Routine use of locking shaft screws is not necessary in volar plate fixation of distal radius fractures

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Published online: 28 February 2015
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Abstract

Hypothesis Volar locking plate fixation is a common treatment method for distal radius fractures. Recently, implants have been designed with an option to use locking screws in the shaft portion of the plate. While there is a high incidence of low bone mineral density in patients who sustain fragility fractures of the distal radius, the need for locking shaft screws is not well defined. Our hypothesis is that the routine use of locking screws in the shaft portion of volar plates is not required to maintain reduction or to prevent hardware failure.

Methods A retrospective review was performed in all patients over age 50 years who underwent volar plate fixation using an implant with non-locking shaft screws for a distal radius fracture during a 2-year period. Patients were permitted to perform early range of motion exercises. Radiographs were examined and measurements were obtained to assess maintenance of reduction and incidence of hardware failure. Patients were followed at least until fracture healing. Patients were excluded from analysis if locking shaft screws were utilized or if follow-up was inadequate.

Results Forty-one patients met the inclusion criteria. The average age was 62 years (range 50–79). There were 12 men and 29 women. The implant used incorporated 3.5-mm shaft screws in 26 patients and 2.4-mm shaft screws in 15 patients. All patients healed within acceptable radiographic parameters (mean volar tilt=4.9°, mean radial inclination=21.7°, mean radial height=11.6 mm). There were not any instances of hardware failure.

Discussion Distal radius fractures frequently occur in patients with low bone mineral density. Non-locking, bicortically

placed shaft screws provide adequate stability to allow for early range of motion without loss of reduction or hardware failure. The routine use of locking screws in the shaft portion of volar plates does not appear justified.

Keywords Distal radius fracture · Volar plate · Locking screws

Volar locking plate fixation has become commonplace in the treatment of distal radius fractures [2, 5]. Locked screws are typically used in the distal metaphyseal and subcondral portion of the plate due to the poor bone quality and the desire to minimize extensor tendon complications. Recently, many distal radius implants have been designed such that there is the option of placing locking screws in the shaft, but the need for locking screws in the shaft portion of distal radius plates is less clear.

One indication for the use of locking plates is fixation of osteoporotic bone [7], and it is well known that there is a high incidence of low bone mineral density in patients who have sustained a distal radius fracture [8]. Therefore, low bone density may be an appropriate indication for locking screws in the shaft of distal radius fractures treated with volar locking plates. In practice, however, the routine use of non-locked screws in the shaft portion of distal radius plates does not seem to result in hardware failure or loss of reduction.

The purpose of the current study was to assess the radiographic outcomes and the incidence of hardware failure in a cohort of patients treated surgically for a distal radius fracture using a volar plate with non-locking shaft screws. Our hypothesis is that the routine use of locking screws in the shaft portion of volar plates is not required to maintain reduction or to prevent hardware failure.

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Table 1 Distribution of fracture types based on AO classification

AO fracture type	Number of patients
A2	10
A3	7
B1	1
B3	5
C1	6
C2	8
C3	4
Total	41

Materials and Methods

Institutional Review Board approval was obtained for this study. A retrospective review was performed to identify all patients over the age of 50 years old, who underwent surgical treatment of a distal radius fracture by a single surgeon, during a 2-year period. We included all patients who were treated with a volar plate and screw construct that utilized only non-locking shaft screws and who had radiographic examinations at least until the fracture had healed. Neither the diaphysis nor the distal radius had screws placed outside of the plate. The implants used were the Hand Innovations DVR plate (DePuy, Warsaw, IN, USA), the Synthes 2.4-mm two-column variable angle locking plate (Synthes, Paoli, PA, USA), or the Synthes volar rim plate (Synthes, Paoli, PA, USA). Postoperatively, all patients started an early range of motion program, which began by the second postoperative week.

Injury films were examined, and the AO classification of the fracture was assigned [6]. The final follow-up radiographs were then examined to determine the specific plate that was used and to assess whether the construct included locking shaft screws (if that was an option given the plate type). Standard radiographic parameters were measured including radial height, radial inclination, and volar tilt. The presence or absence of hardware failure (i.e., implant breakage, radiographic screw loosening or back-out) was noted.

Patients were excluded if the follow-up time period was not sufficient to demonstrate fracture healing or if a locking screw or screws were used in the shaft portion of the plate.

Results

We identified 130 patients who were treated operatively for a distal radius fracture during the study period. Eighty-three of

these patients were over 50 years old at the time of surgery. Of these, 41 met the inclusion criteria and made up the study group. There were 12 males and 29 females. The average patient age was 62 years (range 50–79). The distribution of patient ages is 50–59 ($n=18$), 60–69 ($n=15$), and 70–79 ($n=8$). There were five patients with diabetes. The distribution of fracture types is summarized in Table 1. The Hand Innovations DVR plate was used in 26 patients, the Synthes 2.4-mm two-column variable angle locking plate in 14 patients, and the Synthes volar rim plate in 1 patient. Regardless of plate or screw type, three screws were used in the shaft.

The final radiographic measurements are summarized in Table 2. There were not any cases of plate or screw failure.

Discussion

The surgical treatment of distal radius fractures using volar locking plates has become commonplace. In these implants, the locking screws are used in the distal portion of the plate to create a fixed angle construct that stabilizes the distal articular fragment(s) of the fracture.

In non-locked plating constructs, bicortical screw purchase tightens the plate to the bone. Stability is obtained through friction between the undersurface of the plate and the bone [7]. Unfortunately, the cancellous metaphyseal bone of the distal radius does not allow standard non-locked screws to obtain adequate purchase. In addition, bicortical screws are inadvisable in the distal portion of the distal radius since prominent dorsal screw tips can result in extensor tendon irritation or rupture [2, 9].

With locking screws, the threads on the screw heads lock directly into the plate, so compression of the plate to the underlying bone is not needed and unicortical screws can provide adequate stability [3, 9]. By virtue of the screws threading into the plate, locking plates provide stability by creating a fixed angle construct. Unlike non-locked plate constructs which fail by sequential screw loosening and pull-out, locked plate constructs fail as a unit [1]. The entire segment attached to a bone fragment must pull out rather than individual screws failing in sequence.

In cortical bone, the indications for the use of locking constructs have not been firmly established [1]. Locking plates are appropriate as a “bridge plate” to avoid devascularizing multifragmentary fractures and to provide fixed angle stability and improved fixation in osteoporotic bone [7]. Furthermore, locking plates may be considered in

Table 2 Postoperative radiographic measurement results

	Mean volar tilt, degrees (range)	Mean inclination, degrees (range)	Mean radial height, mm (range)
Results	4.9 (–5.8 to 14.1)	21.7 (16.5–29.6)	11.6 (8.7–16.1)

patients with osteoporotic bone in whom standard bicortical screws may not achieve adequate purchase.

Patients with distal radius fractures have a high incidence of decreased bone mineral density [4, 8]; in fact, Rozental et al. [8] demonstrated that 90 % of patients over age 50 years with a fragility fracture of the distal radius had either osteopenia or osteoporosis. Despite the high incidence of poor bone quality in patients with distal radius fractures, it is not clear that the use of locking screws in the shaft of these plates is necessary during routine fixation of distal radius fractures. While most plate manufacturers include the option to place locking screws in the shaft portion of distal radius plates, all patients in the current study were treated without the use of locking plates in the shaft, and there were no instances of hardware failure or loss of reduction. This suggests that even in a patient population with a high incidence of low bone mineral density, the use of non-locking screws in the shaft does not compromise fixation in this location.

If fixation is not compromised, one potential benefit of using non-locking screws is cost savings. In regard to the Synthes plate used in this study, the 2.4 locking screws were more than twice as expensive as the 2.4 cortical screws at our institution. While the price difference between screws may vary between manufacturers, the savings reaped by using non-locking screws can be substantial. Moving forward, this may be of increased importance as the government and insurance companies try to promote fiscal responsibility within medicine.

This study is limited by a possible selection bias in that patients who were found intraoperatively to have poor bone quality or poor screw purchase may have had locking screws used (and therefore were not included in the analysis). However, for patients in whom the DVR plate was chosen, there is no locking shaft screw option so this would not have been a factor. Alternatively, a smaller pilot hole may have been used for patient with poor bone quality to enhance the purchase of non-locking screws. For patients who had the Synthes plate used, locking screws were used only if the screw purchased with the initial non-locking screw was exceptionally poor. Otherwise, all patients had non-locking screws placed. Although we did not specifically assess these numbers, this situation arose infrequently. We feel that the study group is a reasonable representation of distal radius fracture patients.

In conclusion, there are situations in which it would be appropriate to use locking shaft screws. In particular, if

intraoperative bicortical non-locking screw purchase in the shaft is poor, we would recommend either increasing to a larger size screw (if possible with the particular system) or using a locking shaft screw. Based on our data, however, we feel that the routine use for locking screws in the shaft portion of distal radius plates is not necessary, even in patients with known or suspected low bone mineral density.

Conflict of Interest Kevin Lutsky is a consultant for Synthes but did not receive any financial compensation for this study.

Statement of Human and Animal Rights All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Statement of Informed Consent We obtained IRB approval from our university IRB board and were waived of informed consent and were authorized to collect protected health information.

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