Cartilage-retaining Wafer Resection Osteotomy of the Distal Ulna

Jason A. Barry MD, Wadih S. Macksoud MD

Received: 16 May 2007 / Accepted: 18 October 2007
© The Association of Bone and Joint Surgeons 2008

Abstract Ulnar-sided wrist pain resulting from ulnar impaction is common. We describe a new cartilage-retaining wafer resection osteotomy designed to keep the cartilage intact and decompress the ulnocarpal articulation without requiring internal fixation. We retrospectively reviewed seven patients with ulnar impaction who had the procedure. The minimum followup was 14 months (mean, 30 months; range, 14–38 months). The mean change in ulnar variance was -1.29 mm. Patients showed radiographic healing by a mean of 11 weeks. Our preliminary results suggest the cartilage-retaining wafer resection osteotomy may be an effective way to unload the ulnocarpal joint without requiring internal fixation or destruction of the distal ulna cartilage.

Level of Evidence: Level IV, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent was obtained.

J. A. Barry (✉), W. S. Macksoud
Department of Orthopaedic Surgery, Orlando Regional
Healthcare, 22 West Underwood Street, Orlando, FL 32806,
USA
e-mail: Jaybarry3@yahoo.com

W. S. Macksoud
Jewett Orthopaedic Clinic, Orlando, FL, USA

Introduction

Ulnar impaction syndrome and triangular fibrocartilage complex (TFCC) injuries are relatively common causes of ulnar-sided wrist pain. The conditions are usually idiopathic or posttraumatic, and patients present with painful wrist extension and ulnar deviation, particularly under load. There is often a positive ulnar variance resulting in increased contact pressures between the lunate and the ulnar head [14]. Chronic impaction between these structures may lead to degeneration of the triangular fibrocartilage and chondromalacia of the lunate and the ulnar head [9].

Nonoperative treatment alternatives include activity modification, antiinflammatory medications, corticosteroid injections, and splinting. The surgical options include ulnar shortening osteotomy [3], the Feldon wafer resection [6], the Darrach procedure [5], the Pechlaner osteotomy [15], and the hemiresection arthroplasty described by Bowers [2]. Each of these procedures has disadvantages. The wafer resection, Darrach procedure, and hemiresection arthroplasty all remove bone and cartilage from the distal ulna to remove the painful stimulus. The ulnar head decompressive osteotomy described by Pechlaner [15] and the traditional ulnar shortening osteotomy retain the cartilaginous distal ulna but allow for complications related to hardware placement. Likewise, a secondary procedure for hardware removal often is performed after the osteotomy has healed.

We describe a new technique of ulnar resection that preserves the cartilage of the distal ulna and avoids internal fixation while providing adequate decompression of the ulnocarpal joint. This is a hybrid of the currently accepted Feldon wafer resection [6] and the traditional ulnar shortening osteotomy that we believe may confer some benefit

by retaining the distal ulna cartilage. We describe our preliminary results.

Materials and Methods

We retrospectively reviewed the charts and radiographs of seven patients (all female) who underwent a cartilage-retaining wafer resection osteotomy of the distal ulna from January 2003 to December 2004. The mean age of the patients was 32 years (range, 16–48 years). Our indication for the wafer resection included isolated ulnar impaction syndrome with an otherwise seemingly healthy distal radioulnar joint (DRUJ) as determined by examination; a healthy DRUJ was presumed when there were no clinical or radiographic signs of arthritis. All patients reported ulnar wrist pain and noted worsening of symptoms with ulnar deviation and loading. All patients responded inadequately to a minimum 6-week trial of nonoperative treatment consisting of activity modification, splinting, and corticosteroid injections. We excluded those with obvious DRUJ subluxation or dislocation or radiographic arthritis, as we considered this a contraindication to the procedure. In addition, we considered a radiographically incongruent DRUJ as a contraindication. All patients had followup of at least 14 months (mean, 30 months; range, 14–38 months).

Three patients had previous arthrograms and arthroscopy of the wrist; two patients had arthrograms and wrist arthroscopy at the same time as the resection osteotomy. The preoperative ulnar variance averaged +1.28 mm (range, 0–4 mm) as measured on standard neutral rotation posterior-anterior radiographs. A line was drawn on the radiograph parallel to the distal radial articular surface. The distance from that line to the distal ulnar articular surface then was measured. The approximate amount of bone to be removed was determined with preoperative radiographs and marked intraoperatively with a surgical marker (Fig. 1). The amount of resected bone was determined by analyzing the variance present preoperatively with the goal to make the wrist ulnar neutral or 1 mm ulnar negative. The goal of the procedure was to decompress the ulnocarpal joint sufficiently to relieve symptoms of ulnar impaction while preserving the distal ulna cartilage and avoiding internal fixation.

We made a longitudinal incision approximately 2 to 3 cm in length on the dorsal ulnar aspect of the wrist centered over the DRUJ. Careful dissection avoided the dorsal sensory branch of the ulnar nerve. The fifth dorsal compartment was identified and incised longitudinally, freeing the extensor digiti quinti from its sheath. The floor of the compartment then was incised longitudinally to gain access to the DRUJ. We created a flap of the joint capsule by longitudinal incision to allow direct observation of the TFCC and the distal ulna. The extensor carpi ulnaris

Fig. 1 The proposed cut in the distal ulna is shown in a sawbones model. The cut is just proximal to the articular cartilage and does not extend all the way across the ulna.

tendon and its compartment were not opened or dissected. The TFCC then was inspected for tears and degenerative changes.

We preserved the ulnar styloid and the TFCC attachments. A microsagittal saw was used to make a transverse cut beneath the cartilage cap of the ulnar head, leaving approximately 1 to 2 mm of subchondral bone. The cut was started on the radial side of the ulna and extended to, but did not include, the ulnar cortex of the ulna. This cutting technique left a small hinge of bone intact on the ulnar cortex. The kerf of the saw blade was used for the width of the first cut and was approximately 1 mm. Additional passes were made with the saw to remove more bone as needed. Once the cut was made, the remaining ulnarly based hinge was cracked by applying gentle pressure with a small osteotome in a distal prying movement at the osteotomy site (Fig. 2). The crack tended to progress ulnarly across the osteotomy site proximal to the ulnar styloid and allowed full decompression across the osteotomy site. This decompression was the basis for the surgery. Because the cracked wafer of bone did not displace and the extensor carpi ulnaris subsheath, TFCC insertions, and ulnar-sided periosteum were not disrupted, the hinged subchondral bone remained stable after cracking.

Fig. 2A–B (A) The cut is made after the wafer of bone has been removed, as seen in the sawbones model. (B) A drawing shows removal of the wafer of bone and cracking of the hinge.

To verify removal of enough bone, the wrist was deviated ulnarly after the osteotomy and cracking. The osteochondral cap was observed to compress down and nearly touched the proximal edge of the cut (Fig. 3). This ensured adequate decompression of the ulnocarpal joint. If the two bone edges continued to come into contact, we judged more bone needed to be resected. In this manner, the surgeon witnesses the decompression during the

Fig. 3A–B (A) Adequate decompression is evaluated by placing the wrist in ulnar deviation, as shown in the sawbones model. (B) A drawing shows the same. The distal bone should collapse down under the load and just touch the proximal cortex of the cut region.

procedure and can tailor exactly how much bone to remove during each procedure.

The capsule and retinaculum then were closed, leaving the extensor digit quinti superficial to the repair to ensure enough tissue for a tight closure without constricting tendon passage. We used no internal bony fixation.

A volar splint was applied and immediate pronation and supination were allowed postoperatively. The splint was

removed 1 week postoperatively and gentle motion was continued at that time. Full flexion and extension were started on the third week. We restricted heavy use of the involved extremity for 2 to 3 additional weeks, after which we allowed activity as tolerated without restrictions.

The senior author (WM) evaluated patients postoperatively with clinical examinations to assess range of motion and DRUJ stability. To assess patient satisfaction with the procedure, patients were asked by the physician's assistant to state whether they would have the procedure again. The physician's assistant gave the patients a visual analog scale (VAS), ranging from 0 (no pain) to 10 (most pain) and instructed them to mark the location best describing their pain. To determine the improvement in pain, postoperative pain scores were compared with preoperative pain scores obtained retrospectively. We (WM) judged the bone healed on radiographs when the radial side of the osteotomy cut appeared to have filled in with new bone. We judged union occurred when the gradual opacification at the osteotomy site. Longer-term clinical and radiograph followups were obtained for five of the seven patients at a minimum of 32 months (mean, 36 months postoperatively, range, 32–38 months).

Results

All resection procedures healed uneventfully. Union was obtained in all seven patients at an average of 11 weeks (range, 5–32 weeks). The mean postoperative ulnar variance was -0.43 mm (range, 0 to -1 mm). This represented an average change in ulnar variance of -1.29 mm. No patient had ulnar positive variance at final followup (Fig. 4). Of the three patients who had arthroscopy at the time of the procedure, two had no TFCC tear and one had a small central tear. The osteotomy was preceded by arthroscopy in two other patients who had TFCC tears. One of these was peripheral and was repaired at the time of the osteotomy. The other was a central tear that was débrided.

The mean final postoperative ulnar variance in the five patients for whom longer-term radiographs were obtained was -0.2 mm (range, $+1$ to -1 mm). We observed no evidence of osteonecrosis or further collapse of the distal ulna on these radiographs. Between the initial postoperative radiograph and the final radiograph, there was an average change of 0.6 mm in ulnar variance.

Patients regained full range of motion compared with the contralateral side by 3 to 5 weeks after the procedure. Final examinations were performed on five of the seven patients and all five had regained full range of motion compared with the contralateral wrist. None of the five patients with longer-term followup had loss of motion greater than 10° , compared with the contralateral side, in

Fig. 4A–B (A) Preoperative and (B) postoperative radiographs show adequate correction of ulnar variance and position of the subchondral bone cap verifying decompression of the ulnocarpal joint.

any plane of motion. There were no instances of DRUJ instability or osteotomy displacement after the procedure. Two patients had a small residual gap at the osteotomy site on initial postoperative radiographs; however, the gaps gradually compressed under the ulnocarpal load and healed in an adequate position.

In the five patients with longer-term followup the average VAS scores decreased from a mean of 8.1 (range, 5.9 – 9.8) to 0.98 (range, 0 – 3.5). Six of the seven patients were satisfied with the procedure in general and would have the procedure again. The one patient who was not

satisfied had a burning pain develop in the operative arm approximately 10 weeks postoperatively. She was diagnosed as having a mild case of complex regional pain syndrome. A Bier block manipulation was performed on diagnosis. The pain continued for 1 year and required a subsequent cortisone injection before resolving. One patient had extensor carpi ulnaris tendinitis develop 2 months postoperatively. This resolved after one injection of cortisone. There were no other complications.

Discussion

Ulnar impaction syndrome is a common cause of ulnar-sided wrist pain. There are several well-accepted surgical techniques to treat this disorder. There are few instances in orthopaedics in which the cartilage of a joint is removed as treatment, without replacement in some fashion; yet the wafer resection does just that. It removes not only the bone of the distal ulna but also the cartilage surface. The gliding motion that occurs between the distal ulna and the undersurface of the TFCC is undeniably impaired and may form adhesions. A procedure that retains the native surfaces for motion while obtaining the same decompression may be advantageous. The aim of this study was to describe a new technique that avoids the need for fixation while retaining the normal distal ulnar cartilage and articular surface.

Our study has several limitations. Its small sample size and retrospective nature prevent inference of concrete conclusions. The results would be enhanced with a prospective, comparison study with a larger patient population. In addition, we did not measure outcomes with a standard validated scoring system, which would have strengthened our outcomes. Our goal was to describe our technique and show it may be an effective surgical option for ulnar impaction. We have provided extended followup on five of the seven patients and have described our preliminary results. Additional study is required to compare our technique with other standard techniques in a prospective fashion with validated scoring systems to evaluate outcomes. Two of five patients had a complication (one extensor carpi ulnaris tendinitis and one case of mild complex regional pain syndrome). Owing to the small number of patients, we cannot ensure this accurately reflects the complication rate of the procedure. Both of these diagnoses are quite common even with minor trauma to the wrist.

The primary surgical procedures available to treat ulnocarpal impaction syndrome are Feldon's wafer resection and ulnar shortening osteotomy. Feldon et al. believed the wafer distal ulnar resection to be advantageous over other treatment methods [6]. The wafer resection retains the ligamentous attachments and therefore integrity of the

TFCC while not requiring internal fixation devices. In addition, it exposes the TFCC and allows for repair if necessary. Several studies have had excellent clinical outcomes (range of motion, pain improvement, and function) of the Feldon wafer resection after a minimum of 12 months [4, 6, 7, 17]. The wafer resection seems to successfully unload the ulnocarpal joint in ulnar neutral and positive wrists, although slightly less effectively at increased positive variance [13]. Wnorowski et al. [18] confirmed an arthroscopically performed wafer resection also decreases the load across the ulnocarpal joint.

Constantine et al. [4] directly compared ulnar shortening osteotomy and wafer resection at 18 months and found no difference in clinical results, including range of motion, grip strength, pain relief, and return to work. However, five secondary procedures were performed in that study's osteotomy group for painful hardware removal, and two patients showed delayed union [4]. The open wafer resection reportedly improves pain and allows return of range of motion and grip strength in 90% of patients by as early as 6 weeks postoperatively [17].

The results of ulnar shortening osteotomy have been mixed. A previous study suggests, although the wafer resection is easier to perform than ulnar shortening, removing the articular cartilage surface of the distal ulna may have consequences [16]. Fricker et al. [8] reported 89% of patients were satisfied at 20 months when questioned. In this instance, a high rate of patient satisfaction was combined with rather poor Gartland-Werley wrist scores. However, Chun and Palmer [3] documented 51-month followup of ulnar shortening osteotomies and noted substantial improvements in range of motion and pain scores. Loh et al. [12] evaluated 23 wrists at 33.1 months and noticed a decrease in pain and some improvement, although not considerable, in wrist function, grip strength, and range of motion.

Pechlaner [15] described an oblique decompressive osteotomy of the ulnar head for ulnar impaction. The osteotomy site, like others, requires internal fixation. This technique also requires substantial dissection around the distal ulna that potentially may interrupt blood flow to the osteotomy site. There is still a problem with nonunion and osteonecrosis of the distal fragment with this technique.

All ulnar shortening osteotomies have complications specific to that procedure. Plate removal was required in 20 of 28 patients in the study by Fricker et al. [8]. Another study reported 65% of patients had implant irritation after ulnar shortening osteotomy fixation [12]. Hulsizer et al. [10] had four of 13 hardware-related complications, and Bernstein et al. [1] had 10 of 16 hardware complications requiring secondary surgical procedures. In addition to hardware irritation and removal, the osteotomy carries a risk of nonunion. Loh et al. [12] reported one of 23 patients

and Köppel et al. [11] reported six of seven patients had nonunion. Refracture through the osteotomy site after removal of the plate is also a risk of this method of treatment and has been documented [13].

Our results suggest union is likely after this procedure and it does not require internal fixation or substantial immobilization. Thus, hardware-related complications are avoided. The patient with union at 32 weeks was lost to followup until 32 weeks. At 7 weeks, she had full, painless motion of the wrist. She did not return to the office until 32 weeks. All patients who returned for final followup were satisfied and had improved VAS pain scores. Whether maintenance of the distal ulnar articular cartilage will make a difference in the long term is yet unknown, but we can speculate the maintenance of this surface can only be beneficial.

Extensor carpi ulnaris tendinitis is a fairly uncommon, but real, complication of the wafer resection, which usually responds to steroid injection [7, 17]. This may be caused by any surgical procedure that results in inflammation around the dorsal and ulnar side of the wrist. We attempt to minimize this complication by avoiding the sixth dorsal compartment of the wrist altogether. The wafer resection avoids the complications of painful hardware and delayed or nonunion while providing excellent clinical outcomes.

We believe our cartilage-retaining wafer resection osteotomy of the distal ulna offers the advantages of the traditional wafer resection while retaining the cartilage cap on the distal ulna. Similar to the Feldon wafer resection, the attachments of the TFCC are retained, and function and stability are maintained while adequately decompressing the ulnocarpal articulation. Inability to perform the procedure arthroscopically may be a disadvantage. However, the benefits of an open, cartilage-retaining procedure may outweigh those of an arthroscopic cartilage-destroying procedure. This is one aspect that needs additional evaluation. Longer-term followup in larger series is required. The cartilage-retaining wafer resection osteotomy of the distal ulna may be a reasonable alternative to the Feldon wafer resection. Thus far, it appears to be safe and easy to perform and seems to preserve the native cartilage of the ulnar head.

Acknowledgment We would like to acknowledge Rima Macksoud for assistance with illustrations.

References

- Bernstein MA, Nagle DJ, Martinez A, Stogin JM Jr, Wiedrich TA. A comparison of combined arthroscopic triangular fibrocartilage complex debridement and arthroscopic wafer distal ulna resection versus arthroscopic triangular fibrocartilage complex debridement and ulnar shortening osteotomy for ulnocarpal abutment syndrome. *Arthroscopy*. 2004;20:392–401.
- Bowers W. Distal radioulnar joint arthroplasty—the hemiresection interposition technique. *J Hand Surg Am*. 1985;10:169–178.
- Chun S, Palmer AK. The ulnar impaction syndrome: follow-up of ulnar shortening osteotomy. *J Hand Surg Am*. 1993;18:46–53.
- Constantine KJ, Tomaino MM, Herndon JH, Sotereanos DG. Comparison of ulnar shortening osteotomy and the wafer resection procedure as treatment for ulnar impaction syndrome. *J Hand Surg Am*. 2000;25:55–60.
- Darrach W. Partial excision of the lower shaft of ulna for deformity following Colles' fracture. *Ann Surg*. 1913;57:764–765.
- Feldon P, Terrono AL, Belsky MR. The “wafer” procedure: partial distal ulnar resection. *Clin Orthop Relat Res*. 1992;275:124–129.
- Feldon P, Terrono AL, Belsky MR. Wafer distal ulna resection for triangular fibrocartilage tears and/or ulna impaction syndrome. *J Hand Surg Am*. 1992;17:731–737.
- Fricker R, Pfeiffer KM, Troeger H. Ulnar shortening osteotomy in posttraumatic ulnar impaction syndrome. *Arch Orthop Trauma Surg*. 1991;115:158–161.
- Friedman SL, Palmer AK. The ulnar impaction syndrome. *Hand Clin*. 1991;7:295–310.
- Hulsizer D, Weiss AP, Akelman E. Ulna-shortening osteotomy after failed arthroscopic debridement of the triangular fibrocartilage complex. *J Hand Surg Am*. 1997;22:694–698.
- Koppel M, Hargreaves IC, Herbert TJ. Ulnar shortening osteotomy for ulnar carpal instability and ulnar carpal impaction. *J Hand Surg Br*. 1997;22:451–456.
- Loh YC, Van Den Abbeele K, Stanley JK, Trail LA. The results of ulnar shortening for ulnar impaction syndrome. *J Hand Surg Br*. 1999;24:316–320.
- Markolf KL, Tejwani SG, Benhaim P. Effects of wafer resection and hemiresection from the distal ulna on load-sharing at the wrist: a cadaveric study. *J Hand Surg Am*. 2005;30:351–358.
- Palmer AK, Werner FW. Biomechanics of the distal radioulnar joint. *Clin Orthop Relat Res*. 1984;187:26–35.
- Pechlaner S. Dekompressionsosteotomie des Ellenkopfes bei Impingementbeschwerden im ulnaren Handgelenkkompartiment. *Operat Orthop Traumatol*. 1995;7:164–174.
- Tatebe M, Nakamura R, Horii E, Nakao E. Results of ulnar shortening osteotomy for ulnocarpal impaction syndrome in wrists with neutral or negative ulnar variance. *J Hand Surg Br*. 2005;30:129–132.
- Tomaino MM, Shah M. Treatment of ulnar impaction syndrome with the wafer procedure. *Am J Orthop*. 2001;30:129–133.
- Wnorowski DC, Palmer AK, Werner FW, Fortino MD. Anatomic and biomechanical analysis of the arthroscopic wafer procedure. *Arthroscopy*. 1992;8:204–212.