Radiocarpal Osteochondral Allografts for Wrist Pain Postproximal Row Carpectomy

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Abstract

Background Surgical options for patients with recurrent wrist pain after salvage procedures, such as proximal row carpectomy (PRC), are limited and primarily result in total wrist arthrodesis (TWA). Osteochondral allografting (OCA) offers an additional option to address refractory wrist pain due to arthritis while preserving some range of motion.

Case Description A 65-year-old, right hand dominant male developed chronic wrist pain, secondary to untreated scapholunate and triangular fibrocartilage complex ligament tears. The patient underwent a PRC, radial styloidectomy, and partial wrist denervation with good initial pain relief. Two years later, symptoms returned with radiographs demonstrating capitate sclerosis. A salvage arthroplasty with OCA produced relief of symptoms.

Literature Review Refractory wrist pain after salvage procedures have traditionally been managed with TWA or less commonly, wrist arthroplasty. Capitate resurfacing and interposition have expanded indications for PRC. OCA is a chondral replacement procedure that utilizes cadaveric cartilage allograft plugs to replace damaged cartilage in various articular joint surfaces. Although OCA used in the lower extremity and shoulder has demonstrated improved pain relief and return of function, it has not been reported in the wrist.

Clinical Relevance There are limited options for refractory wrist pain after salvage procedures. We present an additional alternative to TWA, by resurfacing the radiocarpal joint affected by chondromalacia after a PRC. This option offers another treatment modality for recurrent wrist pain while still preserving some element of range of motion.

Keywords

- osteochondral allograft
- radiocarpal arthritis
- wrist pain
- proximal row carpectomy

Wrist arthritis affects up to 14% of Americans. When conservative therapy fails to improve symptoms, common motion-preserving procedures include proximal row carpectomy (PRC) and four-corner fusion.[1] Recurrent, severe wrist pain persisting after these procedures can be addressed with salvage procedures such as total wrist arthrodesis (TWA) or less commonly, wrist arthroplasty.[1] Wrist arthroplasty involves the replacement of all or part of the wrist joint with hardware, biologic substitutes, or grafts. PyroCarbon implants can be used in the replacement or resurfacing of the proximal scaphoid, capitate, radiocarpal joint, and midcarpal joints in the treatment of wrist osteoarthritis.[2] These devices are generally reserved for low-demand patients, as reported complication rates can be high.[2]

Integrity of wrist cartilage is an important determinant of surgical outcomes in the wrist. In procedures such as PRC, new

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articulations are introduced between the capitate and distal radius. Preservation of these new articulation sites is paramount to persistent pain relief in patients. Unfortunately, these sites do not represent normal wrist mechanics and are subject to premature chondromalacia and ultimately arthritis. There are a few reports of autologous capitate resurfacing (CR) and capsular interposition (CI) as a means of expanding the indications for PRC by reinforcing an arthritic radiocarpal joint. This technique requires harvesting of the patient's own cartilage, is limited by the amount of viable, expendable donor-site cartilage, and also leaves behind a donor-site defect. When preexisting radiocarpal arthritis exists, autologous grafts can be taken from the recently removed proximal carpal row immediately following PRC. However, when capitate degeneration evolves over time after PRC, separate donor sites must be accessed to harvest the graft.

Chondral replacement therapies such as mosaicplasty, autologous chondrocyte transplantation (ACI), osteochondral autograft transplantation (OAT), and osteochondral allografting (OCA) have been described for use in the lower extremity.[3] Of these nonimplant solutions, OAT has been used to treat upper extremity arthritis. There are reports in the literature on the use of OAT as an adjunct procedure to PRC in the presence of capitate arthritis.[4,5] Additionally, this autologous arthroplasty has been used for the treatment of focal wrist pathologies causing pain, such as capitate avascular necrosis and scaphoid nonunions.[6] OCA is a similar procedure; however, it utilizes cadaveric cartilage allografts instead of autologous grafts, thus eliminating donor-site morbidity. Prior studies have shown it to provide pain relief and adequate return to sporting activity in the treatment of lower extremity cartilage defects.[3] However, there are no reports in the literature for its application in the wrist. This case report highlights a novel use of OCA for recurrent wrist pain following PRC as a means to avoid TWA or replacement.

Case Report

A 65-year-old, right hand dominant male laborer presented with chronic, right wrist pain. Workup demonstrated chronic scapholunate and triangular fibrocartilage complex ligament tears. Two years after initial surgical management with PRC, radial styloidectomy, and partial wrist denervation, he returned with similar complaints and radiographic evidence of capitate sclerosis (►**Fig. 1**). A salvage arthroplasty with OCA was performed. The joint capsule was accessed through a dorsal, distally based capsular flap. Minimal radiocarpal, articular cartilage was noted. First, an allograft sizer was used to approximate the coverage of the recipient site. A guide pin was inserted at a perpendicular angle to the articular surface of the distal radius. A recipient scorer was used to score the site, and a recipient site reamer overdrilled the guide pin, coring out the articular surface 12 mm in diameter and 10 mm in depth (Arthrex, Naples, FL). This process was replicated on the articulating surface of the capitate using an 8-mm ×10-mm reamer. The fresh, cadaveric cartilage allografts (LifeNet Health, Virginia Beach, VA) were inset and tapped into place with a mallet (►**Fig. 2**). Fresh allografts were stored between 1 and 10°C with a 45-day shelf life to ensure chondrocyte viability.

Additionally, a completion denervation of the wrist, concomitant cubital tunnel and carpal tunnel releases, and a Darrach procedure were performed. At a 3-month follow-up visit, the patient reported significant improvement of his wrist pain, increased range of motion, increased strength, and preserved height of the radiocarpal joint on radiographs (►**Fig. 3**). The patient endorsed maintained improvements at a 1-year follow-up, with increased grip strength. A wrist X-ray demonstrated slightly increased lucency and sclerosis of the proximal aspect of the capitate as compared with his 3-month radiograph (►**Fig. 4**). The patient's 1 year postoperative Disabilities of the Arm, Shoulder, and Hand (DASH) score was 19.17.

Discussion

Recurrent wrist pain after initial surgical management typically warrants revision, TWA, or arthroplasty. TWA is effective at eliminating pain, but it sacrifices all range of motion.[2] PyroCarbon arthroplasty utilizes nonbiologic grafts to replace articular surfaces, but they are at risk of shifting. TWA utilizes a

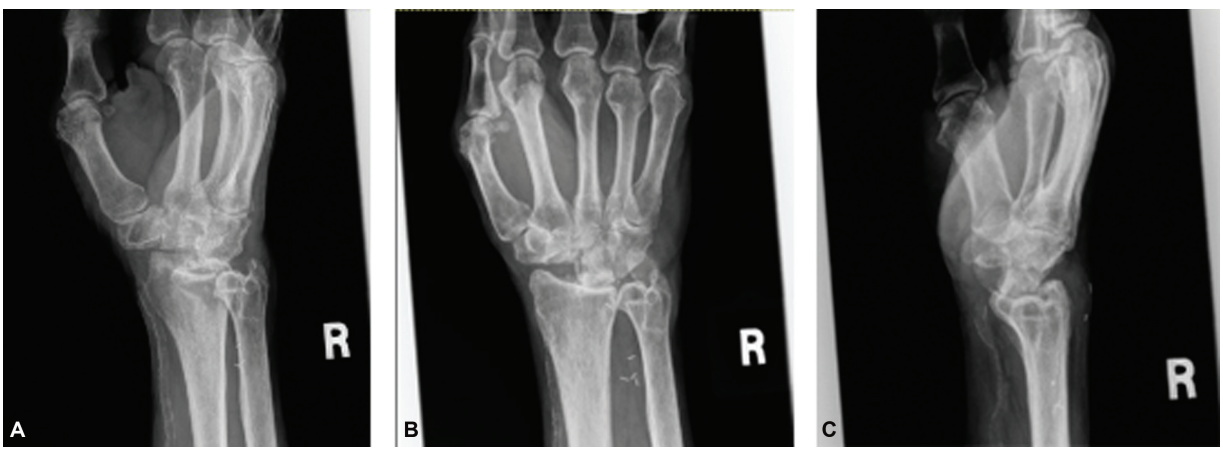

Fig. 1 The preoperative (**A**) oblique, (**B**) anteroposterior, and (**C**) lateral X-rays demonstrated flattening of the proximal aspect of the capitate with increased sclerosis secondary to impaction against the radial articular surface.

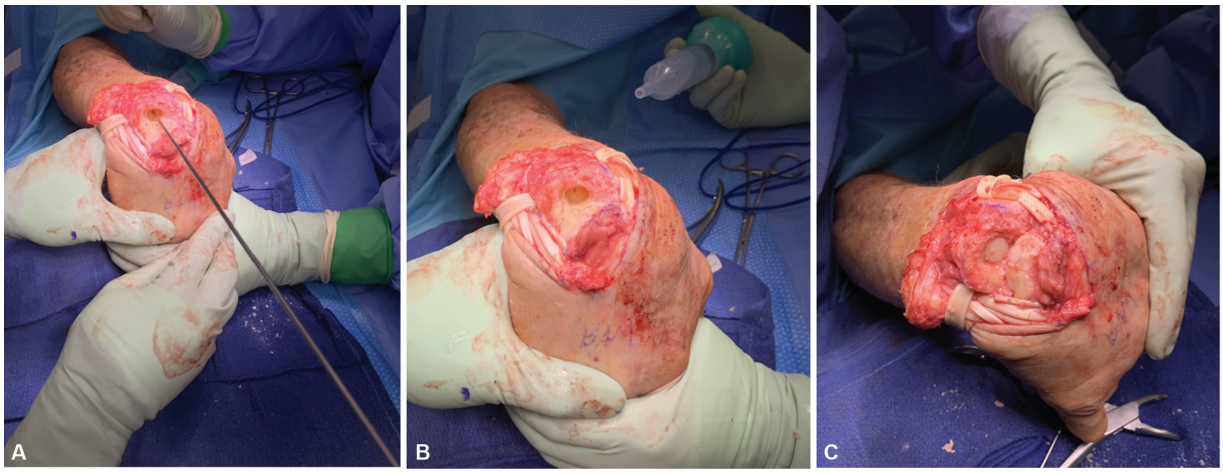

Fig. 2 Intraoperative demonstration of the (**A**) guide pin used for targeting the trajectory of the cannulated reamer creating the defect for osteochondral allograft insertion, (**B**) resulting defect from reaming of the radial articular surface. (**C**) Distal radial surface and proximal capitate with inserted allografts.

Fig. 3 Three-month postoperative radiograph without evidence of degenerative changes at the radial or proximal capitate allograft sites.

Fig. 4 One-year postoperative radiograph without evidence of significant degenerative changes at the radial or proximal capitate allograft sites. Mildly increased lucency of the proximal capitate allograft site is seen.

significant amount of hardware which carries with it a risk of nonunion and distal loosening.[2] Hand surgeons have attempted to combat the transition to arthrodesis or replacement procedures after PRC by performing ancillary procedures at the time of PRC. When capitate arthritis exists, CR and CI can be used to reinforce the new articulation between the capitate and radius, allowing PRC to become a reasonable treatment option.[7] There are two reports of CR using autologous osteochondral grafts, an OAT procedure.[4,5] These grafts were harvested from the proximal carpal bones and incorporated into the arthritic, proximal capitate at the same time as the PRC.

OAT is a chondral replacement therapy. Several other chondral replacement therapies, including microfractures, mosaicplasty, ACI, and OCA have been used in the treatment of lower extremity joint cartilage injuries.[3] Parameters such as lesion size, number of procedures, number of operative sites, donor-site morbidity, operative time, and cost all play significant roles when selecting a treatment modality. Studies comparing the use of these chondral replacement therapies in the knee have shown OCA to be most effective for large

cartilage defects (>4 cm^2).[3] ACI and microfracture are limited by a costly, two-stage procedure and the creation of a less durable and less resilient fibrocartilage, respectively.[3]

To the authors' knowledge, this is the first case describing the use of OCA in the wrist, though its application in other joints has been studied. Clinically significant decreases in postoperative pain levels and improved functional status, including return to athletic activity, have been demonstrated in OCA transplantation of the ankle, knee, and glenohumeral joints.[8] OCA exhibits high levels of comparable 5-year operation-free survival rates to OAT while avoiding donor-site morbidity and decreasing operative times.[9] A systematic review by Saltzman et al on the use of OCA transplants for humeral head defects found significant improvements in shoulder flexion and external rotation, with no cases of graft necrosis, resorption, or arthritic changes with the use of fresh allografts unlike in frozen allografts.[8] Similarly, radiographic images throughout this patient's postoperative course showed very mild increases in degenerative changes at 1 year postoperatively. Magnetic resonance imaging may better assess osseous incorporation and cartilage survival in OCA. The reported patient did not have indications for undergoing one, given his overall clinical improvement.

Regarding wrist chondral replacement, Miller et al described the successful use of OAT in the treatment of wrist and hand avascular necrosis in six patients, most commonly of the metacarpal head, capitate pole, and proximal scaphoid pole.[6] This study describes multiple advantages of this procedure including preservation of ligaments and native, healthy cartilage, and osseous integration without the need for vascularized bone grafts or hardware. They recommend limiting its use to a maximum defect size of 10 mm. Additionally, they postulate that increased depth of grafting into the native bone improves integration.[6]

The risk of donor-site morbidity and increased failure rates of OAT procedures in patients older than 40 years made OCA a more amenable choice for our patient.[3] Further research is needed to determine long-term outcomes associated with OCA transplants for wrist pathologies and to compare OCA with other salvage procedures. However, this case provides a framework for the use of OCA as an effective chondral replacement therapy for patients suffering from chronic wrist pain. Factors such as radiologic evidence of arthritis, advanced patient age, number of operations, cost, and the existence of comorbidities that could be exacerbated by donor harvest should be taken into consideration when deciding on a chondral replacement procedure.

The comparability of clinical outcomes for factors such as functional status, pain level, and range of motion between OATS and OCA in the lower extremity and the reports of the successful use of OAT in the wrist suggest that OCA can be a viable option in the repair of articular cartilage defects of the wrist.[4–6,10] With no current published data on OCA in the wrist, outcome data comparisons to OAT as an augmentation to PRC are beneficial and summarized in ►**Table 1**. Follow-up outcomes for our patient are similar to those reported by Tang and Imbriglia who used OAT to augment PRC in eight patients. Though pain levels in both our patient and Tang and Imbriglia

Table 1 Published studies documenting radiocarpal osteochondral replacement procedures during or after PRC

Study	Patients	Gender	Hand dominance	Work	Diagnosis	Surgery	Additional procedures	Follow-up period	Preoperative X-ray findings	Previous surgery	Preoperative pain	Postoperative pain	Preoperative work	Postoperative work
Bagdady et al (present study)	1	Male	RHD	Laborer	Capitate arthritis	OCA 2 y post-PRC	1. CTR; 2. CuTR; 3. Darrach; 4. additional wrist denervation	12 mo	Increased lucency of the proximal capitate	1. PRC; 2. styloidectomy; 3. partial wrist denervation	Severe	Mild	Regular job	Regular job
Tang and Imbriglia[5]	8	Seven males, one female	All RHD	Five manual labors; three office workers	SLAC or SNAC	OAT at the time of PRC	Six PRC; one CTR; one ganglion excision	8–25 mo	Mild to severe capitate degenerative changes	Three scaphoid ORIF; one CTR; one styloidectomy with first dorsal compartment release	Mild to severe	None to moderate	Five regular job; two restricted; one unable	Seven regular job; one restricted
Dang et al[4]	5	NR	NR	NR	NR	OAT at the time of PRC	NR	Up to 6 y	NR	NR	NR	Average DASH score: 37.87	NR	Regular job

Abbreviations: CTR, carpal tunnel release; CuTR, cubital tunnel release; DASH, Disabilities of the Arm, Shoulder, and Hand; NR, not reported; OAT, osteochondral autograft transplantation; OCA, osteochondral allografting; ORIF, open reduction and internal fixation; PRC, proximal row carpectomy; RHD, right hand dominant; SLAC, scapholunate advanced collapse; SNAC, scaphoid nonunion advanced collapse.

are subjectively reported, major decreases are noted following surgery. An average postoperative DASH score was reported as 19.5 as compared with our patient's 1-year postoperative DASH score of 19.17. We do not report quantitative data for this patient in regard to ROM or grip strength. However, there was preservation in both ROM and patient-reported increase in strength after surgery, likely related to the decrease in pain, which persisted 1-year postoperatively. Comparatively, Tang and Imbriglia report nonstatistically significant increases in both total arc of motion and grip strength.[5] Dang et al discuss the use of OAT in a similar fashion to Tang and Imbriglia. They do not report individual findings for their patients, but report that their results are comparable to traditional PRC.[4]

For patients with pre-PRC capitate arthritis or those who present with redemonstrated wrist pain post-PRC, OCA can be an effective tool to avoid TWA, while preventing the adverse outcomes at donor sites which may accompany autografting. To address the patient's pain and severe debilitation, a multifaceted approach which included addressing his radiocarpal cartilage degeneration was deemed necessary as an appropriate alternative to TWA. However, more comparative studies are needed to fully assess the degree of pain relief provided by OCA alone. Similar postoperative DASH scores between this patient and patients who underwent capitate OAT with adequate postoperative outcomes show immense promise for the application of OCA in the treatment of wrist pain. Additional studies may benefit from investigating the treatment of isolated capitate chondromalacia (post-PRC) to better understand response to OCA post-PRC as a stand-alone procedure, which was not appropriate in this patient. Continued comparison to alternative chondral replacement therapies such as OAT will help establish OCA as an effective tool for hand surgeons.

Conflict of Interest
None declared.

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