Low Profile Volar Rim Plates do not Prevent Flexor Pollicus Longus Tendon Wear Compared to Distally Placed Conventional Plate

Nicole A. Zelenski, MD[1]
Elaine Schmidt, BA[1]
Daniel Gittings, MD[1]
David Steinberg, MD[1]
Michael Hast, PhD[2]

1 Department of Orthopaedic Surgery, University of Pennsylvania, Philadelphia, PA

2 Biedermann Lab for Orthopaedic Research, Philadelphia, PA

Hypothesis

A standard variable angle volar plate (VA-LCP) distal to the watershed line can be used to treat distal radius fractures with a small volar rim fragment; however, this technique may lead to inflammation, tendon wear, and ultimately rupture.[1] Low profile plates have been specifically designed to address this issue but the clinical efficacy of these implants is still unknown. We hypothesized that low profile volar rim plates would decrease contact pressure, reduce tendon-wear, and improve tendon mechanical properties relative to distally placed standard plates.

Methods

9 matched pairs of fresh-frozen cadaveric upper extremities were used in this study. Three groups were compared: 1) VA-LCP implants proximal to watershed line (VA-LCP); 2) VA-LCP implants distal to the watershed line (VA-LCP Distal); and 3) low profile volar rim plates (Volar Rim). N = 6 per group. A mass of 1 kg was hung from the thumb, and specimens were cyclically loaded by actuating the flexor pollicis longus (FPL) tendon. A thin-film pressure sensor was placed between the plate and FPL tendon and maximum contact loads were measured over the course of 10 cycles. Specimens were then cyclically loaded for 10,000 cycles. FPL tendons were harvested, photographed, and graded for wear by 5-blinded observers on a Likert scale. Uniaxial tensile testing was performed. Stress relaxation, ultimate strain, and ultimate tensile strength were recorded while stiffness and Young's modulus were determined by calculating the slopes of the linear portions of the force-displacement and stress-strain curves, respectively.

Results

Contact pressure was significantly higher in VA-LCP Distal (Median 7.6N, $p = .006$) and Volar Rim (Median 3.9N, $p = .016$) relative to VA-LCP plates (Median 0.11N) (Figure 1). Tendon-wear was also significantly increased in VA-LCP Distal (Mean 3.0, SD 0.9, $p = 0.024$) and Volar Rim plates (Mean 3.0, SD 0.7, $p = 0.015$) relative to VA-LCP plates (Mean 2.0, SD 0.5) (Figure 2). There was no significant difference in contact pressure or tendon-wear between distally placed VA-LCP and volar rim plate.There was no significant difference in mechanical properties between any of the groups.

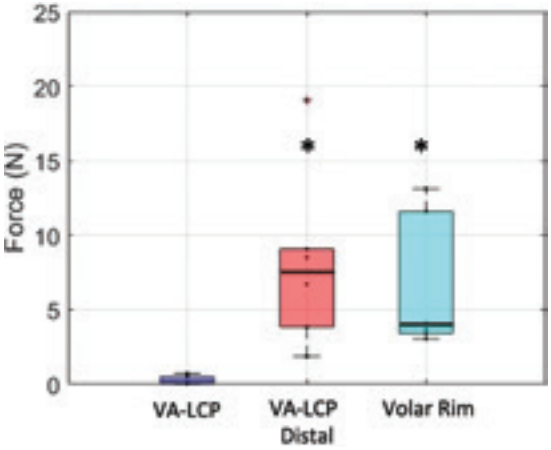

Figure 1. Median average maximum normal contact force between FPL tendon and plate increased significantly in VA-LCP placed distal to watershed line and volar rim plate when compared to VA-LCP placed proximal to the watershed line. Box represents 25%, bars represent 75%. **Indicates $p<0.05$ by Tukey Test.*

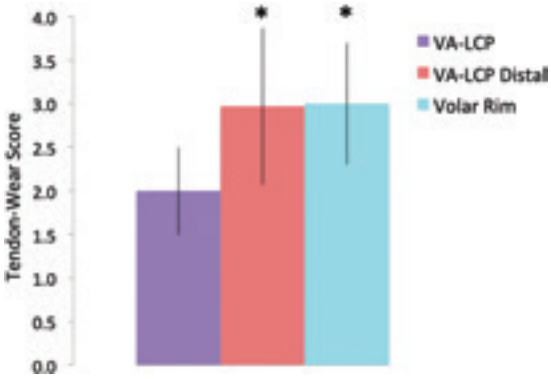

Figure 2. Mean tendon-wear score in distally placed VA-LCP and volar rim plate increased significantly when compared to appropriately placed VA-LCP. **Indicates $p<0.05$ in two tailed t-test when compared to VA-LCP group.*

Summary Points

- Plates placed distal to the watershed line including low profile rim plates have high contact pressure and high tendon-wear
- Low profile plates do not decrease contact pressure, grade of FPL tendon-wear or mechanical properties in tendons

- Although volar rim plates allow for fixation of smaller volar fragments, they do not have improved tendon-wear properties and may contribute to FPL tendon rupture if not removed.

References

1. Soong M, Earp BE, Bishop G, Leung A, Blazar P. Volar locking plate implant prominence and flexor tendon rupture. J Bone Joint Surg Am. 2011;93(4):328e335.