SCIENTIFIC ARTICLE

# Distal Radius Volar Locking Plate Design and Associated Vulnerability of the Flexor Pollicis Longus

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**Purpose** Flexor pollicis longus (FPL) tendon rupture is a well-documented complication related to the use of distal radius volar locking plates (VLPs). The final common pathway of flexor tendon rupture appears to involve implants prominent at the watershed line. We hypothesized that significant differences in VLP prominence exist between various plate designs.

**Methods** Ten fresh frozen specimens were dissected to identify the path of the FPL in relationship to the distal radius at the watershed line. Five VLP designs were fixed to each specimen based on their anatomic fit, and slid distally until the distal edge of the plate reached the watershed line. The position of each fixed plate was evaluated by fluoroscopy. We used a 3-dimensional laser scanner to create computer models. The total surface area of plate prominence volar to the watershed line and the prominent area beneath the FPL were measured in the axial plane using computer software.

**Results** At the watershed line, the FPL was located at 54% of the maximal width of the radius, as measured from its volar-ulnar corner. There were no significant differences in the location of plate fixation on lateral view radiographs according to the classification of Soong et al. The mean total surface area of plate prominence was 36 $mm^2$. The mean prominent area beneath the FPL was 10 $mm^2$. Significant differences in plate prominence were noted for various designs.

**Conclusions** Despite optimal plate placement, various VLP designs were observed to have prominent profiles volar to the watershed line, to varying extents.

**Clinical relevance** The results raise concerns regarding interference between all of the analyzed VLP designs and the FPL. This study may help guide both implant design considerations and assist the surgeon in better understanding implant morphology as it relates to iatrogenic flexor tendon injury. *(J Hand Surg Am. 2014;39(5):852–860. Copyright © 2014 by the American Society for Surgery of the Hand. All rights reserved.)*

**Key words** Distal radius fracture, flexor tendon rupture, plate prominence, volar plating, watershed line.

The treatment of distal radius fractures has evolved considerably over the past decade owing to advancements in implant technology and surgical techniques. Since its introduction in 2000,[1] the volar locking distal radius plate (VLP) has become the workhorse for the treatment of unstable distal radius fractures. The frequency of the use of these plates has more than doubled over the past

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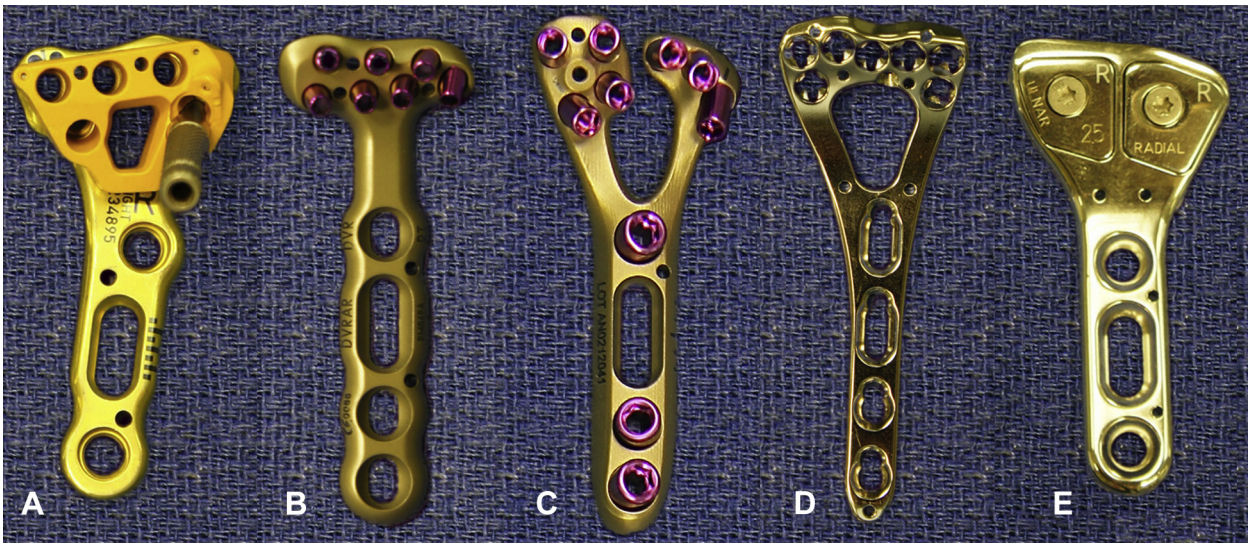


**FIGURE 1: A** Acu-Loc 2 Proximal VDR plate (Acumed, Hillsboro, OR), standard size, head width 24.4 mm, titanium alloy. **B** DVR Anatomic (Hand Innovations, Warsaw, IN), standard size, head width 24.4 mm, titanium alloy. **C** Geminus distal radius volar plate (Skeletal dynamics, Miami, FL), standard size, head width 24.5 mm, titanium alloy. **D** A 2.4-mm variable-angle LCP 2-column volar distal radius plate (Synthes, West Chester, PA), standard size 7-hole, head width 25.5 mm, stainless steel. **E** CoverLoc volar plate (Tornier, Bloomington, MN), head width 25 mm, stainless steel.

decade.[2] However, despite its popularity, VLP fixation predisposes patients to specific risks and complications, such as intra-articular screw placement, prominent hardware, and possible extensor and flexor tendon injury.[3] Before the introduction of VLPs, flexor tendon ruptures after distal radius fracture fixation were less frequent and most often reported to result from malunion, chronic use of steroids, prominent hardware, or the improper use of plates and screws.[4–8]

The flexor pollicis longus (FPL) and flexor digitorum profundus tendons travel close to the volar ridge of bone in the distal radial metaphysis, which is known as the watershed line.[9] This landmark is clinically important because placement of the VLP distal to the watershed line may be associated with increased rates of flexor tendon irritation, fraying, and ultimately, rupture. Furthermore, the final common pathway of flexor tendon rupture after VLP fixation appears to involve prominent implants at the watershed line.[10] Drobetz and Kutscha-Lissberg[11] reported FPL tendon ruptures in 12% of their population during the use of an early VLP design (Mathys, Salzburg, Austria). They concluded that plate design and distal plate placement contributed to tendon-related problems.

In an attempt to reduce the incidence of flexor tendon attritional injury and provide maximal stability, recent plate designs have enhanced anatomical contours, lower profiles, and variable-angle locking screws. Despite these design modifications, attritional flexor tendon injury continues to be problematic.[12,13]

The aims of this morphometric study were to evaluate volar plate prominence of various VLP designs and to assess the relationship of the FPL to the watershed line, because these parameters may be associated with flexor tendon attritional injury. Particular emphasis was placed on the FPL tendon, because this is one of the most frequently damaged structures after volar plate fixation. This information may aid surgeons in making a more informed decision during plate selection and placement.

## MATERIALS AND METHODS

Twelve fresh-frozen, matched-pair, elbow-to-hand specimens were obtained for this study. Wrist x-rays were performed on all specimens, and 1 pair was excluded after a healed distal radius fracture was identified. The remaining 10 specimens were studied in detail. We studied 5 current designs of widely used plates. To be included, each plate was required to have an anatomical precontoured design, manufacturer-recommended fixation proximal to the watershed line, and a standard head size with a range between 24 and 26 mm. Figure 1 shows the details of each design. Throughout the text, the various VLP designs are denoted as plates A, B, C, D, and E.

### Dissection, plate fixation, and data acquisition

Before dissection, we thawed the specimens at room temperature. To standardize our dissection and subsequent mapping of the path of the FPL, each specimen was