Nonunion After Hybrid Plating with Locking and Nonlocking Screws in Radius and Ulna Shaft Fractures: Report of Two Cases

Zainab Cheema, BS*; Nathan E. Huff, BS†; Deana M. Mercer, MD‡
*Dow University of Health Sciences, Karachi, Pakistan
†School of Medicine, University of New Mexico
‡UNM Department of Orthopaedics & Rehabilitation

Abstract

Conventional compression plating has been found effective in treating forearm diaphyseal fractures, providing stability as well as resistance to axial, torsional, and bending forces. Locked plating has provided stability without frictional force between the bone-plate interface, which may help preserve periosteal blood supply, and is useful in treating metaphyseal, comminuted, and osteoporotic fractures. Hybrid plating has been used in an attempt to combine the strengths of these two techniques; however, in the context of simple forearm diaphyseal fractures with healthy bone, its effectiveness is only theoretical. We describe two patients in whom open reduction and internal fixation with hybrid plating to treat radius and ulna diaphyseal fractures resulted in nonunion. We performed a revision procedure using conventional compression plating and achieved full healing with complete union in both cases. These findings suggest that hybrid fixation for treating such fractures may not lead to better outcomes than conventional plating.

Introduction

The popularity of locked plating has increased relative to conventional nonlocked plating for treating various fractures. The two plate types have different benefits; conventional plates provide absolute stability and primary bone healing, whereas locked plates provide relative stability and secondary bone healing.[1] These benefits are related to the differing biomechanics of the plating systems.

Conventional plating achieves dynamic axial compression by means of eccentric placement of screws in the oblique screw holes, which provides absolute stability. Compression of anatomically aligned fragments results in friction, allowing resistance to axial, torsional, and bending loads.[1] The concept of leaving no gap between bone and plate to provide compression relies on the frictional force created by the screws.[2] However, nonlocking screws can provide very limited purchase in thin cortex or osteoporotic bone. Because the screws do not lock to the plates, the plates provide no control over which direction the screws will orient when force is applied,[1,3] which can lead to weakening of the bone surrounding the screw during healing with loosening of the screw-to-bone interface (also known as screw toggle or cut-out). Therefore, nonlocked plating may not be successful in weak or pathologic bone, and the loss of absolute stability can lead to nonunion.[1]

Locked plating relies on a stable angular construct between the screws and plate and is useful in treating metaphyseal, comminuted, and osteoporotic fractures.[1] This technique uses threaded screws that thread directly into the plate and underlying bone, which eliminates screw toggle within the plate when loaded during healing. Subsequently, this plate design acts as an "internal external fixator." The plate is not compressed against the bone cortex but can be positioned to allow maintenance of the periosteum and external blood supply to the bone cortex.[1,3] On the other hand, locked plates do not offer any significant advantage over nonlocked plating techniques in treating diaphyseal fractures in bones of normal density.[2]

Hybrid fixation (combining locking an nonlocking screws), has been developed and promoted as having the benefits of both techniques. After anatomical reduction, the plate is fixed to bone with nonlocking screws, with use of locking screws to prevent screw toggle and loosening of load during healing. We present two cases in which open reduction and internal fixation (ORIF) with hybrid plating to treat concomitant radius and ulna diaphyseal fractures led to nonunion, which was successfully salvaged by revision procedures with conventional plating.

Case Reports

Case 1

A 19-year-old male baseball player sustained a left radius ulna shaft fracture but was otherwise healthy. At another facility, he underwent hybrid ORIF with use of locking and nonlocking screws. At 3 months after surgery, no healing had occurred and, by 6 months, an established hypertrophic nonunion of the ulna and radius was observed (Figure 1A). We performed revision ORIF with removal of all previously placed screws and plates. Low-contact dynamic compression plates with nonlocking, small-fragment, hex-head screws (3.5 mm) were implanted. A compression and lag technique and local bone grafts were used. By 1 month postoperatively, nearly complete healing had occurred (Figure 1B). Eight weeks later, the patient resumed playing baseball. After an additional 8 months, the ulnar implant was removed because of prominence of the ulna plate. The patient had no additional problems and returned to playing collegiate baseball.

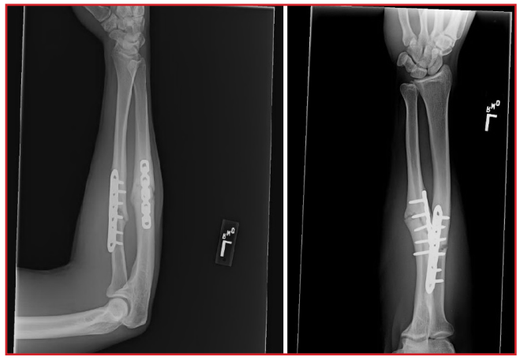

Figure 1A. Preoperative radiographs in case 1 show hypertrophic nonunion of ulna and radius after repair with hybrid plating.

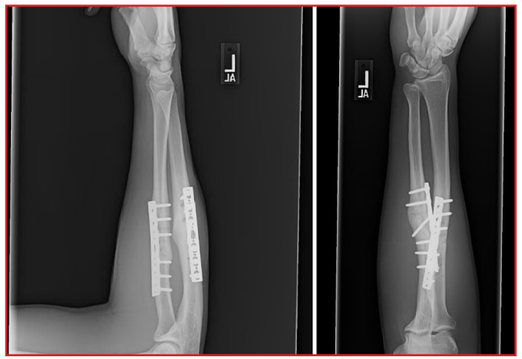

Figure 1B. Postoperative radiographs in case 1 show nearly complete healing by 1 month after revision open reduction and internal fixation with use of nonlocking plates.

Case 2

A 24-year-old healthy man sustained fractures of his right radius and ulna shafts during work, with minimal comminution. He underwent hybrid ORIF at another facility, in which there was a delayed radiographic union. About 18 months postoperatively, the patient fell while playing volleyball. Radiographs showed a right radius and ulna nonunion with a break of the radial plate at the site of the previous fracture (Figure 2A). The patient also had partial palsy of the posterior interosseous nerve. During the revision operation, a hypertrophic nonunion of the ulna and an atrophic nonunion of the radius, with a break of the radius shaft plate, was confirmed.

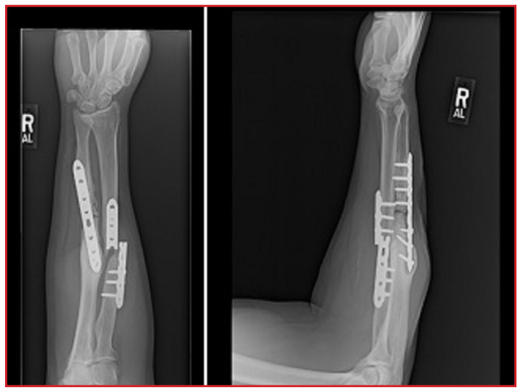

Figure 2A. Preoperative radiographs in case 2 show a right radius and ulna nonunion with a break of th radial plate after hybrid plating.

Both implants were removed, and revision ORIF of the right radius and ulna nonunion was performed with use of local bone grafts. Periarticular nonlocking plates were implanted, and compression fixation was established by using standard nonlocking screws (Figure 2B). At 3 months postoperatively, no pain or infection was present and healing to near union had occurred. By 6 months, the patient had complete radiographic and clinical union.

Discussion

The traditional treatment of diaphyseal forearm fractures has involved use of conventional nonlocking compression plates.[4] In light of newer technology and the increasing success of hybrid plating in osteoporotic and comminuted fractures, some surgeons have attempted to use hybrid plating on diaphyseal forearm fractures with normal bone quality.

The findings of the current cases indicate that nonunion rate for locked and hybrid plating is greater, not less, than conventional plating after treating radius and ulna shaft fractures in healthy individuals. Although the cause of nonunion is not clear, some locking-plate or hybrid constructs may be too stiff to allow secondary bone healing, or hybrid fixation may combine the problems more than benefits of the two techniques.

Hybrid plating may be appropriate for osteoporotic bone[2,5,6] and other anatomical locations, but the procedure does not appear to be optimal for the indications used here. Based on our experience, we do not recommend locked or hybrid fixation of radius and ulna shaft fractures in healthy individuals. The use of standard nonlocking plates may be more effective in achieving successful healing rates.

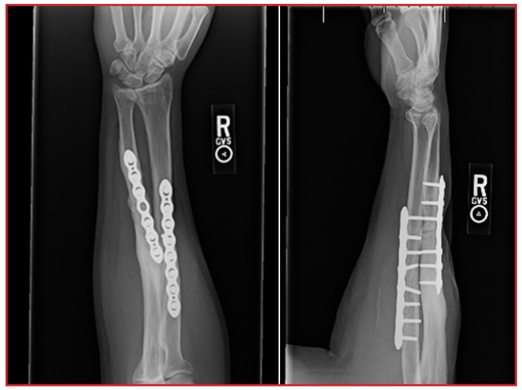

Figure 2B: Postoperative radiographs in case 2 after revision open reduction and internal fixation with use of nonlocking plates.

References

1. Egol KA, Kubiak EN, Fulkerson E, Kummer FJ, Koval KJ. Biomechanics of locked plates and screws. J Orthop Trauma 2004;18(8):488-93.
2. Doornink J, Fitzpatrick DC, Boldhaus S, Madey SM, Bottlang M. Effects of hybrid plating with locked and nonlocked screws on the strength of locked plating constructs in the osteoporotic diaphysis. J Trauma 2010;69(2):411-7.
3. Fulkerson E, Egol KA, Kubiak EN, Liporace F, Kummer FJ, Koval KJ. Fixation of diaphyseal fractures with a segmental defect: a biomechanical comparison of locked and conventional plating techniques. J Trauma 2006;60(4):830-5.
4. Roberts JW, Grindel SI, Rebholz B, Wang M. Biomechanical evaluation of locking plate radial shaft fixation: unicortical locking fixation versus mixed bicortical and unicortical fixation in a sawbone model. J Hand Surg Am 2007;32(7):971-5.
5. Gardner MJ, Griffith MH, Demetrakopoulos D, et al. Hybrid locked plating of osteoporotic fractures of the humerus. J Bone Joint Surg Am 2006;88(9):1962-7.
6. Freeman AL, Tornetta P 3rd, Schmidt A, Bechtold J, Ricci W, Fleming M. How much do locked screws add to the fixation of "hybrid" plate constructs in osteoporotic bone? J Orthop Trauma 2010;24(3):163-9.