

Danger Zones for Flexor Tendons in Volar Plating of Distal Radius Fractures

Sonya P. Agnew, MD, Karin L. Ljungquist, MD, Jerry I. Huang, MD

Purpose To define a danger zone for volar plates using magnetic resonance imaging by analyzing the position of the flexor tendons at risk around the watershed line.

Methods We analyzed 40 wrist magnetic resonance images. The location of the flexor pollicis longus (FPL) and index flexor digitorum profundus (FDPI) tendons was recorded at 3 and 6 mm proximal to the watershed line of the distal radius. We measured the distance between the volar margin of the distal radius and the FPL and FDPI tendons, and the coronal position of the tendons.

Results At a point 3 mm proximal to the watershed line, FPL and FDPI were located on average 2.6 and 2.2 mm anterior to the volar margin of the distal radius. This distance increased to 4.7 and 5.3 mm at a point 6 mm proximal to the watershed line. The FPL and FDPI were located at 57% and 42% of the total width of the distal radius from the sigmoid notch at 3 mm from the watershed, and at 66% and 46% at 6 mm from the watershed.

Conclusions Surgeons should be aware of the close proximity of the flexor tendons to the volar cortex of the distal radius proximal to the watershed line and their radial to ulnar position. Three millimeters proximal to the watershed line, plate placement more than 2 mm anterior to the volar cortex or the use of plates thicker than 2 mm poses a high risk for directly contacting flexor tendons.

Clinical relevance This article may prove to be helpful in avoiding flexor tendon injury during volar plate fixation. (*J Hand Surg Am.* 2015;40(6):1102–1105. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)

Key words Watershed line, distal radius, flexor tendon rupture, volar plating, danger zone.

FLEXOR TENDON RUPTURE IS A well-recognized complication after volar plating of distal radius fractures, with an incidence as high as 12%.^{1–7} Before the introduction of volar plate fixation, flexor tendon rupture after distal radius fractures was described in case reports as a rare complication related to attritional rupture over malunited fractures.^{8–11}

The relationship of flexor tendons to the watershed line—the location of the origin of the volar carpal ligaments and the bony prominence where flexor tendons are most closely apposed to the distal radius—has been well described in cadaveric studies.^{12–14} Distal plate placement brings hardware in closer contact with flexor tendons and is thought to lead to pressure necrosis or attritional rupture. Limthongthang et al¹² in a detailed morphometric study compared 5 commonly used volar plates and their relationship to the flexor pollicis longus (FPL) tendon based on cadaver dissections. They concluded that volar locking plates had at least some prominence volar to the watershed line, even with ideal plate placement. In addition to FPL tendon ruptures, ruptures of the index finger flexor digitorum profundus (FDPI) tendon have been described.^{3,5,6} Soong et al⁵ performed a retrospective study analyzing flexor tendon ruptures with

From the Department of Plastic Surgery, Jesse Brown VAMC, Chicago IL; the Department of Orthopaedics, Kaiser Permanente, Portland, OR; and the Department of Orthopaedics and Sports Medicine, University of Washington Medical Center, Seattle, WA.

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Corresponding author: Sonya P. Agnew, MD, Department of Plastic Surgery, Jesse Brown VAMC, 820 S Damen Avenue, Chicago IL 60612; e-mail: paisles@gmail.com.

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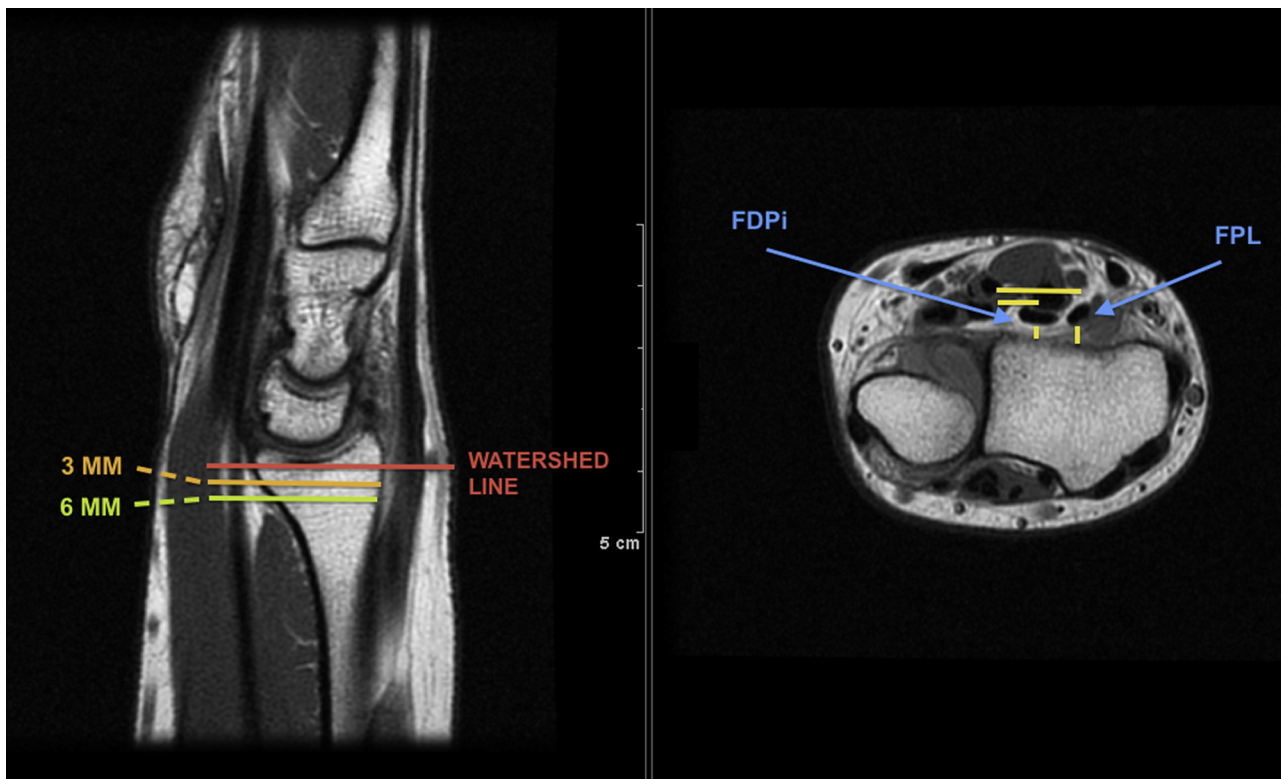


FIGURE 1: Sagittal wrist MRIs were cross-linked and referenced to axial images to locate the FPL and FDPi 3 and 6 mm proximal to the watershed line. Yellow lines on the axial image represent the distances of the FPL and FDPi tendons from the ulnar corner and volar cortex of the distal radius.

volar plating of distal radius fractures and described a classification system for the position of volar plates based on proximal and anterior location of the plate relative to the watershed line and volar lip of the distal radius.

One possible criticism of cadaver studies is that the anatomy is distorted by desiccation and dissection. We sought to study the undisturbed anatomy to quantify the native position of the FPL and FDPi tendons at the level of the watershed line *in situ* by using magnetic resonance imaging. Our goal was to define a danger zone for surgeons to keep in mind during volar plating of distal radius fractures to minimize risk of flexor tendon irritation or rupture.

MATERIALS AND METHODS

With approval from our institutional research board, we evaluated wrist magnetic resonance images (MRIs) (Centricity PACS; GE Healthcare, Little Chalfont, United Kingdom) of 40 patients without distal radius pathology. Most of the MRIs had been ordered to investigate ulnar-sided wrist pain. There were 20 men and 20 women. The watershed line was identified on sagittal images at the lunate facet and then linked and

cross-referenced to axial images. The distance from the volar cortex to the FPL and FDPi tendons was recorded at both 3 and 6 mm proximal to the watershed line. We also recorded the coronal position, the radial to ulnar position of the tendons from the sigmoid notch, expressed as a percentage of total distal radius width (Fig. 1).

RESULTS

At 3 mm proximal to the watershed line, the FPL and FDPi were located an average of 2.6 mm (± 1.0 mm) and 2.2 mm (± 1.1 mm) anterior to the volar margin of the distal radius. This distance increased to 4.7 mm (± 1.5 mm) and 5.6 mm (± 1.7 mm) at 6 mm proximal to the watershed line. The FPL and FDPi were located 44% ($\pm 8\%$) and 62% ($\pm 10\%$) of the total width of the distal radius from the sigmoid notch at 3 mm from the watershed, and 44% ($\pm 8\%$) and 65% ($\pm 8\%$) at 6 mm from the watershed.

DISCUSSION

The watershed line is an anatomic boundary point beyond which placement of volar plates risks flexor tendon irritation or rupture. Soong et al⁵ developed a system for grading plate prominence relative to the

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