or superficial fissures of the cartilage; III: deep fissuring of the cartilage without exposed bone; IV: exposed bone. Patients with grade II to IV chondrosis that was less than 10 mm in diameter were enrolled in the study and underwent capitare resurfacing with osteochondral grafts. The location, grade of chondrosis, and size in both the volardorsal direction and the radioulnar direction were recorded, and the location of the graft harvest was noted.

We recorded the age, sex, dominance, operative side, and previous surgeries. Preoperative pain level (none, mild, moderate, severe), work status (regular employment, restricted, able to work but unemployed, unable), motion, and grip strength (using a Jamar dynamometer set at III and adjusted for dominance assuming the dominant extremity is 10% stronger than the nondominant extremity) were obtained from clinic notes and patient interviews. Postoperative data including pain level, work status, motion, grip strength, and Disability of the Arm, Shoulder and Hand scores (DASH; 100 being the worst and 0 being the best possible score) were obtained at postoperative office visits or physical therapy visits. With the available data, pre- and postoperative Modified Mayo Wrist Scores (MMWS) were calculated (excellent, 90–100 points; good, 80–90; fair, 65–80, and poor, less than 65). A Student’s t-test was used to compare the pre- and postoperative pain level, work status, motion, grip strength, and MMWS. Pre- and postoperative radiographs were evaluated for degenerative changes of the lunate fossa using the classification proposed by Culp. Degenerative joint disease was rated mild if there was only a decreased joint space, moderate if there was a decreased joint space with adjacent subchondral sclerosis, and severe if there was collapse and cyst formation. The radiographic degeneration and functional outcome was compared using analysis of variance with $\eta^2$ to evaluate the relationship between the radiographic findings and continuous variables of function (i.e., wrist motion, grip strength, MMWS). For categorical variables (i.e., pain level and work status), Cramér’s $V$ correlation coefficient was used.

Eight patients (seven male, one female) with an average age of 53 years (range: 39–67 years) were enrolled in the study. The average follow-up was 18 months (range: 8–25 months). The dominant extremity was involved in six patients. Half the patients were diagnosed with SLAC wrist (two with stage II and two with stage III), and the rest had the diagnosis of SNAC wrist (three with stage III and one with stage IV). Five patients were laborers (a roofer, a welder, a power company lineman, a maintenance supervisor, and a body shop manager), while the others included an administrator, a business owner, and a retired secretary.

Three of the six patients with SNAC wrist had a prior open reduction and internal fixation (ORIF). One of these three patients had two other surgeries prior to the PRC procedure. These included a carpal tunnel release, a radial styloidectomy, and a concomitant first dorsal compartment release for de Quervain syndrome. During our index procedure, one patient had a carpal tunnel release and another had a dorsal wrist ganglion excision.

Surgical Technique

A longitudinal incision is made just ulnar to the Lister tubercle. The interval between the third and fourth compartments is opened and the tendons retracted. A longitudinal incision is made in the joint capsule, and the capsule is elevated radially and ulnarily, exposing the proximal and distal carpal rows. The articular surfaces of the proximal capitare and lunate fossa of the radius are inspected for degenerative changes. If the area of chondrosis of the capitare is grade II to IV and the size is less than 10 mm, osteochondral grafting can be considered (Fig. 1). As a general guideline we prefer to resurface with a single graft that is less than 10 mm in diameter for concerns of fracture of the capitare if the grafting if more than 10 mm.

If grafting is to be performed, the next step is a proximal row resection. Because the scaphoid is generally the most arthritic, and therefore a poor source of an osteochondral graft, the scaphoid is mobilized, osteotomized into smaller pieces, and excised. Care is taken to preserve the radioscapocapitate and radiolunotriquetral volar ligaments. The lunate is usually the least affected in terms of degeneration...
and will most likely serve as the osteochondral graft source. Thus, this bone is removed intact. The triquetrum is also removed intact, in case the graft needs to be harvested from it. After the carpal bone resection, the wrist motion is checked to rule out impingement with radial deviation. If necessary, a radial styloidectomy is performed.

At this point, the site of capitate chondrosis is prepared. A sizer from the Osteochondral Autograft Transfer System (OATSI Arthrex, Inc, Naples, Florida) is used to determine the size of the graft that will be needed. A 2.4-mm guide pin is drilled into the center of the site of chondrosis, perpendicular to the articular surface. Then, the appropriately sized cannulated headed reamer is drilled over the top of the guide pin to the depth of 10.0 mm (Fig. 2). An alignment rod is used to tap the bed of the recipient site and can be used as a guide to the direction of graft placement. The resected carpal bones are evaluated for the most pristine articular cartilage, where an appropriately sized graft can be harvested. Using a donor harvester, the graft is obtained from the stabilized carpal bone on a sterile back table. The harvester is tapped with a mallet through the whole carpal bone. Then, using the push pin puncher, the graft is backed out of the harvester so that 10.0 mm of graft remains in the harvester. The excess is rongeured to an even edge (Fig. 3). The graft is then inserted into the capitate using the alignment rod as a guide to direction. Gentle taps, to prevent chondrocyte damage, are used to place the articular surface of the graft flush with the surrounding cartilage (Fig. 4).

A capsular closure is performed with interrupted 3-0 nonabsorbable sutures. The retinaculum is closed, followed by skin closure and application of a wrist splint. The sutures are removed at 2 weeks postoperative, and occupational therapy is started. Patients are told before surgery that it will take 4 to 6 months before there is pain-free range of motion.
Results

Surgical Findings
On intraoperative examination, two patients had grade II chondrosis (fibrillation), four patients had grade III (deep fissuring without exposed bone), and two had grade IV (exposed bone). All defects measured $5.0 \times 5.0$ mm, except in two patients whose defects measured $10.0$ (radioulnar direction) $\times 6.0$ (volardorsal) mm and $5.0 \times 6.0$ mm. All grafts in the study were $10$ mm long and $6$ mm in diameter, even in the two patients with the largest defects. Because of the irregular nature (not perfectly oval or circular) of the chondrosis and the fact that the measurements were of the maximum diameter of the chondrosis and did not necessarily represent the average size of the lesion, the operating surgeon believed that a $5$ mm diameter graft best resurfaced these areas. Seven of the eight osteochondral grafts were harvested from the lunate, except for one case in which the graft was harvested from the triquetrum.

Pain Level
Preoperatively, one patient responded that the pain was mild, two patients responded moderate, and five responded severe. Postoperatively, four patients reported no pain, three reported mild pain, and one reported moderate pain.

Employment Status
Preoperatively, one patient reported inability to work, two reported restricted employment, and five reported regular employment. Postoperatively, two patients reported restricted employment and six reported regular employment.

Range of Motion
Preoperatively, the total arc of motion of the wrist was $84^\circ$ (74% of the contralateral side) with an average extension of $34^\circ$, and an average flexion of $50^\circ$). Postoperatively, the total arc of motion was $75^\circ$ (66% of the contralateral side) with an average extension of $37^\circ$, and average flexion of $38^\circ$.

Grip Strength
Preoperatively, the average grip strength was $29$ kg, or $62$% of the contralateral extremity adjusted for dominance. Postoperatively, the grip strength increased to $34$ kg, or $71$% (73% when not adjusted for dominance) of the contralateral side, which was not a significant change ($p > 0.05$).

Modified Mayo Wrist Score and DASH Score
The preoperative MMWS was $51$, which corresponds to a poor score, while postoperatively the score significantly increased to $68$, which is rated as fair. Three patients improved from poor to fair, and one improved from poor to good. Two fair patients were unchanged. Only postoperative DASH scores were available, and the patients scored an average of $19.5$ (range, $0.8 \text{–} 46.7$).

Radiographic and Imaging Evaluation
The radiographs were evaluated pre- and postoperatively. On follow-up evaluation, two patients had no arthritis of the lunate fossa or proximal capitate, four had mild degeneration (decreased joint space alone), and two had severe degeneration (collapse and cyst formation) (Figs. 5a, b; 6a, b). Radiographic degeneration did not correlate with the pain level, work status, motion, grip strength, or wrist score. One postoperative magnetic resonance image (MRI) at 21.3 months showed bone incorporation of the graft and the presence of a viable cartilage graft (Fig. 7a, b).

Complications
No complications were encountered in this series of patients. No patients required further surgery.
four patients had only occasional pain with strenuous activi-
ty. The grip strength improved from 19 to 26 kg following
surgery. The four patients having dorsal capsule interposition
achieved an average extension/flexion arc of 111° (range, 95–
176°), the fascial interposition patients achieved an arc of 88°
(range, 55–176°) and the single patient treated with distraction
achieved 90°. Three patients had partial carilage resec-
tion but no interposition or distraction and achieved an 80°
of total extension/flexion arc. Because of the carilage resec-
tion, radiographic changes of degeneration could not be evaluated.

Our technique enables the surgeon to improve the status of
the carilage cartilage. Osteochondral grafting has been success-
fully used in treating osteochondritis dissecans of the knee.22
This technique “restores architecturally appropriate, mature
hyaline cartilage in acquired articular cartilage defects.”23 In
multiple studies including rabbit, ovine, and porcine models,
chondrocytes and osteocytes of the osteochondral graft have
been shown to survive transplantation.24–30

Osteochondral grafting has also been used in the capitel-
lum, talus, and femoral head, with graft viability proven with
second-look arthroscopy, MRI, and biopsy.31–37 The MRI of our
patient at 21 months postoperative showed bone incorpo-
ration of the graft to the capitate and the presence of graft
cartilage (Fig. 7b). Weaknesses of the study include only one
patient undergoing a MRI and no patients having a secondary
procedure where graft viability could be assessed. Other
weaknesses of this study are the lack of a control group and
the short follow-up period. Although good outcomes were
achieved in six patients, two patients developed severe capi-
tolunate degeneration in the relatively short follow-up period.

In the fingers and wrist, autogenous osteochondral grafts
have also been harvested from the carpometacarpal (CMC)
joint, toe, hamate, and ribs for multiple conditions including
fracture-dislocation, trauma, and failed trapeziectomy in
thumb CMC arthritis.38–42 Sandow advocated costo-osteoch-
dral (rib bone/cartilage autograft) replacement for the
proximal scaphoid.43 Furthermore, the distal fibula has been
used to reconstruct the distal radius after giant cell tumor
resection.44 Lastly, osteoarticular grafts from the proximal
tibiofibular joint have been used to reconstruct the scaphoid
and lunate facets in severe distal radius fractures.45

Our technique has several advantages including the lack of
donor site morbidity since the grafts are harvested from
resected carpal bones. There is usually sufficient healthy
cartilage to allow graft harvest since the radioulnar joint is
preserved even in advanced SLAC and SNAC wrist. Further-
more, there is no risk of disease transmission or transplant
rejection because autogenous tissue is used. Since the auto-
genous transplantation is immediate, there is no risk of
chondrocyte death due to storage. Lastly, the costs are lower
since the procedure was performed in a single stage.43

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Conflict of Interest

None

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