Microfracture for Ulnar Impaction Syndrome: Surgical Technique and Outcomes with Minimum 2-Year Follow-up

David Kaufman, MD¹ Jennifer Etcheson, MS² Jeffrey Yao, MD³

¹Department of Orthopaedic Surgery, Stanford University Medical Center, Palo Alto, California

²Dartmouth Medical School, Lebanon, New Hampshire

³Department of Orthopaedic Surgery, Stanford University Medical Center, Redwood City, California

Address for correspondence Jeffrey Yao, MD, Department of Orthopaedic Surgery, Robert A. Chase Hand and Upper Limb Center, Stanford University Medical Center, 450 Broadway Street, Suite C442, Redwood City, CA 94063 (e-mail: jyao@stanford.edu).

J Wrist Surg 2017;6:60–64.

Abstract

Purpose The purpose of this study is to assess functional and patient-reported outcomes after lunate microfracture for management of lunate chondral lesions in the setting of ulnar impaction syndrome.

Methods This was a retrospective review of all patients undergoing wrist arthroscopy for triangular fibrocartilage complex pathology by one surgeon from 2007 until 2010. Disabilities of the arm, shoulder, and hand (DASH) scores were assessed preoperatively and at minimum 2-year follow-up. Patient-rated wrist evaluation and bilateral wrist range of motion, grip strength, and key pinch strength were assessed at final follow-up.

Results A total of 22 patients underwent microfracture of the carpus during the study period, of which 7 met all inclusion and exclusion criteria. Mean DASH scores improved significantly ($p < 0.001$), from 58.3 (standard deviation: 13.5) before the procedure to 15.1 (standard deviation: 8.6) at minimum 2-year follow-up. Operative wrist pronation and supination showed equivalence with the contralateral wrist at final follow-up ($p < 0.05$, $E = 15$ degrees, standard deviation pronation: 3.25, supination: 3.49).

Discussion This study suggests that lunate microfracture may be a useful technique for treating articular defects of the lunate in the setting of ulnar impaction syndrome.

Type of Study/Level of Evidence Therapeutic, level IV.

Keywords

- ▶ microfracture
- ▶ ulnar impaction syndrome
- ▶ ulnocarpal abutment syndrome
- ▶ ulnocarpal arthritis
- ▶ wrist arthroscopy

Ulnar impaction syndrome, also known as ulnocarpal abutment syndrome, is a well-described clinical entity that results from chronic overloading of the ulnocarpal articulation.¹ This typically occurs in the case of ulnar-positive variance, but may also be seen in patients with ulnar-neutral variance.^{1–3} An ulnar-positive variance may lead to degenerative wear of the triangular fibrocartilage complex (TFCC), ulnar carpus, and distal ulna.

Ulnar shortening osteotomy (USO) is a mainstay of treatment for ulnar impaction syndrome.^{1,2} This procedure decompresses the ulnocarpal joint and tightens the ulnocarpal

and radioulnar ligaments. Wrist arthroscopy is increasingly used to debride or repair the TFCC at the time of USO. In a retrospective review of 27 patients who had undergone USO alone, USO with wrist arthroscopy, or arthroscopy alone, Kim and Song found that patients who underwent USO with wrist arthroscopy have superior outcomes at a mean follow-up of 23 months, with improved Mayo wrist and disabilities of the arm, shoulder, and hand (DASH) scores compared with patients undergoing USO or arthroscopy alone.⁴

The wafer procedure is an all-arthroscopic means of simultaneously addressing TFCC pathology and ulnar-

received

May 13, 2016

accepted

June 27, 2016

published online

August 5, 2016

Copyright © 2017 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA.
Tel: +1(212) 584-4662.

DOI <http://dx.doi.org/10.1055/s-0036-1586496>.
ISSN 2163-3916.

positive variance.⁵ In a retrospective review comparing arthroscopic TFCC debridement and wafer procedure versus USO, 9 of 11 patients undergoing wafer procedure reported good to excellent outcomes over 1 year after surgery, compared with 11 of 16 patients undergoing USO.⁶

Current descriptions of wrist arthroscopy for ulnar impaction syndrome do not address all potential ulnar-sided pain generators. While TFCC debridement is useful, Palmer identified increasing carpal chondral damage as a hallmark of type IIB through IIE lesions of the TFCC.⁷ Often, ulnar impaction lesions within the lunate are isolated chondral defects. In other joints, particularly the hip, knee, and ankle, microfracture procedures are the first-line option for treating isolated chondral lesions.⁸

The purpose of this study is to assess functional and patient-reported outcomes at minimum 2 years after lunate microfracture for the management of lunate chondral lesions in the setting of ulnar impaction syndrome. We hypothesized there would be significant improvement in pre- and postoperative DASH scores, and functional range of motion near or equivalent to the nonoperative side.

Patients and Methods

Before the study was initiated, approval was granted from our institutional review board for this retrospective cohort study. Inclusion criteria for the study were patients older than the age of 18 years who had undergone a lunate microfracture procedure for articular cartilage lesions in the setting of ulnar impaction syndrome, and were a minimum of 2 years postoperative at the time of study. Exclusion criteria were patients younger than the age of 18, inability to provide consent, concomitant ulnar shortening osteotomy procedure, and microfracture procedures performed beyond the lunate and triquetrum, or follow-up less than 2 years postoperatively. We retrospectively reviewed the billing records of all patients treated by one surgeon from 2007 through 2010 with wrist arthroscopy and lunate microfracture for ulnar impaction syndrome, with arthroscopically confirmed cartilage lesions.

Preoperatively and postoperatively, all patients were assessed utilizing the following parameters: three-view wrist radiographs; pain levels; grip strength; wrist range of motion (flexion, extension, pronation, supination); and DASH scores. Patient-rated wrist evaluation (PRWE) scores were assessed at final postoperative follow-up. Patients received routine postoperative care at 2 weeks, 6 weeks, 3 months, 6 months, 1 year, and minimum 2-year intervals by the senior author. We compared the preoperative status to final postoperative follow-up. All patients had final follow-up at a minimum of 2 years after the procedure. Anteroposterior, lateral, and oblique radiographs were reviewed by the operating surgeon and a musculoskeletal radiologist. Pain levels were assessed on a standardized 10-point Likert scale. Grip strength was tested on a Jamar device (Sammons Preston, Rolyan, Bolingbrook, IL) set at the third position, and reflected a maximal single effort. Active and passive wrist range of motion was assessed with a goniometer. The DASH-wrist score was used to measure preoperative and postoperative functional status.

A test of equivalence compared with the contralateral wrist was performed with two one-sided *t*-tests for each functional outcome, which included wrist supination, pronation, flexion, extension, grip strength, and pinch strength. Minimum clinically important difference was defined as 15 degrees for wrist range of motion, 4.5 kg for grip strength, and 1.8 kg for pinch strength.

Surgical Technique

The surgical technique begins with general or regional anesthesia and wrist distraction is a standard arthroscopy tower to 12 lb. The standard 3–4, 4–5, and 6R portals are typically utilized. The 6R portal is first established and a 2.7 or 3.5-mm arthroscope inserted for visualization. The ulnar structures are visualized, scar tissue and loose flaps debrided with a shaver, and tears within the central disk of the TFCC are debrided. The articular surface of the lunate is examined. If an isolated full-thickness chondral lesion with exposed subchondral bone is apparent, microfracture is performed using a microfracture awl placed into the joint via the 3–4 or 4–5 portal and the arthroscope in the 6R portal (►Fig. 1). If a chondral defect is noted without an exposed bone, the lesion is debrided but no microfracture is performed. The subchondral bone is fractured to allow for egress of blood from the lunate to create a hematoma (►Fig. 2). Typically 3 to 6 microfracture sites are possible given the surface area of cartilage deficit. The patient is then placed in a short arm splint for 2 weeks, followed by a short arm cast for an additional 4 weeks to allow for maturation of the hematoma and to avoid shear stresses across the maturing hematoma. Six weeks postoperatively the cast is removed and the patient begins range of motion exercises under the supervision of a certified hand therapist. A removable splint is worn for protection during sleep and strenuous activities. At 3-months postoperatively the patient returns to full activity.

Fig. 1 Lunate chondral injury consistent with a Palmer IIB lesion, seen from the 3–4 portal. Microfracture awl is in position.

Fig. 2 Bleeding subchondral bone after use of the microfracture awl to penetrate the subchondral bone, seen from the 3–4 portal.

Results

Following chart review, a total of 22 patients underwent microfracture for ulnar-sided wrist pain. Among the 22 patients, 7 patients (5 men, 2 women, the mean age of 47 years, range 21–66 years) underwent lunate microfracture and satisfied all the inclusion and exclusion criteria. The remaining patients underwent concomitant ulnar shortening osteotomy, wafer procedure, or other procedures within the wrist, including four patients who underwent concomitant microfracture of other carpal bones. Six of the seven patients demonstrated ulnar-positive variance (mean: 1.2 mm) on appropriate preoperative X-rays. All patients had Palmer IIB or more severe TFCC injuries, reflecting the involvement of the lunate chondral surface.

All seven patients participated in the quick DASH preoperatively. The remaining functional and outcome measures of

PRWE and bilateral key and pinch strength and range of motion measurements were measured at final follow-up. Mean follow-up was 34.4 months after surgery. There was an average improvement of 43 points between the preoperative DASH scores (58.3 ± 13.5) and the postoperative DASH scores (15.1 ± 8.6), which was statistically significant using a paired *t*-test ($p < 0.001$). Final DASH scores suggest there was some residual disability in five of the seven patients. However, none of these patients required further management. Mean postoperative PRWE was 20.4 ± 9.4 (►Table 1). There was no significant difference in mean wrist pronation or supination ($p < 0.05$, $E = 15$ degrees, standard deviation pronation: 3.25, and supination: 3.49) when compared with the contralateral side, without significant disability on either side (►Table 2). The operative side showed nonequivalence with the operative side with respect to wrist flexion and extension, grip strength, and pinch strength, and this is likely due to wide confidence intervals in a small series of patients. There were no surgical complications. Plain radiographs obtained at the final follow-up revealed no evidence of radiolunate arthrosis in any patients. One patient returned to the operating room for an unrelated issue, which enabled second-look arthroscopy of the lunate microfracture site. There was excellent coverage of the osteochondral lunate defect with fibrocartilage (►Fig. 3).

Discussion

In 1989, Palmer described his classification of tears of the TFCC. Class I tears are of a traumatic etiology and are subclassified based on location. Class II tears are degenerative. Class II TFCC tears are further classified based on the level of wear of the TFCC, chondral surfaces, and ulnar ligaments. Class IIA lesions reflect wear of the central TFCC. Class IIB lesions also have lunate or ulnar chondromalacia. Class IIC injuries additionally show a perforation of the TFCC. Class IID manifest with perforation of the lunotriquetral ligament. Class IIE lesions present with all of the above, plus ulnocarpal arthritis.^{7,9}

Treatment of articular cartilage injuries in the setting of ulnar impaction syndrome presents a significant therapeutic

Table 1 Patient-reported outcomes

Patient	Operative side	Ulnar variance (mm)	Final postoperative (mo)	Preoperative DASH	Postoperative DASH	Postoperative PWRE
1	L	2.59	45	60	4	14
2	R	0.13	28	51	19	25
3	L	–1.81	32	32	0	0
4	R	1.63	31	53	17	28
5	R	2.11	28	70	24	24
6	L	1.84	55	75	22	27
7	L	1.96	22	67	20	25
Mean		1.2	34.4	58.3	15.1	20.4
Standard deviation		1.4	10.6	13.5	8.6	9.4

Abbreviations: DASH, disabilities of the arm, shoulder, and hand; L, left; R, right; PWRE, patient-rated wrist evaluation.

Table 2 Functional outcomes

Patient	Pronation (degree)		Supination (degree)		Flexion (degree)		Extension (degree)		Grip (lb)		Pinch (lb)	
	Op	Non-op	Op	Non-op	Op	Non op	Op	Non op	Op	Non-op	Op	Non-op
1	80	75	80	80	85	85	75	80	55	75	12	20
2	74	75	75	80	65	80	70	70	56	58	10	12
3	62	70	65	75	86	88	45	65	68	80	26	24
4	70	72	75	80	85	85	78	90	70	78	22	22
5	80	80	80	80	60	60	60	75	30	41	10	15
6	65	80	60	68	75	80	78	88	35	42	16	15
7	80	80	80	80	62	90	90	90	38	47	9	18
Mean	73.0	76.0	73.6	77.6	74.0	81.1	70.9	79.7	50.3	60.1	16.8	18.0
Standard deviation	7.0	3.8	7.4	4.3	9.6	9.3	13.5	9.4	14.9	16.1	5.4	4.0

Abbreviations: Non-op, nonoperative; Op, operative.

challenge given the limited regenerative capacity of this tissue. This article describes the benefit of microfracture of the lunate in the setting of arthroscopically confirmed chondral injuries with a minimum of 2-year follow-up. Microfracture was used only in full-thickness articular cartilage lesions, described as grade IV lesions in the classification by Outerbridge.¹⁰ Less severe chondral lesions were debrided and excluded from the study.

Ulnar shortening osteotomy or arthroscopic wafer procedure is a mainstay of treatment for ulnar impaction syndrome. Combining ulnar shortening with wrist arthroscopy and TFCC debridement or repair has shown significant improvement in pain, grip strength, and functionality.¹¹ However, patients still report some pain after these procedures.¹² While modern wrist arthroscopy techniques address known TFCC and intrinsic ligament injuries, we are not aware of

studies that address management of chondral degeneration of the carpus in Palmer IIB or more severe lesions. Prior failures to address chondral degeneration may explain persistent pain after combined arthroscopy and USO for ulnar impaction syndrome.

Microfracture is a well-established technique for managing articular cartilage lesions in the elbow, shoulder, hip, knee, and ankle. Microfracture is a means of stimulating cartilage regrowth on articular surfaces. A standard technique starts with careful debridement and removal of unstable cartilage around the lesion. Specially designed awls are used to make multiple perforations, or microfractures, into the subchondral bone plate. Perforations are made as close together as possible while maintaining the integrity of subchondral bone. Localized bone bleeding initiates a cascade beginning with hematoma formation, mesenchymal stem cell migration, and synthesis of fibrocartilage that fills the original cartilage defect.¹³

To our knowledge, there are currently no studies regarding the use of microfracture in the lunate for ulnar impaction syndrome. Although there is no validated algorithm for managing articular cartilage defects in the hip, knee, ankle, and shoulder, microfracture is a commonly used first-line option before alternative techniques such as autologous chondrocyte implantation, osteochondral autograft or allograft transplants.⁷ Microfracture is shown to generate reparative fibrocartilage with variable amounts of type II collagen and matrix proteoglycan content at second-look arthroscopy with cartilage biopsy.⁷ While fibrocartilage that results from microfracture is less stiff and less resilient than hyaline cartilage, these differences are minimized with appropriate rehabilitation in smaller chondral lesions. The end effect is a durable repair cartilage that fills the original defect.¹⁴ The biomechanical differences in fibrocartilage are thought to portend a worse long-term outcome in weight-bearing joints.¹⁵ Since the coefficient of friction is similar between cartilage types, nonweight-bearing joints may have improved outcomes with the presence of fibrocartilaginous repair tissue.¹⁶ While multiple potential pain generators may be

Fig. 3 Fibrocartilage coverage of the defect seen at second-look arthroscopy, seen from the 3–4 portal.

associated with ulnar impaction syndrome, cartilage defects are one possible source of pain, and may hasten the progression of ulnar ulnocarpal arthritis.

Lunate microfracture is a low morbidity procedure with minimal risk, and may improve symptoms and reduce the need for a more invasive joint leveling procedure. In fact, none of the patients in this cohort required any further intervention such as USO at a mean of 32 months following the index procedure. Microfracture may be performed in isolation or with the concomitant arthroscopic ulnar recession (wafer procedure). Should this procedure fail, salvage treatment with an ulnar shortening osteotomy may be employed.

Limitations

This study is limited in its retrospective design and small number of patients. There was no control group, so clinical improvement may be confounded by the simultaneous TFCC debridement or the independent effect of immobilization and therapy. However, all of these patients failed a course of immobilization and therapy before being indicated for surgical management. A larger, prospective study would be helpful to compare TFCC debridement, with and without microfracture of the carpus in the face of ulnar impaction syndrome.

Conclusion

Lunate microfracture improves DASH scores at minimum 2-year follow-up, and patients regained considerable wrist range of motion and strength compared with the contralateral limb. No patient in this cohort required a more invasive ulnar shortening osteotomy.

Note

The investigation was performed at the Stanford University Hospital and Clinics, Redwood City, CA. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation, Stanford University Institutional Review Board, and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Conflict of Interest

The author J. Y. has commercial associations with Smith and Nephew Endoscopy, Arthrex, Elevate Braces, BME, McGinley Orthopedics, 3D Systems. None relevant to this

study. D. K. and J. I. E. declare that there is no conflict of interest.

References

- 1 Friedman SL, Palmer AK. The ulnar impaction syndrome. *Hand Clin* 1991;7(2):295–310
- 2 Baek GH, Lee HJ, Gong HS, et al. Long-term outcomes of ulnar shortening osteotomy for idiopathic ulnar impaction syndrome: at least 5-years follow-up. *Clin Orthop Surg* 2011;3(4):295–301
- 3 Tomaino MM. Ulnar impaction syndrome in the ulnar negative and neutral wrist. Diagnosis and pathoanatomy. *J Hand Surg [Br]* 1998;23(6):754–757
- 4 Kim BS, Song HS. A comparison of ulnar shortening osteotomy alone versus combined arthroscopic triangular fibrocartilage complex debridement and ulnar shortening osteotomy for ulnar impaction syndrome. *Clin Orthop Surg* 2011;3(3):184–190
- 5 Katz DI, Seiler JG III, Bond TC. The treatment of ulnar impaction syndrome: a systematic review of the literature. *J Surg Orthop Adv* 2010;19(4):218–222
- 6 Tomaino MM, Weiser RW. Combined arthroscopic TFCC debridement and wafer resection of the distal ulna in wrists with triangular fibrocartilage complex tears and positive ulnar variance. *J Hand Surg Am* 2001;26(6):1047–1052
- 7 Palmer AK. Triangular fibrocartilage complex lesions: a classification. *J Hand Surg Am* 1989;14(4):594–606
- 8 Mithoefer K, McAdams T, Williams RJ, Kreuz PC, Mandelbaum BR. Clinical efficacy of the microfracture technique for articular cartilage repair in the knee: an evidence-based systematic analysis. *Am J Sports Med* 2009;37(10):2053–2063
- 9 McBeath R, Katolik LI, Shin EK. Ulnar shortening osteotomy for ulnar impaction syndrome. *J Hand Surg Am* 2013;38(2):379–381
- 10 Outerbridge RE. Further studies on the etiology of chondromalacia patellae. *J Bone Joint Surg Br* 1964;46:179–190
- 11 Bickel KD. Arthroscopic treatment of ulnar impaction syndrome. *J Hand Surg Am* 2008;33(8):1420–1423
- 12 Papapetropoulos PA, Wartinbee DA, Richard MJ, Leversedge FJ, Ruch DS. Management of peripheral triangular fibrocartilage complex tears in the ulnar positive patient: arthroscopic repair versus ulnar shortening osteotomy. *J Hand Surg Am* 2010;35(10):1607–1613
- 13 Alford JW, Cole BJ. Cartilage restoration, part 1: basic science, historical perspective, patient evaluation, and treatment options. *Am J Sports Med* 2005;33(2):295–306
- 14 Steadman JR, Rodkey WG, Rodrigo JJ. Microfracture: surgical technique and rehabilitation to treat chondral defects. *Clin Orthop Relat Res* 2001(391, Suppl):S362–S369
- 15 Franke O, Durst K, Maier V, et al. Mechanical properties of hyaline and repair cartilage studied by nanoindentation. *Acta Biomater* 2007;3(6):873–881
- 16 Burkhead WZ Jr, Krishnan SG, Lin KC. Biologic resurfacing of the arthritic glenohumeral joint: Historical review and current applications. *J Shoulder Elbow Surg* 2007;16(5, Suppl):S248–S253