Polyaxial versus uniaxial volar locking plate for distal radial fractures

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ABSTRACT

Purpose. To compare the penetration of the distal screws in relation to the thickness of the distal metaphysis in the polyaxial versus uniaxial volar locking plates.

Methods. Records of 78 patients aged 16 to 79 years who underwent open reduction and internal fixation for distal radial fractures (n=81) were reviewed. All fracture subtypes were included. 20 men and 22 women aged 18 to 79 (mean, 50) years were treated with the uniaxial locking plate, whereas 15 men and 21 women aged 16 to 79 (mean, 51) years were treated with the polyaxial locking plate. The choice of plate was determined by the operating surgeon based on familiarity and perceived advantages of the 2 plates. Penetration of the distal locking screws in relation to the volar-dorsal thickness of the distal radial metaphysis was measured, and the percentage of subchondral bone unsupported by the screws calculated.

Results. The mean percentage of unsupported subchondral bone was significantly lower in the polyaxial than uniaxial volar locking plate group (12% vs. 23%, p<0.001). No patient had screw over-penetration.

Conclusion. The polyaxial volar locking plate system enabled deeper insertion of distal screws into the subchondral bone, and thus providing better buttress for the fracture fragments.

Key words: bone plates; radius fractures

INTRODUCTION

In theory, angular stable fixation devices enable better restoration of the radiocarpal and radioulnar anatomy for distal radial fractures in osteoporotic bones. The devices mechanically bridge the bone and load bearing through the locked construct and thus reduce fixation failure owing to screws locking into the plate and not relying on bone thread for purchase (Fig. 1). Benefits include early return of hand and upper-limb function, reduced frequency and duration of physiotherapy, and less overall pain.1,2
In biomechanical studies, accurate placement of the most distal screws is important to ensure maximum support of the subchondral bone and articular surface. The length of the distal-row screws in relation to the volar-dorsal metaphyseal width affects the construct stiffness. Variable angle or polyaxial locking plates can achieve better biomechanics and versatility. The variable angle plates have greater flexibility in screw angle insertion, particularly for peri-articular fragments (Fig. 2). We hypothesise that the polyaxial locking plates enable placement of longer distal-row screws and therefore confer better support for the subchondral bone. This study compared the penetration of the distal screws in relation to the thickness of the distal metaphysis in the polyaxial versus uniaxial volar locking plates.

MATERIALS AND METHODS

Records of 78 patients aged 16 to 79 years who underwent open reduction and internal fixation for distal radial fractures (n=81) in our hospital over a 12-month period by various orthopaedic surgeons were retrospectively reviewed. All fracture subtypes were included. 42 fractures in 20 men and 22 women aged 18 to 79 (mean, 50) years were treated with the uniaxial volar locking plate, whereas 39 fractures in 15 men and 21 women aged 16 to 79 (mean, 51) years were treated with the polyaxial volar locking plate.
The choice of plate was determined by the operating surgeon based on familiarity and perceived advantages of the 2 plates. The decision for open reduction and internal fixation over closed reduction and stabilisation with Kirschner wires, or external fixation, or plaster cast immobilisation was based on fracture stability on post-reduction radiographs or at the 1-week follow-up.

The penetration of the distal locking screws (a) in relation to the volar-dorsal thickness of the distal radial metaphysis (b) is measured. The percentage of the subchondral bone unsupported by the screws in relation to the thickness of the distal radial metaphysis is indicated as \( b-a/b \).

**RESULTS**

The mean percentage of the unsupported subchondral bone was significantly lower in the polyaxial than uniaxial volar locking plate group (12% vs. 23%, \( p<0.001 \), unpaired \( t \)-test; 95% confidence interval, -0.18 to -0.09). No patient had screw over-penetration.

**DISCUSSION**

Volar plating for distal radial fractures has gained popularity.\(^1\,5\) Volar plate constructs are further enhanced by the locking mechanism and become fixed-angle devices that decrease screw toggle and increase rigidity. Volar locking plates are superior to dorsal plates and volar unlocking plates.\(^6\,9\)

Polyaxial volar locking plates enable insertion of screws at variable angles. This is facilitated by the use of different grades of titanium at the screw-plate interface. Increase in the screw-locking angle results in decreased ultimate or fatigue strength.\(^10\) Whether this decrease in strength has any clinical significance is unclear. Polyaxial locking plates are biomechanically sound for the management of intra-articular fractures of the distal radius in a cadaveric study.\(^11\) The Synthes variable angle plate enables screw insertion within a 30º cone around the central axis of the plate hole to purchase more of the dorsal fragments while avoiding articular surface penetration.

When the locked unicortical distal screws are inserted into at least 75% of the thickness of the distal radial metaphysis, the construct produces stiffness similar to bicortical fixation, but a construct with screw penetration of 50% of the metaphysis requires a much lower force to fail.\(^4\) This suggests that the greater the proportion of distal metaphysis thickness covered by a screw, the greater the biomechanic stability of the construct. In our study, neither group had screw lengths that were <75% of the thickness of the distal metaphysis, and so it was not known whether a few millimeters of extra screw penetration achieve any clinical advantage. This subtle advantage may improve stability, especially for comminuted fractures in osteoporotic bones.

One limitation of this study was its retrospective nature. Furthermore, the patient groups were not randomised, and inclusion of all fracture patterns may have biased the implant choice due to fracture configuration. The use of dorsal horizon (rather than lateral) radiographs may have offered better measurements of screw penetration in relation to metaphyseal thickness. A follow-up study...
incorporating quality of reduction on radiographs and clinical outcome scores may help to correlate these biomechanical parameters with clinical outcomes.

CONCLUSION

The polyaxial volar locking plate system enabled deeper insertion of distal screws into the subchondral bone, and thus providing better buttress for the fracture fragments. This is likely due to its ability to vary the angle of screw insertion by 15° from the centre. This may confer greater rigidity to the construct and thus provide better outcome for patients with osteoporotic distal radial fractures.

DISCLOSURE

No conflicts of interest were declared by the authors.

REFERENCES