Ulna Shortening Osteotomy Using a Compression Device

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Purpose: To report the functional and radiographic outcomes of a cohort of patients treated for ulnar impaction syndrome with a single technique of ulnar shortening osteotomy.

Method: We performed ulnar shortening osteotomy on 18 consecutive patients over a 10-year period by using an oblique osteotomy and compression plating technique with an AO compression device (Synthes, Paoli, PA). There were 11 men and 7 women in the series, with an average age of 32.7 years. All patients were graded before and after surgery with the modified wrist grading system of Chun and Palmer.

Results: All 18 osteotomies healed over an average of 6–8 weeks. There were significant improvements in pain, function, strength, and range of motion at an average follow-up of 3 years. Thirteen wrists were graded excellent, 3 good, and 2 fair. There were no postoperative complications, however, 8 patients ultimately required plate removal for local discomfort.

Conclusions: This study showed that ulnar shortening osteotomy using an oblique osteotomy and an AO compression device is easy to execute and is associated with satisfactory outcomes. Healing time is rapid and postoperative cast immobilization is not required. (J Hand Surg 2003;28A:88-93. Copyright © 2003 by the American Society for Surgery of the Hand.)

Key words: Ulna, shortening, compression, impaction, syndrome.

In the early 1900s a number of reports described a syndrome of ulnar head dislocation on pronation or supination after malunited distal radius fractures.[1,2] To treat these dislocations Darrach[3] devised a surgical procedure that resected a portion of the "low shaft of the ulna." In 1941, however, Milch[4] however, proposed that dislocation of the ulnar head and the associated grip weakness and distal ulna tenderness were principally related to the "reversal of the normal relationships of the radial and ulna styloids," and the dislocation was a result of the ulnar styloid impacting on the carpal bones on forearm rotation. As treatment he suggested a cuff resection involving a .75-in osteotomy of the ulnar diaphysis and wire fixation.

Fifty years later, as the understanding of internal fixation matured, attention returned to these earlier reports. Darrow et al[5] began performing cuff resections using modern open reduction and internal fixation techniques. Despite the improved stability their procedure had long healing times. In 1991 Friedman and Palmer[6] described the ulna impaction syndrome; and in 1993 Chun and Palmer[7] reported a series using an oblique cuff resection, lag screw, and plate fixation. There were no nonunions and excellent outcomes but other surgeons have not had the same success. Over the past 7 years a number of new techniques and devices have been suggested to simplify the procedure including using an AO distractor (Synthes, Paoli, PA), a specialized oblique osteotomy system developed by Rayhack,[8] and Charnley wires to maintain orientation.[9,10]

For the past decade we have used a simple reliable technique of ulna shortening using an AO compression device that minimizes the risk of malalignment and facilitates rapid healing. This article reports our experience with this procedure.

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Patients and Methods

Over a 10-year period 18 patients were treated surgically for ulna impaction syndrome with ulna shortening osteotomy. There were 11 men and 7 women with an average age of 32.7 years (range, 16–51 y). The dominant hand was involved in 5 patients. The symptoms were related to occupation in 4 patients, sports in 3, and secondary to trauma in 11. Six cases involved worker's compensation. Average length of follow-up evaluation was 37 months (range, 12 months–102 months).

Conservative treatment was attempted for each patient and included 3 to 6 months of anti-inflammatory medications, splinting, corticosteroid injections, and/or hand therapy. Preoperative assessment included a detailed history, physical examination, and standardized radiographs. The diagnosis of ulna impaction syndrome was made clinically based on localized pain with forced ulnar deviation and confirmed with radiographs that showed positive ulnar variance and/or cyst formation in the lunate or triquetrium. Ulnar variance was measured from the perpendicular to the forearm axis at the subchondral distal edge of the sigmoid fossa on the radius. The goal of shortening was to attain a negative postoperative ulnar variance of 1 to 2 mm. Arthroscopic evaluation was performed routinely before ulnar shortening osteotomy to confirm the diagnosis. Surgical findings of impaction syndrome included central attritional tears of the articular disc and focal softening or eburnation of articular cartilage on the lunate and/or triquetrum.

All 18 patients had pre- and postoperative wrist evaluations using a modified grading system devised by Chun and Palmer[7] (Table 1). After surgery the time to bony union was recorded in all patients and was shown by lack of tenderness at the osteotomy site and trabeculae crossing the osteotomy site on x-ray. We analyzed our data by using the Wilcoxon signed rank test for paired differences because there was not a normal distribution of scores with equal population variances or independent selection of samples. Statistical significance was determined by using an α level of .05.

Surgical Technique

An 8 to 10-cm midaxial incision was made over the subcutaneous border of the ulna. The interval between the extensor carpi ulnaris and the flexor carpi ulnaris was opened to expose the ulnar periosteum. Extraperiosteal dissection was done to avoid devascularization, with the exception of a 1-cm circumferential zone at the site of the planned osteotomy, approximately 5 to 6 cm proximal to the ulnar styloid. A 6-hole dynamic compression plate was centered about the planned osteotomy site with 3 holes distal, 1 across, and 2 proximal to the osteotomy. Positioning of the plate on the palmar surface is preferable to avoid a subcutaneous prominence of the hardware after surgery. The plate was then fixed distally with two 3.5-mm cortical screws applied in the neutral mode. The AO compression device was fixed to the ulna proximally with a unicortical screw, having engaged the mobile arm in the most proximal plate hole (Fig. 1). The compression device and one distal screw were then removed to rotate the plate away to gain access for the osteotomy. An oblique osteotomy cut was inclined so that an acute 45° angle was formed with the distal portion of the plate. This osteotomy cut was made freehand and the initial saw cut was not completed. Approximately 10% of the ulnar cross-section was left intact and a second saw blade was inserted into the cut portion. The blade acted as a planar guide for the second parallel and proximal osteotomy cut, measured to excise a 2 to 4-mm wafer of bone. The initial saw cut was then completed and a wafer of bone was removed. The distal screw and compression device were reapplied. With this maneuver normal alignment was restored to before compression and final fixation. The compression device was tightened to result in simultaneous closure and compression at the osteotomy site. Compression was applied after the 2 ends abutted; however, compression was stopped before undue tension was applied on the distal screws. Anatomic rotational and angular alignment were maintained simultaneously during compression. A gliding hole was drilled for placement of an interfragmentary screw and drill guide. After the gliding hole was drilled a proximal screw was placed in the compression mode. Next the interfragmentary screw was applied. The remaining screws were applied and the compression device was removed. Postoperative support with a short arm splint was applied for 2 to 4 weeks.

Results

Patients were evaluated before and after surgery by means of the Chun and Palmer[7] wrist grading system. Before surgery the mean wrist score was 70.0 ± 7.4,

Table 1. Wrist Grading System

	Subjective Score
Pain	
Excellent—no pain	20.0
Good—occasional pain, no compromise in activities, mild discomfort with strenuous use	15.0
Fair—moderate pain, tolerable but some limitation to activities	10.0
Poor—severe pain, serious limitation of activities	5.0
Function	
Excellent—back to usual (preinjury) sports/activities	20.0
Good—back to usual sports/activities with mild limitations or discomfort	15.0
Fair—can perform activities of daily living (ADL) but cannot return to usual activities requiring high-demand wrist use.	
Poor—can perform ADL with some limitation/discomfort	5.0
Motion	
Excellent—equal to opposite side	10.0
Good—not equal to opposite side, but enough to perform usual activities	7.5
Fair—enough motion to perform ADL but not enough to perform usual activities	5.0
Poor—stiff, not enough motion for ADL	2.5
Objective score	
Motion	
Excellent—equal to opposite side	10.0
Good—limited but more than functional wrist motion (range of motion [ROM])*	7.5
Fair—functional ROM	5.0
Poor—less than functional ROM	2.5
Strength	
Excellent	10.0
D: Equal to opposite	
ND: 75% of opposite	
Good	7.5
D: 75% of opposite	
ND: 50% of opposite	
Fair	5.0
D: 50% of opposite	
ND: 25% of opposite	
Poor	2.5
D: <50% of opposite	
ND: <25% of opposite	
Union	
Completely healed in <6 months	10.0
Healed in >6 months	7.5
Nonunion or malunion	2.5
Post operative ulnar variance	
0 to −2 mm	10.0
0 to +1 mm or −2 to −3 mm	5.0
>+1 mm or <−3 mm	2.5
Complications	
None	10
One or more	5

*5° flexion, 30° extension, 10° radial deviation, 15° ulnar deviation. D, dominant; ND, nondominant. Adapted from Chun and Palmer.[7]

with 14 fair and 4 poor. After surgery the mean wrist score improved to 93.8 ± 8.1, with 13 excellent, 3 good, and 2 fair. This difference was significant at an α level of less than .05. The subjective pain score improved from 10.5 ± 3.6 to 19.2 ± 2.6 ($p < .05$). The subjective function score improved from 9.5 ± 2.8 to 17.2 ± 3.5 ($p < .05$). The subjective range of motion improved from 7.2 ± 2.2 to 9.6 ± 1.0 ($p < .05$). The objective range of motion changed from 7.2 ± 2.2 to 8.8 ± 1.8 and the objective strength changed from 7.0 ± 1.0 to 9.4 ± 1.6 ($p < .05$).

One patient with a fair result scored 57.5 before

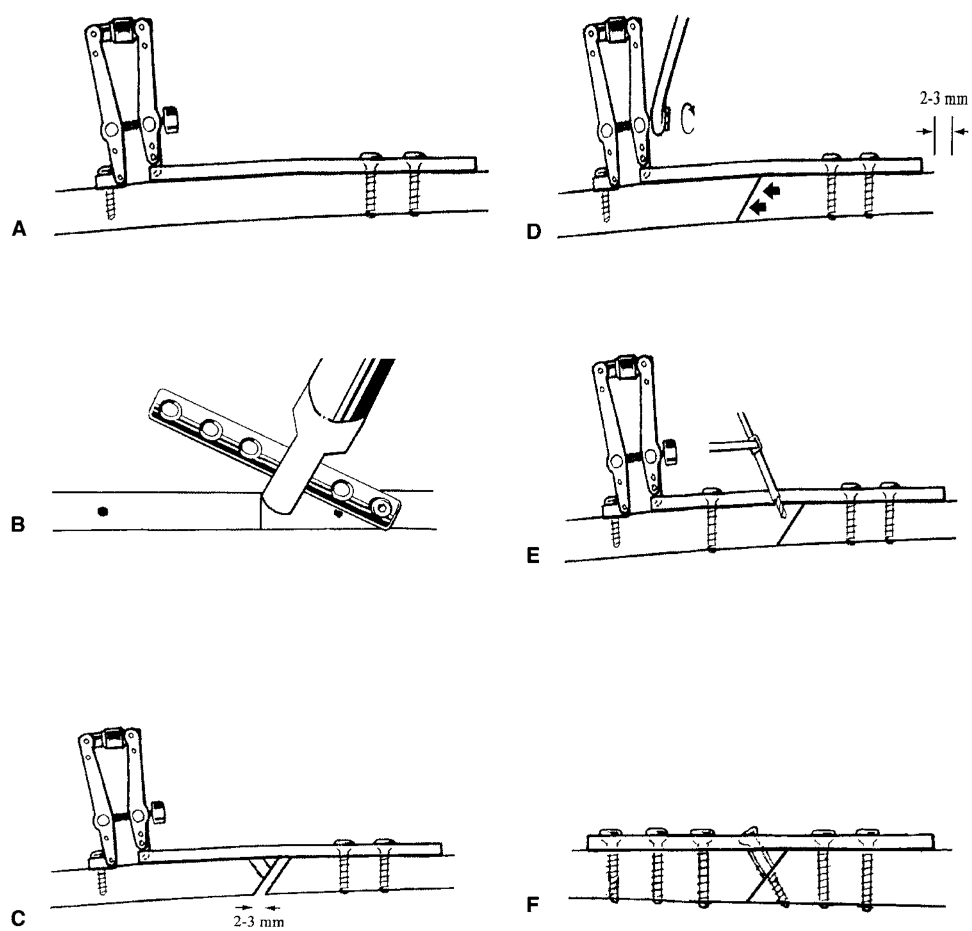


Figure 1. (A) A 6-hole DC plate is fixed distally with two 3.5-mm cortical screws. The compression device is fixed proximally with a unicortical screw. (B) One screw is removed distally, the compression device is removed, and the plate is rotated for oblique osteotomy. (C) A 2 to 3-mm wafer of bone is excised with parallel osteotomies and the compression device is reapplied. (D) The compression device is tightened with closure of the osteotomy site; anatomic rotational and angular alignment are maintained. (E) The proximal screw is placed. A gliding hole is drilled; the drill guide and the interfragmentary screw are placed. (F) The compression device is removed and the remaining screws are applied. Modified with permission.[16]

surgery and 75 after surgery. He was a masseur who had fallen on an outstretched hand years before presentation. Initially after ulna shortening he reported significant improvement, but his course worsened shortly after resuming his massage work against the advice of the senior author. He has now developed pain in both wrists and is still being followed up. The other patient with a fair result scored 52.5 before surgery and 70 after surgery. This patient had suffered a cerebrovascular accident and had a right-sided hemiparesis. She presented after her right wrist was struck by a car door. Her weakness and limited range of motion continued but her pain significantly improved from a 5 to a 15.

There were no infections or nonunions. The most common complication was plate irritation that resulted in plate removal in 8 patients.

Discussion

Ulna shortening remains the standard for surgical treatment of the ulna impaction syndrome. The use of ulna shortening has been extended to treat failed triangular fibrocartilage complex debridements, ulna impaction syndrome with carpal instability, and early posttraumatic distal radioulnar joint osteoarthritis.[11–14]

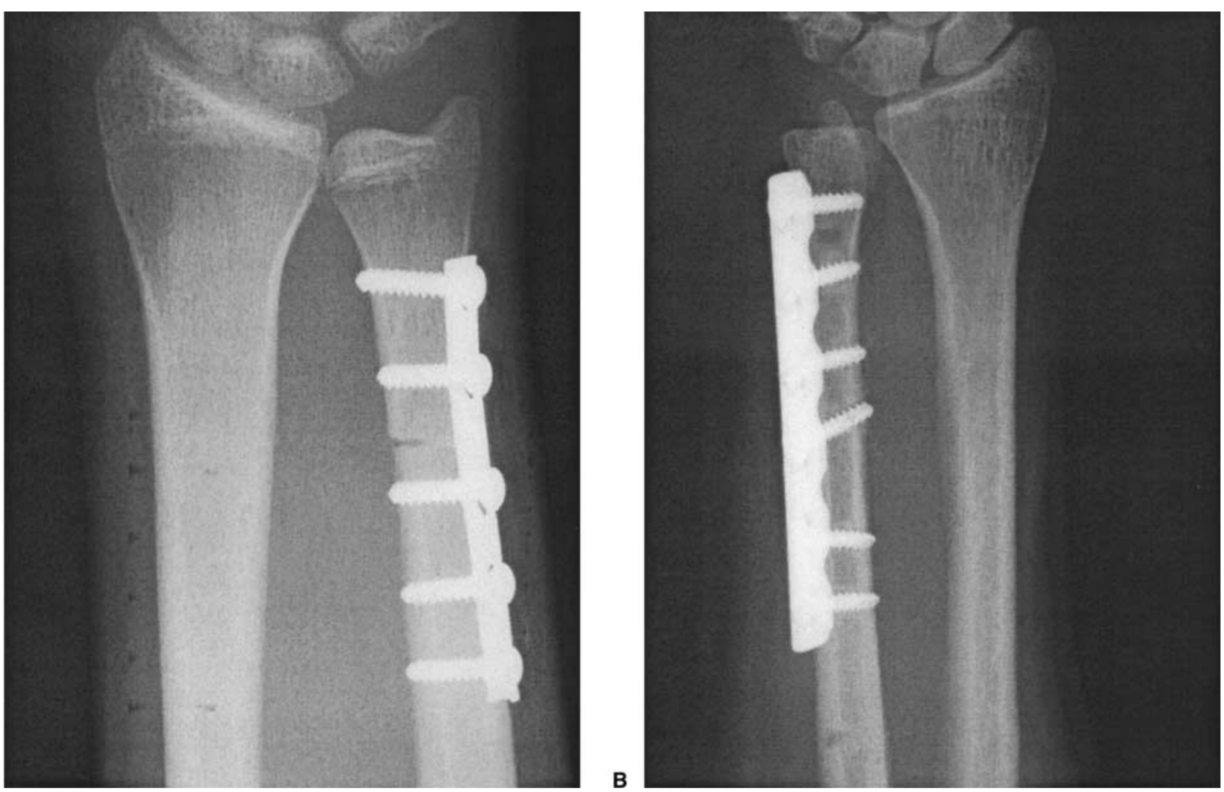
Previous reports use different osteotomy orientations, methods of alignment, and compression techniques. Darrow et al[5] used a transverse osteotomy with plate fixation, Chun and Palmer[7] used an oblique os-

Table 2. Comparison With Previous Studies

Study	Osteotomy	Fixation	Cases	Range of Motion Started	Time to Union (wks)	Nonunion
Darrow	Transverse	DCP	35	>13	13	1
Rayhack	Transverse	Plate	23	6	21	1
	Oblique	Plate	17	6	11	0
Wehbe	Transverse	DCP	24	Wrist 2/forearm 6	9.7	0
Koppel	Transverse	DCP	32	6	28	5
	Oblique	DCP	15	6	20	1

teotomy, lag screw, and plate fixation, Wehbe and Cautilli[9] used a transverse osteotomy, an AO small distractor, and fixation with a DCP plate. Each variation in technique has produced different rates of nonunion and time to union. The average time to union in this study was 6.8 weeks, which compares favorably with previous studies using both oblique and transverse osteotomies (Table 2). As Wehbe and Cautilli[9] have noted, however, objective bony union is difficult to define. They defined bony union radiographically as clear evidence of callus formation and clinical union as lack of tenderness at the osteotomy site and a painless range of motion. Rayhack et al[8] defined healing as trabecular bone bridging the osteotomy site coupled with blurring of the cortical margins of the osteotomy. Our definition used the radiographic criteria of Rayhack et al[8] because rigid fixation should favor primary bone healing and preclude formation of callus.

One strength of the technique we used comes from its foundation in AO principles and recommendations. Lag screws provide 2 to 4 kN of compression as



A B

Figure 2. (A) Delayed union 5 months after a transverse osteotomy fixed with a third tubular plate and without an interfragmentary screw. (B) Comparison radiograph 6 weeks after oblique osteotomy fixed with interfragmentary screw and plate compression. A removable protective forearm splint was applied at 2 weeks after surgery and the patient was allowed wrist range of motion exercises. Note the unicortical hole proximal to the plate where the compression device was fixed temporarily.

compared with 0.6 to 1.0 kN provided by dynamic compression plate fixation.[15] Biomechanical studies have shown that the use of a compression plate and lag screw increased stability to bending and rotational forces.[15] Both of these factors suggest that an oblique osteotomy with plate fixation should provide more solid union than a transverse osteotomy (Fig. 2).

A major difference between our technique and others using specialized devices is the ready availability of the AO compression device in most operating rooms. The use of the compression device rather than conventional dynamic compression plating adheres to AO principles. The AO Association for the Study of Internal Fixation group recommends that the compression device be used instead of a compression plate when the gap to be closed is greater than 1 mm or the desired compression is greater than 100 kp.

One of the difficulties of standard techniques of ulnar shortening is the need to maintain alignment when removing the dynamic compression plate to create the osteotomy. Premounting of the AO compression device maintains alignment and prevents malangulation after the osteotomy has been completed. The use of a compression device minimizes additional steps and adds the benefit of greater compression at the osteotomy site. An additional benefit of using the AO compression device is that if osteotomy cuts are not exact, the device can compensate for small errors in alignment.

A point that should be emphasized is that the osteotomy needs to be oriented properly such that the osteotomy forms an acute angle with the proximal end of the plate, otherwise the bone fragments will displace when compressed. Others have reported fragment translation while placing compression screws in an oblique osteotomy and may have experienced less adverse translation if the osteotomy was oriented in the opposite direction.[17]

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