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POINT OF TECHNIQUE

Subcapital ulnar shortening osteotomy

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Abstract Ulnar shortening osteotomy is the standard treatment for the condition of ulnocarpal impaction. Traditionally ulnar shortening osteotomy has been performed in the diaphysis and secured with a 3.5 mm plate. Delayed union, nonunion, and symptomatic hardware have been cited as detractors of this technique. A number of alternatives have consequently been proposed that range from different hardware to different patterns of osteotomy to resection of the distal portion of the ulnar head. This article describes one method for ulnar shortening osteotomy that seeks to draw upon the advantages of several of these variations in order to minimize complications.

Keywords Ulnar · Shortening · Osteotomy · Impaction · locking, plates

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Introduction

Ulnocarpal impaction, regardless of etiology, is ultimately treated by ulnar shortening osteotomy in those cases that fail non-surgical management. Consideration is given to a distal osteotomy of the ulnar head by open or arthroscopic means in those cases whose individual details suggest an advantage to that method (Fig. 1). Otherwise, the ulnar osteotomy has traditionally been performed in the diaphysis and secured with a 3.5 mm plate (Fig. 2).

Fig. 1 Arthroscopic wafer procedure shows removal of the segment of ulnar head that is distal to the margin of the sigmoid notch but radial to the insertion of the radioulnar ligament. A radiolucent impaction lesion can be seen in the proximal ulnar corner of the lunate (arrow)

This strategy, however, has been plagued with high rates of delayed union, nonunion, and symptomatic hardware requiring removal [1–5]. These problems are fundamental to the selection of the diaphysis as the site of osteotomy and the use of a bulky 3.5 mm plate as the implant (Fig. 3). Experience with the use of 2.3 mm and 2.4 mm plates in the distal ulna for fracture fixation (Fig. 4) indicated that similar hardware could be used to secure an ulnar osteotomy cut through the cancellous bone of the distal ulnar metaphysis as opposed to the diaphysis. Newer implants that include distal locking capabilities in smaller sized plates permit the osteotomy site to be moved to the subcapital region of the ulna where short healing times through cancellous bone can reliably be achieved (Fig. 5). Patients are allowed earlier return to function, and the smaller implant obviates the need for hardware removal.

Surgical technique

Incision is made 5 cm longitudinal in the ulnar midaxial line terminating at the level of the proximal volar wrist crease. The most important target for identification is the dorsal branch of the ulnar nerve which must be kept volar and distal to the operation at all times, particularly the most proximal transverse branch which often will cross the midaxis at the level of the base of the ulnar styloid. The extensor carpi ulnaris (ECU) sheath should be left undisturbed except just at the level of the osteotomy where subperiosteal elevation is performed to allow the osteotomy to close correctly. The volar surface of the distal ulna is prepared to receive the plate and a model is chosen based on surgeon preference. The plate design should provide for multiple points of fixation into the ulnar head with locking capability if possible (Fig. 6). The plate is contoured and secured to the ulnar head before cutting the osteotomy. The exact site of osteotomy is then chosen in relation to the series of holes in the plate, making sure the intended cut is through cancellous bone, oblique, and proximal to the joint capsule of the distal radioulnar joint (DRUJ). The plate is then removed and the osteotomy cuts made with a saw using standard principles of soft tissue protection and cooling irrigation (prime attention given to protection of the dorsal branch of the ulnar nerve). The amount of bone resection is determined by the pre-operative templating and is tailored to individual patient requirements with most osteotomies removing between 2 mm to 4 mm of bone. The plate is then reapplied to the distal ulna and the osteotomy compressed. With the osteotomy held manually compressed the final screws are inserted into the shaft of the plate proximally. If the plate model selected uses oval holes, then the osteotomy can be further compressed by drilling eccentrically at the proximal edge of the oval hole for each successive screw until the osteotomy is so tightly compressed that it blocks any further translation of the plate. Intraoperative imaging should be used to check the fit of the osteotomy and the placement of the hardware (Fig. 5). Particular attention should be given to rule out penetration of the DRUJ given the multiplicity of screws entering the ulnar head. Clinical assessment should support the imaging findings with a full range of smooth and congruent joint motion appreciable in both the wrist and the DRUJ. Closure is with 4-0 absorbable monofilament for periosteum, antebrachial fascia and dermis with steristrips on the skin surface. The wrist is splinted in extension with the hand and forearm free. Rehabilitation includes a thermoplastic custom splint worn for protection but removed daily for active full range of motion exercises. Strength training is not permitted until clinical and radiographic union is achieved at around 6 weeks.

Fig. 2 This current generation plate designed specifically for ulnar shortening osteotomy still constitutes a substantial amount of hardware. The diaphyseal segment of the ulna demonstrates radiographically slow maturation of healing in this clinically fully healed patient at 5 months following surgery

Discussion

Clinically significant ulnocarpal impaction can occur in several settings. Many patients with congenitally ulnar positive variance simply become symptomatic over time. Some sustain an acute on chronic tear of the fibrocartilage disc that renders them symptomatic [6]. Others develop impaction as a result of shortening from a distal radius malunion. Even patients with neutral or ulnar

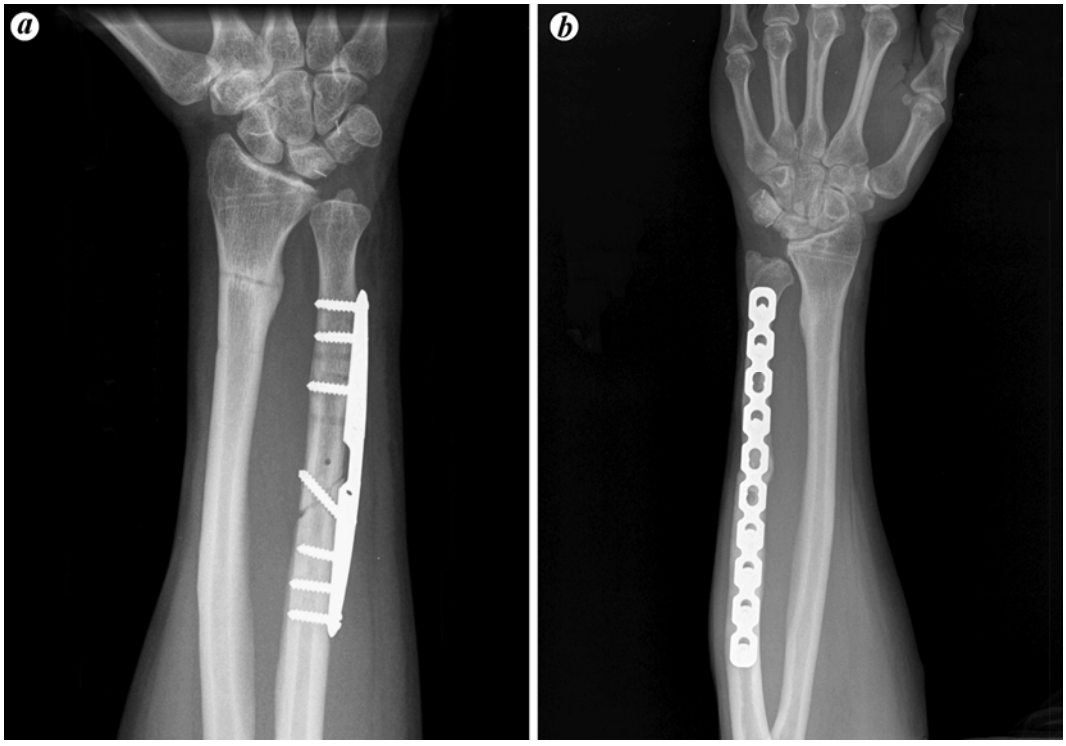

Fig. 3 (**a**) Another current generation plate designed specifically for ulnar shortening osteotomy led ultimately to nonunion in this patient that would not stop smoking. (**b**) Long revision plating and bone graft were required to achieve osteosynthesis

Fig. 4 A 2.3 mm plate used for fixation of a comminuted distal ulnar fracture

negative variance can ultimately be diagnosed with clinical ulnocarpal impaction as long as other sources of ulnar wrist pain have been carefully ruled out. Non-surgical treatment should be pursued initially, including activity modification, oral non-steroidal medications, intermittent splinting, and corticosteroid injection. Some patients will respond effectively with long term relief. Many will relapse after temporary relief and require surgical treatment. The common theme of all effective treatments is increasing the distance between the bony prominence of the ulnar head and the carpal bones. Factors that need to be considered include the slope of the DRUJ and any focal points of cartilage loss in that joint. The relative contribution to the patient's symptoms of ulnar head to proximal ulnar lunate approximation (ulnocarpal impaction) must be evaluated compared to any ulnar styloid to triquetrum approximation (stylocarpal impaction). These assessments and others form the basis of choosing the exact method of ulnar shortening osteotomy to be performed. For instance, a wafer resection of the ulnar head (Feldon procedure – open or arthroscopic) will not contribute to lessening any stylocarpal impaction as opposed to a more proximal ulnar shortening osteotomy (Fig. 1). A wafer resection may reduce the cross sectional area of contact between the ulnar seat and the sigmoid notch and thus concentrate joint reactive forces in the DRUJ. Alter-

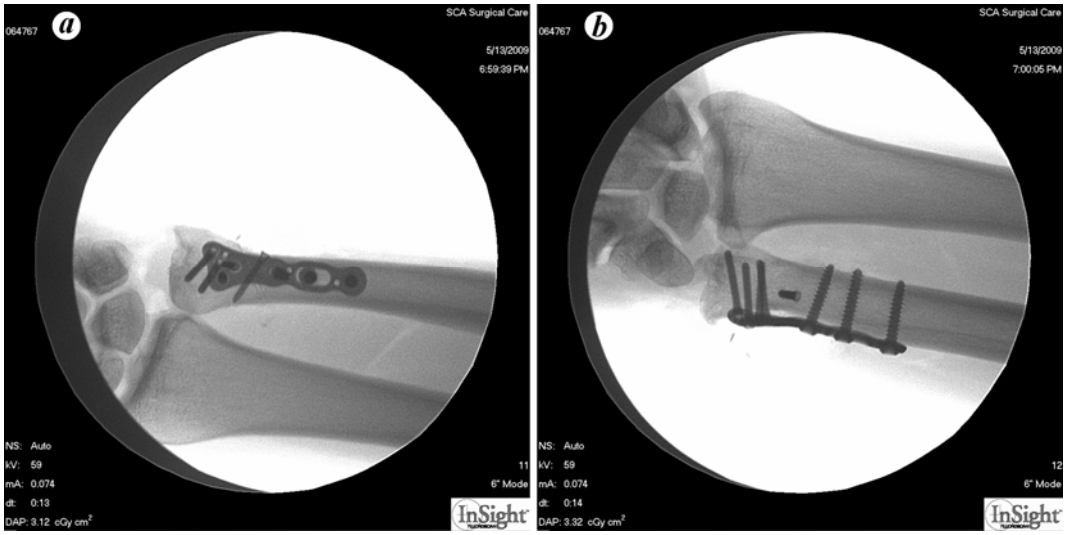

Fig. 5 A 2.3 mm plate used for subcapital ulnar shortening osteotomy. (**a**) PA image shows intra-operative confirmation of correct slight ulnar negative variance and tightly closed osteotomy, (**b**) lateral view of ulna shows intra-operative confirmation of correct screw lengths with particular emphasis on not penetrating either the DRUJ or the ulnocarpal joint

Fig 6 The 5 cm incision used to place the volar locking plate for a distally located ulnar shortening osteotomy

natively, a proximal ulnar shortening osteotomy will increase joint reactive forces when there is a prominent slope of the DRUJ on the posteroanterior radiograph from distal radial to proximal ulnar. A comparative study of the wafer resection and a proximal shortening osteotomy showed a higher complication rate for the proximal osteotomy based on delayed union and the need for painful hardware removal [5].

Despite these considerations, an osteotomy of the ulnar diaphysis with plate fixation has remained the most common method of addressing ulnocarpal impaction (Fig. 2). The chief problems seen with this operation, though, are delayed union, nonunion, and symptomatic plates requiring removal (Fig. 3). Time to union has been documented as high as 10 months, with other research showing an average of 4.1 months in non-smokers and 7.1 months in smokers [1, 4]. Plate removal rates range from 35% to 45% [2, 3, 5]. Various modifications have been introduced in the hope of lessening these high complication rates [7–11]. No difference in outcomes has been demonstrated between freehand osteotomy with plating and systems designed to make guided cuts referenced from a specially designed plate [8, 10].

These problems of delayed union, nonunion, and symptomatic hardware are all fundamental to the selection of the ulnar diaphysis as the site for osteotomy. Optimal healing for an osteotomy occurs through cancellous bone with the broadest possible contact surface area, compression, stability, and good blood supply. To achieve stability and compression in the ulnar diaphysis, experience from forearm fractures indicates that a 3.5 mm plate is needed with 6 cortices of fixation on either side of the osteotomy; although one study used a 2.7 mm plate and found no nonunions in 24 patients [11]. Experience with the use of 2.3 mm and 2.4 mm plates for fixation of comminuted fractures in the distal ulna has demonstrated that the patients can undergo early motion without hardware failure (Fig. 4). When fracture geometry does not dictate plate positioning during elective osteotomy, a small plate can be placed on the volar surface of the distal ulna in the concavity of the metaphysis to create minimal soft tissue interference (Fig. 5). The flexor carpi ulnaris myotendinous junction is located very distal. To date no hardware removal has been required in these osteotomies performed through the cancellous bone just proximal to

the ulnar head. With the possibility of multiple points of fixation into the ulnar head using new generation small implant designs, a small implant is sufficient. The incision length is less than half that of a diaphyseal ulnar shortening osteotomy. The cancellous interface osteotomy is routinely healed both clinically and radiographically by 6 weeks as opposed to much longer for a diaphyseal osteotomy [1, 4]. No plates have yet required removal. Surgical time is less than 30 min as opposed to the reported mean 2 h surgical time for one research team to perform a series of 37 freehand osteotomies in the diaphysis [8]. More widespread use of the subcapital osteotomy at multiple centers will be required to define the true incidence of complications and reproducible outcomes as applied to a community setting.

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