Fragment-specific Volar Hook Plate for Volar Marginal Rim Fractures

Adam J. Bakker, MD and Alexander Y. Shin, MD

Abstract: The volar lunate facet/volar marginal rim fragment of distal radius fractures is a challenging problem for current volar plating systems to adequately maintain internal fixation. Fragment-specific wireforms and other constructs can be used to capture these difficult fragments but are difficult to place and have limited resistance to bending and axial load. Fixed-angle volar plates have limited distal translation without increasing the risk of flexor tendon rupture. Failure to reduce and maintain reduction of these volar ulnar intra-articular distal marginal rim fractures result in disastrous volar carpal subluxation. We present an alternative surgical technique using a low-profile volar hook plate designed specifically to address this fragment. The first 6 cases are presented here with no observed surgical complications to date.

Key Words: volar hook plate, volar marginal rim fractures, distal radius fractures

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HISTORICAL PERSPECTIVE

Over the past decade, the trends of treatment of displaced distal radius fractures has been with a volar approach popularized by Orbay[1] and rigidly secured using a locked fixed-angle plates.[2–7] The popularity of volar plate fixation has allowed for earlier return to function following volar fixation compared with other types of fixation.[8] However, complex intra-articular fractures with a volar lunate facet/volar marginal rim fragment of the distal radius fractures can be difficult to maintain reduction[9] with current fixed-angle volar plate technology. Stability of the volar lunate facet/volar marginal rim fracture is critical to providing structural support of the carpus, and failure to maintain reduction of this fragment can lead to catastrophic volar carpal subluxation or dislocation.[9–11] A variety of methods have attempted to capture and maintain reduction of the volar lunate facet/volar marginal rim fractures including tension band wire technique,[12] distal buttress plating,[13] K-wires,[14,15] and compression screw.[15] Few fixation systems have addressed this fragment until Medoff[16] popularized the concept of fragment-specific fracture classification to help better understand the various fragments associated with articular distal radius fractures including the volar rim fragment. Medoff recommended the use of a volar ulnar buttress wireform for these extremely distal marginal rim fractures. Although this implant results in excellent fixation, it can be technically challenging to insert.

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The aim of this study was to describe the design rationale, technique, and preliminary outcomes of a fragment-specific volar hook plate that allows capture and maintenance of reduction of distal volar lunate facet/volar rim fragment.

INDICATIONS/CONTRAINDICATIONS

The indication for the use of the volar hook plates is for distal lunate facet/volar marginal rim fragments of the distal radius (Fig. 1). It also can be applied to distal volar scaphoid fossa fragments. Typically, it is most often used as a part of a fragment-specific fixation for complex intra-articular fractures; this would include radial column and dorsal ulnar fragment fixation. It is also appropriate for osteoporotic bone because of its fixed-angle technology. The narrow size of the plates allows for a wide degree of placement possibilities owing to limited width size, and its distally fixed-angle hooks permits as much distal purchase of the cortex while being just distal to the watershed line. Contraindications are open fractures with inadequate soft tissue coverage, pediatric fractures with open physis, and fractures with a large volar metaphyseal void. Fragments smaller than 3 to 4 mm in size are contraindicated with this technique.

PREOPERATIVE PLANNING

Complex comminuted intra-articular fractures of the distal radius may require advanced imaging to clearly delineate the fracture patterns. A computerized tomographic image of the volar ulnar corner (or volar lunate facet) can be helpful in determining if the volar hook plate would be an appropriate implant. If the fracture is comminuted or is <3 to 4 mm, alternative methods of fixation are necessary. These fractures may require multi-incision approaches and fragment-specific techniques, and the surgeon should plan appropriately.

SURGICAL TECHNIQUE

A volar approach to the distal radius is made that follows the flexor carpi radialis tendon. If a multi-incision approach is made to the wrist, the incision can be shifted ulnarly by 0.5 cm to allow enough of a soft tissue bridge between the radial incision (for the radial styloid fixation). The flexor carpi radialis is mobilized, the floor of the flexor carpi radialis is incised, and the flexor tendons/median nerve are retracted ulnarward. The brachioradialis tendon is identified and divided if necessary to facilitate fracture reduction. The pronator quadratus muscle is identified, and the radial and distal margins are visualized. The pronator quadratus is sharply elevated from the radial side of the radius and bluntly elevated from the distal margin, taking care not to violate the radiocarpal ligaments. It is important to elevate the pronator quadratus to the most ulnar aspect of the radius and obtain excellent visualization of the entire volar ulnar fragment.

The fracture is visualized, cleaned of hematoma and debris, the edges of the fracture are clearly visualized, and a reduction is obtained (Fig. 2). This reduction can be facilitated by placement of

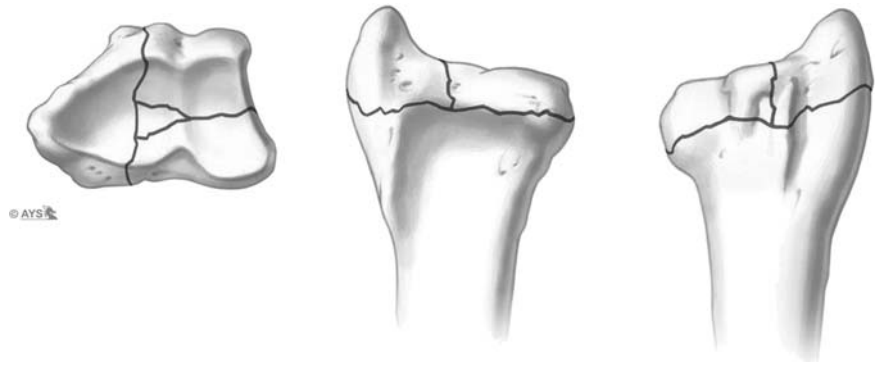

FIGURE 1. Typical complex intra-articular distal radius fracture with a volar lunate facet/volar rim fragment, die punch fragment, dorsal ulnar fragment, and radial styloid fragment. Illustration with permission of A.Y. Shin copyright ©2013.

a bone clap on the radius shaft and traction of the hand. A dental pick or freer elevator can also be used to assist in the elevation of fragments. The volar ulnar corner is reduced anatomically first. It is important to understand that often the volar ulnar corner is covered with the volar carpal ligament attachments and all that can be seen is the fracture line. The volar carpal ligaments must be kept intact and not violated. The fragment is reduced and held in place with a temporary 1.1 mm (0.045 inches) K-wire. The K-wire should be placed such that there is room on the ulnar corner to place one leg of the hook plate. The volar radial fragment, if present, is reduced in a similar manner.

The plate and inserter are held such that the tines of the hook plate are placed at approximately 1 to 2 mm from the distal edge of the radius (Fig. 3). The shaft of the hook plate is positioned parallel to the radius shaft. Because the tines of the hook plate are angled back, they will engage into the fragment and not be intra-articular. The tines of the hook plate are engaged into the fracture fragment distal to the watershed line. Fluoroscopic image of a perfect lateral as well as a radial tilt view are important to carefully evaluate to avoid intra-articular penetration. For a hook plate placed ulnarly, the tines are positioned parallel to the articular surface, and the radioulnar alignment is also verified so the ulnar edge of the plate will be collinear with the ulnar aspect of the radius shaft. The inserter is gently tapped with a small mallet and the tines are engaged and tapped into the fracture fragment. Just prior to seating the hook plate fully, the inserter is disengaged and reposited over hooks final impaction.

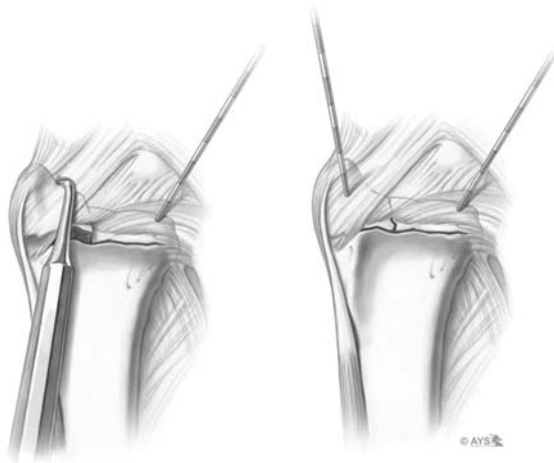

FIGURE 2. Fracture visualization and temporary reduction. Illustration with permission of A.Y. Shin copyright ©2013.

Holding the proximal aspect of the plate to the radius, the 1.8 mm drill is used to secure the plate to the radius shaft with a 2.3 mm screw. A locking peg (either threaded or smooth) can be placed in the locking hole when the dorsal fragments have been reduced. Verification for placement on fluoroscopic image is necessary. An additional hook plate can be placed radially if needed (Fig. 4).

COMPLICATIONS

To date there have been no observed complications. Potential complications that could arise are infection, intra-articular penetration of the volar hook plate tines, failure of maintenance of reduction, need for a second surgery to remove hardware, and potential flexor tendon irritation/rupture. The rationale for the narrow plate design was to allow greater freedom capturing the volar lunate facet/volar marginal rim fragment and to minimize potential flexor irritation/rupture by allowing the flexor tendons to avoid the plate, especially the radial-sided tendons. The potential rational why there has been no flexor tendon irritation/rupture could be because of this narrow design of the plate. The narrow dimension of the plate allows placement adjacent to or distal to the watershed line on the ulnar aspect of the distal radius without violation of the watershed line radially. The narrow width of plate was designed to allow freedom of the plate placement without the concern of having the plate too prominent radially. It is also imperative that the plate and hooks be fully seated against the volar bone cortex to prevent any irritation, especially when used for the radial volar fragment.

If the fragments are too small or comminuted, the use of this device is contraindicated and alternative methods to address the volar ulnar fragment are necessary. If the implant is designed to be inserted after the fracture fragment is reduced. If it is not, the fragment will either rotate or be malreduced once it is fully seated on the radial shaft. If it is inserted at a wrong angle, it can be removed and reinserted at a correct angle. Care must be taken not to further fragment the volar ulnar corner.

CASE SERIES

Results of the first 6 patients, involving 8 wrists, with complete articular involvement, AO type C fractures of the distal radius (all of which presented with a distal volar lunate facet/volar

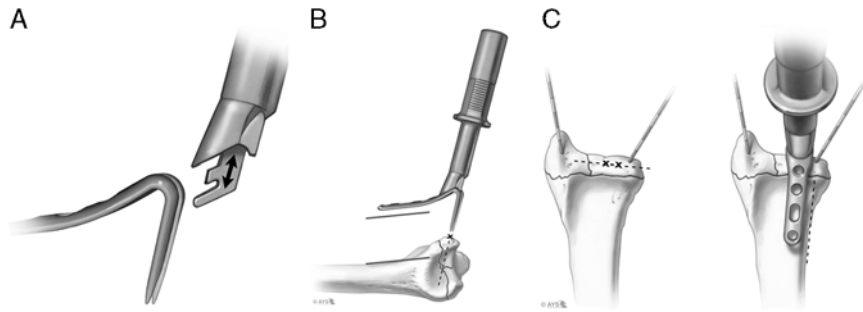

FIGURE 3. A, The volar hook plate and inserter are docked. B, Placement of the volar hook plate and inserter parallel to the radius shaft. C, Ulnar placement of volar hook plate adjacent to or just distal to the watershed line and parallel to the ulnar boarder of the radius. Illustration with permission of A.Y. Shin copyright ©2013.

rim fragment) are presented here from May to August 2012. The average age of the 4 male patients was 47.3 years and the 2 female patients was 46.5 years. Average follow-up from surgery to their last follow-up was 28.4 weeks (ranging from 14 to 40 wk). Five of the patients were right-hand dominant and 1 was left-hand dominant. All of the patients sustained high-energy fractures on their dominant hand and 2 of the male patients had bilateral distal radius fractures. The most common mechanism was a fall from a ladder, 4 patients, with 1 patient each involved in motor vehicle collision and 40-foot fall while attempting to rock climb. Two patients received ulnar styloid fixation and 1 patient with bilateral injuries had bilateral TFCC repairs. Patients received 1 or 2 volar hook plates for fixation of the distal volar lunate facet/volar rim fragment as well as a radial column plate fixation and 1 to 3 dorsal pin plates for fragment-specific fixation technique. Bone allograft was used in every patient. A dorsal arthrotomy was used to evaluate the articular reduction in all cases. Average range of motion for the 8 involved wrists at their last follow-up was: flexion 49.5 degrees, extension 50 degrees, supination 73.8 degrees, and 79.4 degrees of pronation. Five of the 8 wrists had no pain, 2 had no pain at rest but mild to moderate pain with use, and 1 had mild pain. All patients had maintenance of the volar marginal rim fixation, and no patient had volar radiocarpal subluxation or dislocation.

CASE EXAMPLE

We describe an example case of a 67-year-old right-hand dominant man who fell 9 feet off a ladder (Fig. 5). He sustained a communicated intra-articular left distal radius fracture including a distal volar lunate facet/volar rim fragment. He underwent fragment-specific operative fixation of this fracture 3 days after injury with a volar hook plate for his volar lunate facet/volar rim fragment, a volar hook plate for a volar radial fragment, as well as a radial column plate fixation and 2 dorsal pin plate fixation using TriMed fragment-specific distal radius fixation system (Trimed Inc., Santa Clarita, CA) (Fig. 6). His distal radial ulnar joint was stable; therefore, his ulnar styloid fracture was not addressed. At his last follow-up at 36 weeks, his postoperative range of motion was: flexion 55 degrees, extension 40 degrees, supination 65 degrees, and pronation 85 degrees. He had no pain at rest and mild pain with strenuous use.

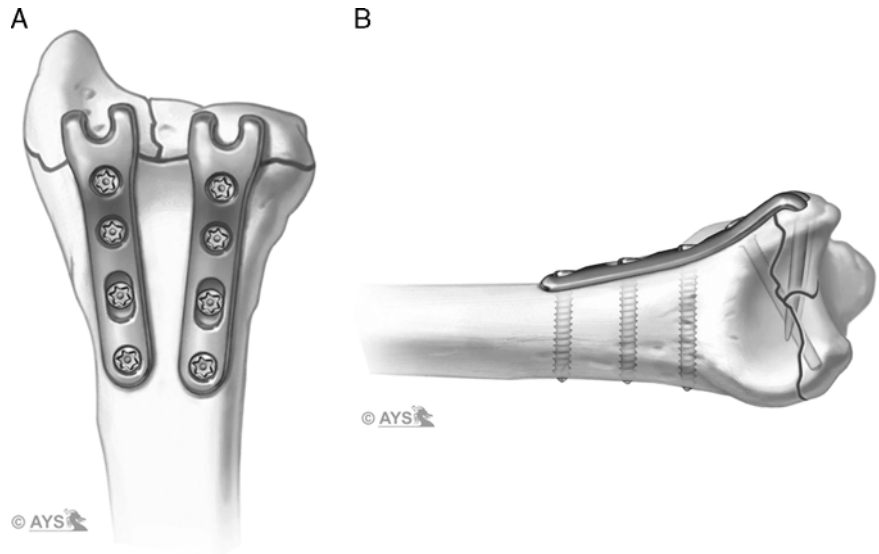

FIGURE 4. A, Final position of volar hook plates with placement of 2.3 mm shaft screws. Placement of an additional hook plate radially if needed. B, Lateral view showing a locking peg (either threaded or smooth) can be placed upon dorsal reduction at the distal most screw hole. Illustration with permission of A.Y. Shin copyright ©2013.

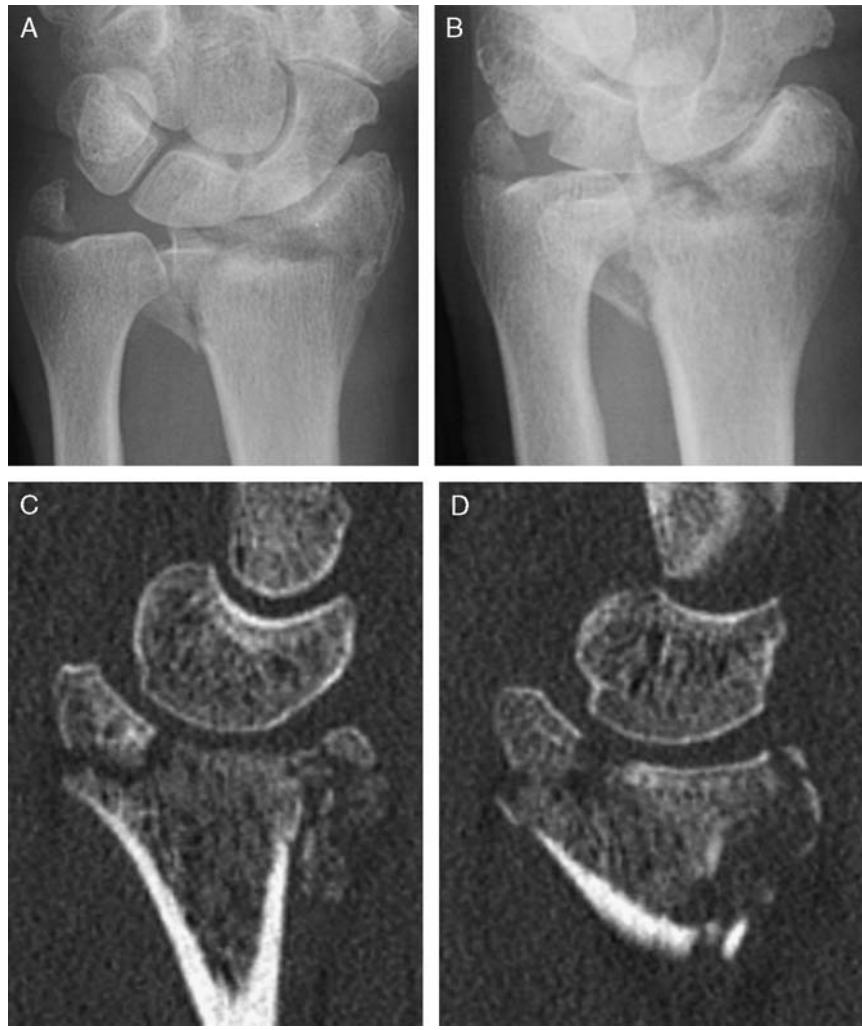

FIGURE 5. A, Posteroanterior x-ray of a 67-year-old man with communiated AO type 3 left distal radius fracture, including a distal volar lunate facet/volar rim fragement B, Oblique x-ray showing intra-articular displacement and comminution. C, Sagittal computed tomography (CT) scan image with volar to the left, demonstrating the small distal volar lunate facet/volar rim fragement, loss of volar inclination, and dorsal communition to the right of the image. D, Sagittal CT scan image further demonstrating the small distal volar lunate facet/volar rim fragment.

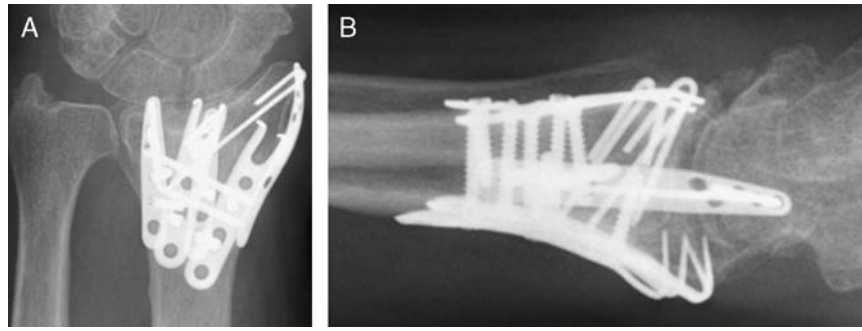

FIGURE 6. A, Postoperative posteroanterior x-ray after open reduction and internal fixation using 2 volar hook plates: one volar hook plate to capture and maintain reduction of the distal volar lunate facet/volar rim fragment and another volar hook plate to capture and maintain volar radial fragment. A radial column plate and 2 dorsal pin plate using fragment-specific fixation technique is also shown. B, Lateral x-ray demonstrating return of volar inclination and capture of the distal volar lunate facet/volar rim fragment.

SUMMARY

We present a surgical technique using the volar hook plates that enables to capture and maintain reduction of the difficult distal volar lunate facet/volar rim fragment. At present, we have performed and reported the results of 6 patients who have undergone the use of this plating system without any complications to date.

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