SCIENTIFIC ARTICLE

Volar Plating of AO C3 Distal Radius Fractures: Biomechanical Evaluation of Locking Screw and Locking Smooth Peg Configurations

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Purpose The goal of this study was to determine whether locking screws or smooth locking pegs optimize fixation of AO C3 intra-articular distal radius fractures. A secondary goal was to determine which combinations of locking screws and smooth locking pegs influence construct stability.

Methods In anatomic radius models, AO C3 intra-articular distal radius fractures were fixed using volar locking plates. For the first part, 16 specimens were randomized to receive either 2 locking screws or 2 smooth locking pegs in each of the 3 pairs of holes in the plate. For the second part, 30 specimens were randomized to receive any 4 combinations of locking screws and smooth locking pegs in each of the 3 pairs of holes. Axial loading to failure was applied.

Results Constructs consisting of 4 smooth locking pegs within the lunate fragment were significantly weaker than constructs with 4 locking screws (means 626 N vs 981 N, respectively). Constructs with smooth locking pegs in the ulnar positions of the lunate fragment were weaker than with locking screws in these positions (means 737 N vs 977 N, respectively). Locking screws in the subchondral position of the lunate fragment were stronger than smooth locking pegs in these positions (means 1,227 N vs 934 N, respectively) and any other combination (means 1,227 N vs 942 N, respectively).

Conclusions Use of locking screws as opposed to smooth locking pegs for AO C3 intra-articular distal radius fractures, particularly subchondral and in the ulnar side of the lunate fragment, optimizes construct stability. This may have implications on postoperative rehabilitation protocols and may limit costs related to use of volar locking plates. *(J Hand Surg 2008;33A:827–834.*

Key words Distal radius fracture, locking plate, volar plate.

In no area of fracture management has there been such a recent explosion of new treatment modalities as there has been in distal radius plating. However, very little evidence-based research actually exists to support the dramatic increase in use and development of volar locking plates.[1,2] A perceived difficulty with commonly used modalities for distal radius fractures on the part of the orthopedic community has been enough to drive into existence an entirely new set of options for distal radius fixation. Because of a high rate of compli-

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cations with dorsal plate placement and with the advent of fixed-angle screw-plate designs, volar fixation has become the standard approach for distal radius fractures with joint congruity.[3–12]

Fixed-angle locking plates are implants with screws or pegs that lock into the plate at a fixed trajectory. The peg or screw head usually has a thread to engage the corresponding screw hole in the plate. Fixed-angled locking plate designs have improved strength characteristics compared with traditional nonlocking plates to resist angular motion. Many volar locking plate designs are available with more than a single row of distal fixation to potentially provide additional distal fragment fixation strength and improve subchondral support.

Volar locking implant manufacturers often offer the option of locking smooth pegs or locking threaded screws. Smooth pegs are intended for subchondral support according to manufacturer guidelines, whereas screws allow direct purchase of bone fragments. The locking pegs may have the advantage of allowing closer placement to the subchondral surface with less concern of screw thread penetration into the joint. However, the specific roles for locking pegs and locking screws or the actual need for this option have not been studied. The optimal configuration or arrangement of locking screws and pegs within the plate has also not been examined experimentally. The choice of using a locking peg or locking screw in any screw hole in the plate at this time is therefore left to the surgeon's whim or manufacturer recommendations without scientific basis.

The primary goal of this study was to determine whether threaded locking screws as opposed to smooth locking pegs are required to optimize fixation in the treatment of AO C3 (Melone type 1) intra-articular fractures of the distal radius. The secondary goal of the study was to attempt to determine which combinations and configurations of locking screws and locking smooth pegs influence overall construct stability in fixation of AO C3 intra-articular fractures of the distal radius.

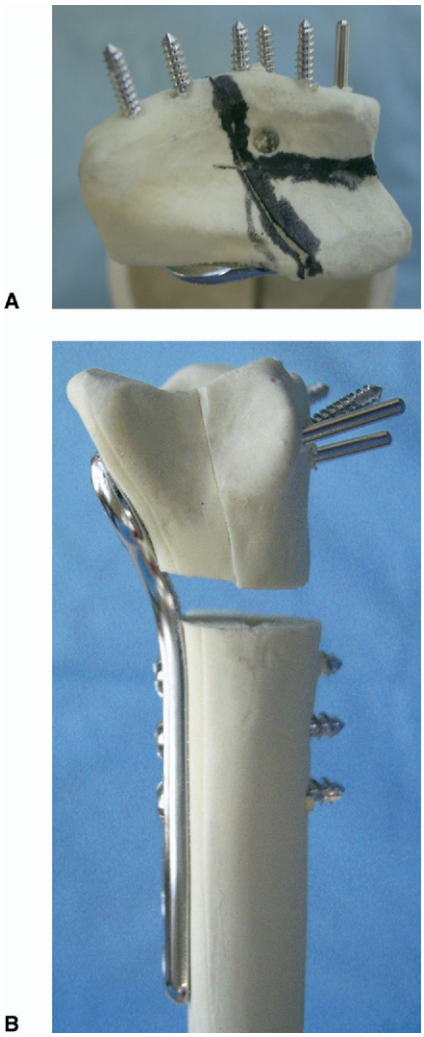

FIGURE 1: A Photograph displaying axial view of articular surface of radius. A 4-part intra-articular fracture has been created with a radial styloid fragment, a dorsal lunate fragment, and a volar lunate fragment. Fracture has been reduced and fixed with a volar uniaxial locking plate. **B** Photograph displaying lateral view of radius model fixed with a volar locking plate. A section of metadiaphyseal bone has been completely removed.

MATERIALS AND METHODS

Specimens

Biomechanical stability was studied in a synthetic radius bone (model 1027, Sawbones; Pacific Research Laboratories, Vashon, WA) to allow for consistent specimen size, shape, density, and screw purchase. In anatomic radius models, an intra-articular distal radius fracture (AO C3, Melone type 1) was created (Fig. 1). Thus, consistent radial styloid, dorsal lunate, and volar lunate fragments were made in each specimen. In addition, a 1-cm segmental resection of a block of bone at the metadiaphyseal junction was performed by means of an osteotomy to render the fracture pattern unstable, to prevent loading through the bony contact, and to focus loads on the plate-bone construct.

The fractures were fixed using a fixed-angle volar plate (Trimed Volar 6 Peg Plate with 5 shaft holes; Trimed Inc., Valencia, CA). Combinations of smooth locking pegs with a shaft diameter of 1.62 to 1.68 mm or locking screws with an inner core diameter of 1.60 to 1.70 mm were used to reconstruct the articular surface as described below in the testing protocol. The joint surface was reconstructed and fixed anatomically with the volar fixed-angle plate spanning the 1-cm metadi-