Results of ulnar shortening osteotomy with a new plate compression system

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Abstract

Purpose The gold standard for treatment of ulnar impaction has become ulnar shortening osteotomy. Previous reports in the literature have shown not only good results with relief of ulnar-sided wrist pain but also significant nonunion rates and painful hardware necessitating further surgery and potentially, metal removal. The purpose of this paper is to review the success rate of ulnar shortening osteotomy utilizing a low profile compression plate designed specifically for ulnar shortening osteotomy.

Methods Ninety-three patients with ulnar abutment syndrome underwent ulnar shortening osteotomy with the low profile osteotomy plate. There were 47 males and 46 females. The Acumed's ulnar shortening system was utilized in all cases. The patients were evaluated for pain, range of motion, grip strength, return to work, time to union, and hardware removal. The patients' results were validated using the Mayo Wrist Score.

Results There was a 100 % union rate in the 93 patients. There were no nonunions or delayed unions, or any hardware removal. All patients noted an improvement in their ulnar-sided wrist pain. Utilizing the Mayo wrist classification, the average post-operative score was 84.5. The average preoperative Mayo score was 49.4, for an average increase of 35.1 points.

Conclusion The Acumed's low-contact plate designed specifically for ulnar shortening osteotomy demonstrated 100 % union rate and no implant removal in our series. This is the largest study to our knowledge of a series of ulnar shortening osteotomies and successful healing without the removal of any implants. Furthermore, the specifically designed ulnar shortening osteotomy plate significantly simplifies the procedure for the surgeon and improves patient outcomes with relief of ulnar-sided wrist pain.

Keywords Ulnar osteotomy · Compression plate · Positive ulnar variance

Ulnocarpal impaction occurs when excessive loading occurs between the ulnar carpus and the distal ulna. This occurs with positive ulnar variance and leads to chronic degenerative triangular fibrocartilage complex (TFCC) tears as well as degenerative wrist arthritis. Ulnar variance is the difference in length between the distal ulnar aspect of the radius and the distal aspect of the ulnar head (Fig. 1). Palmer and Werner [10] showed that loads through the distal ulna change with the ulnar variance. In the ulnar neutral wrist, the radius bears 82 % of the load of the wrist, while the ulna receives 18 % of the load. By increasing the ulnar length by 2.5 mm, the load across the ulna increases by 42 %. However, an acute decrease in ulnar length by 2.5 mm unloads the force across the ulna to 4.3 %.

Ulnocarpal impaction syndrome has also been termed ulnar carpal impaction, or ulnar lunate abutment, which represents clinically identical identities. However, it should not be confused with ulnar impingement that is used to describe pseudoarthrosis and impingement between a surgically shortened ulna and the shaft of the radius.

Ulnar impaction syndrome may be broadly classified as idiopathic versus acquired [4, 6]. Acquired predisposing

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Fig. 1 Pre-operative x-ray

conditions are those that shorten the length of the radius in relation to a normal length ulna and include malunited distal radius fracture, early physal closure of the ulnar aspect of the distal radius, and proximal migration of the radius from previous radial head resection or from an Essex–Lopresti injury [5]. Idiopathic causes of ulnar impaction syndrome are congenital, positive ulnar variance, and dynamic positive ulnar variance with pronation and forceful grip [1].

The treatment of ulnocarpal impaction is ulnar shortening osteotomy. This procedure, and the early implants, has been plagued with high complication rates, including nonunion and painful hardware, both requiring more surgery. This study evaluates the results of ulnar-shortening osteotomy using a new plate and compression system compared to previous results.

Materials and Methods

Ninety-three patients had an ulnar shortening osteotomy using Acumed's ulnar-shortening plate between 2004 and 2009. The inclusion criterion for the study was persistent ulnar-sided wrist pain, unresponsive to a conservative management program, in patients with ulnar positive variance. Conservative therapy included rest, splinting, nonsteroidal

antiinflammatories, and/or steroid injection. Approval by the institutional review board was obtained.

There were 47 males and 46 females. Average age at the time of shortening osteotomy was 39 years old. The average time of the procedure was 58 min. The ulna was shortened an average of 3 mm (range, 2–10 mm). The vast majority of patients underwent wrist arthroscopy at the time of the procedure. Concurrent findings at arthroscopy included attritional tears of the TFCC, lunotriquetral tears, and chondromalacia of the lunate and triquetrum.

Technique

A standard lateral approach to the ulna between the extensor carpi ulnaris and flexor carpi ulnaris interval is utilized for exposure. Then, the dissection proceeds volarly to expose the volar aspect of the ulna. The ulnar shortening plate is placed on the volar side of the ulna 3–5 cm proximal to the distal ulna. This system utilizes a unique plate design that allows for locked fixation of the plate to the bone, prior to osteotomy, to allow for controlled compression at the osteotomy site (Fig. 2). Furthermore, this system has cutting guides that attach directly to the plate. This system gives the surgeon the option of utilizing a cutting guide or making a free-hand cut directly off the plate. The guides and plate markings are designed to allow precise cuts according to the amount of shortening necessary.

The threaded 3.5-mm locking drill guide is placed distally. This is drilled with a 2.8-mm drill, and a locking screw is placed. Next, in the proximal end of measurement slot, a 2.8-mm nonlocking guide is used to drill a 2.8-mm hole and a 3.5-mm nonlocking screw is placed. Next, the osteotomy is performed. The osteotomy can be made free hand and measured off the plate, or the guide can be utilized and attached to the plate. The wafer of bone is removed from

Fig. 2 Standard lateral approach to the ulna that utilizes a unique plate design, allowing for locked fixation of the plate to the bone

Fig. 3 Osteotomy site after removal of wafer of bone

the osteotomy site (Fig. 3). The proximal measurement slot screw is loosened, and the osteotomy site is closed with a compression clamp and the screw is tightened (Fig. 4). A 3.5-mm lag screw is then placed across the osteotomy site. Last, the final three locking screws are placed proximally.

Postoperative Protocol

The patients were placed into a volar splint immediately postoperatively. At the first follow-up visit (1 week), the patients were placed into a removable forearm brace. Range of motion of the fingers was encouraged immediately postoperatively. Gentle strengthening was started after 4 weeks.

Outcome Measures

All patients were evaluated pre- and postoperatively for pain intensity, range of motion, and grip strength. Patient wrist

Fig. 4 Application of compression clamp and compression of osteotomy site

function was established utilizing the Mayo Wrist Score. Time to union was evaluated radio graphically and clinically. Return to work and any complications were recorded.

Results

There was a 100 % union rate in our series (Figs. 5 and 6). To our knowledge, no patients involved in this study have had hardware removal performed, during initial treatment, or after discharge. No patient returned to follow-up requesting hardware removal. All patients were followed an average of 6 months, range of 4–9 months. Time to union was 7 weeks, range of 5–12 weeks. All patients had improvement in pain, increased strength, and range of motion as well as improved wrist function, as illustrated in the change in the postoperative Wrist Mayo score. The average preoperative Wrist Mayo score was 49.4, with a range of 10–60. The average postoperative Wrist Mayo score was 84.5, with a range of 75–100. The average improvement of the Mayo score was 35.1 points. The Wrist Mayo Score defines excellent as 90–100, good as 80–90, satisfactory as 60–80, and poor as below 60.

Complications

While there was no hardware removal, five patients did complain of some irritation from the tip of the lag screw. As the plate is placed on the volar surface of the ulna, the lag screw exits the dorsal radial aspect of the ulna. The bicortical nature of the lag screw, as it crosses the osteotomy site at a 45° angle, caused some patients to feel the tip of the screw. Ultimately though, no patients were bothered enough from the screw to request hardware removal.

Discussion

Ulnar impaction syndrome was defined by Palmer as a degenerative condition characterized by ulnar wrist pain, swelling, and limitation of motion related to excessive load bearing across the ulnar aspect of the wrist [6]. Chronic impaction of the ulnar carpal joint leads to a continuum of pathologic changes [6]: degenerative tears of the TFC, chondromalacia of the lunate, triquetrum, and ulnar head, instability or tear of the lunotriquetral ligament, and finally, arthrosis of the ulnar carpal joint. One of the earliest descriptions of the treatment for ulnar impaction syndrome was when Milch treated distal radius malunions with ulnar shortening osteotomies.

Ulnar shortening osteotomy is not a new concept, as it was first described in 1941 by Henry Milch. However, since its introduction nearly 70 years ago, the technique and hardware systems have evolved tremendously. What was

Fig. 5 Post-operative x-ray

once a technically challenging procedure plagued with complications has now evolved into a technically simple and successful procedure, when the best techniques and hardware systems are utilized.

This is the largest study to our knowledge of a series of ulnar shortening osteotomies and successful healing without the removal of any implants. By placing the plate on the volar aspect of the ulna, there is decreased soft tissue irritation and decreased complications related to hardware removal. Furthermore, the specifically designed ulnar shortening osteotomy plate significantly simplifies the procedure for the surgeon and improves patient outcomes with relief of ulnar-sided wrist pain.

Biomechanical studies have shown that structural stiffness in torsion is clearly greater for oblique osteotomy [2, 11]. The plate system used in this study utilized an oblique osteotomy. Further reports have shown that oblique osteotomies have a faster healing rate, a lower nonunion rate, when compared to transverse osteotomies [2, 3, 11]. Rayhack et al., in their study,

reported a faster healing time with an oblique osteotomy due to the 40 % increased in bony surface area. Their average time to union was 11 weeks. Chen achieved 100 % bony union in his 18 patients in an average of 6.8 weeks with an oblique osteotomy. Similarly, Kitzinger had a 100 % union rate using an oblique osteotomy.

Hardware removal and plate-related problems in ulnar shortening osteotomy has been problematic, with a range

Fig. 6 Post-operative x-ray lateral

of 8–55 % [2, 9, 12]. Luria, in his recent study, compared the Synthes DCP plate and the Trimed ulnar shortening plate and still had significant hardware removal rates of 27 % (Synthes DCP) and 24 % (Trimed) [8]. Kitzinger et al. described their results of ulnar shortening osteotomy in 27 patients using a volar plate. They reported six patients complained of plate irritation; however, they did not specifically comment on if they required hardware removal [7].

Our hardware removal rate was 0 % and continues to have successful healing rates and simplicity of the procedure. We believe that by utilizing a new generation volar low profile plate, we eliminated the necessity for hardware removal, in our series, compared to other studies in the literature. The volar approach provides good soft tissue coverage over the low profile tapered plate. The unique plate design, its volar placement, and oblique osteotomy allows for successful and reproducible results for ulnar shortening osteotomy.

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