Number and Locations of Screw Fixation for Volar Fixed-Angle Plating of Distal Radius Fractures: Biomechanical Study

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Purpose To compare the biomechanical properties of different numbers and locations of screws in a multidirectional volar fixed-angle plate in a distal radius osteotomy cadaver model.

Methods We created an extra-articular fracture in 16 pairs of fresh-frozen human cadaver radiuses. The 32 specimens were randomized into 4 groups. All fractures were fixated with a multidirectional volar fixed-angle plate. We tested 4 different screw-placement options in the distal fragment. The distal fragment was fixed with 4 locking screws in the distal row of the plate in group a, and with 4 locking screws alternately in the distal and proximal rows in group b. In group c, 3 locking screws were used in the proximal row; in group d, 7 locking screws were used, filling all screw holes in the distal and proximal rows of the plate. The proximal fragment was fixed with 3 screws. The specimens were loaded with 80 N under dorsal and volar bending and with 250 N axial loading. Finally, load to failure tests were performed.

Results Group d had the highest mean stiffness, 429 N/mm under axial compression, and was statistically significantly stiffer than the other groups. Group b had a mean stiffness of 208 N/mm, followed by group a, with 177 N/mm. Group c showed only a mean stiffness of 83 N/mm under axial compression. There were no statistically significant differences under dorsal and volar bending.

Conclusions In this model of distal radial fractures, there was a difference regarding the stiffness and the placement of screws in the distal rows of a volar fixed-angle plate. Inserting screws in all available holes in the distal fragment offered the highest stability. Using only the proximal row with 3 screws created an unstable situation. Based on these findings, we recommend placing at least 4 screws in the distal fragment and assigning at least 2 screws to the distal row of the multidirectional screw-holes. *(J Hand Surg 2010;35A:885–891. Copyright © 2010 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Biomechanics, distal radius fracture, locking screw, volar fixed-angle plate.

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The aim of surgical treatment of distal radius fractures is to restore the anatomy and allow early active range of motion. Unstable distal radius fractures with dorsal comminution require anatomical reconstruction and stable fixation to allow optimal functional outcomes.[1,2] The results of recent studies of fixed-angle plate fixations for distal radial fractures are promising.[3–5] Open reduction and internal fixation through a volar approach with angle-stable screws has become a common method of treatment for most unstable distal radius fractures.[6–9] Locking volar plates are considered to provide more stability than conventional plates, especially in osteoporotic bone. Despite the availability of anatomically shaped plates, there is a risk of intra-articular screw placement.[9] In comminuted fractures, the subchondral bone support might be insufficient, with secondary loss of reduction despite angular stable fixation. Multidirectional angular plates that allow screw placement within 2 rows in the distal fragment were developed to prevent this.

Many biomechanical studies concerning the distal radius have been published. Typically, they compare different plates under axial loading.[10–15] We identified only 2 studies investigating the influence of volar and dorsal bending.[16,17]

It is still unclear how many locking screws should be inserted in the distal fragment using a volar locking multidirectional plate with the possibility of 2 rows of screw placement. The purpose of this study was to compare the biomechanical properties of 4 different configurations of screw placement in a volar anatomically shaped plate, which allows angle-stable screw placement in multiple directions. Loading tests were performed under axial compression as well as under dorsal and volar bending conditions.

MATERIALS AND METHODS

Specimen

We selected 32 fresh-frozen cadaver radiuses (16 matched pairs) with no bony deformation and stripped the soft tissues from the bone. We performed x-rays of each bone. The specimens were obtained from the Anatomical Institute of our university; we obtained permission from the ethics commission. Specimens were stored at −20°C until needed for implantation and testing. The average age of the cadavers was 79.3 years of age (minimum, 61 years; maximum, 99 years). A total of 28 pairs were female and 4 were male. We performed bone mineral density measurements using peripheral quantitative computed tomography. The specimens were randomized into 4 groups of 8 specimens each.

Radiuses were cut at a standard length of 11 cm and an extra-articular AO-type A3 fracture was created by the removal of a one-cm-wide segment of bone centered 20 mm proximal to the tip of the radial styloid. All fractures were stabilized with a multidirectional volar fixed-angle plate (APTUS Radius 2.5; Medartis, Basel, Switzerland). Locking screws were used in the distal part of the implant. We studied 4 different screw configurations in the distal fragment (Fig. 1): Group a had 4 locking screws in the distal row of the plate. Group b had 4 locking screws alternately in the distal and proximal rows of the plate (always begun at the tip of the

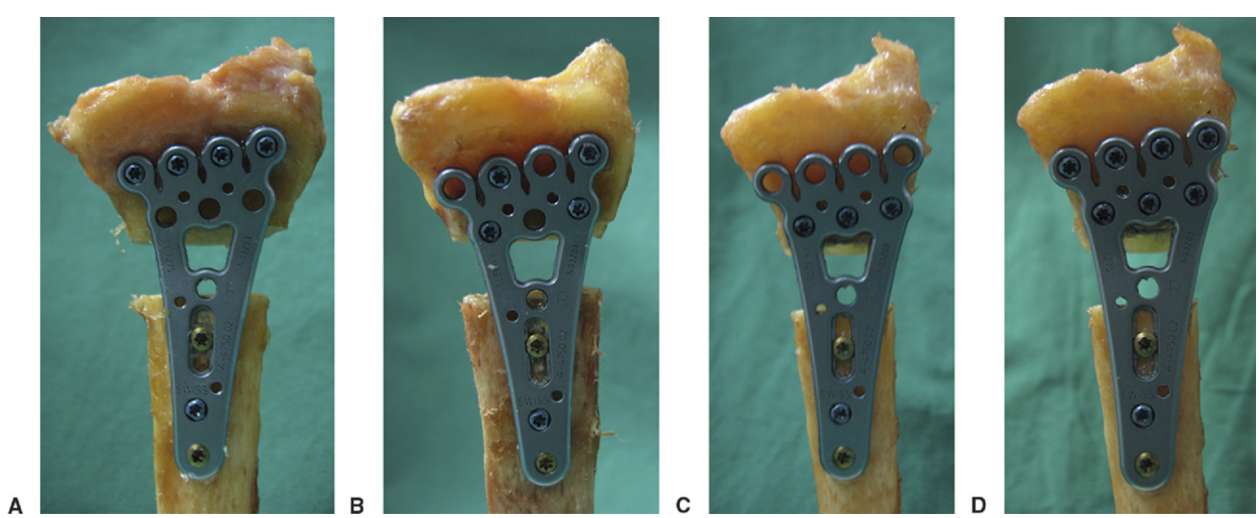

FIGURE 1: Four different screw placement configurations in the distal fragment: **A** locking screws in the distal row of the plate, **B** 4 locking screws alternately in the distal and proximal row, **C** 3 locking screws in the proximal row, and **D** 7 locking screws filling all screw holes in the distal and proximal row of the plate.