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Locked Plating: Clinical Indications

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Summary: As shown in the previous article, locked plating stabilizes fractures differently than conventional plating using different mechanical principles. Although the blade plate is a form of a locked plate and has been around for years, locked plating in its present form offers the surgeon another device to treat fractures. The growth of different types of locked plates has been phenomenal but has increased the confusion over the indications for its use. Armed with the knowledge of the biomechanics of locked plating detailed in the previous article, the surgeon answered the question of why use locked plates and now can investigate when to use locked plates. Although many clinical articles support the use of locked plates, a randomized comparison with conventional plates does not exist. Despite this inadequacy in literature, the author believes that many clinical situations exist where patients have benefited from locked plating. **Key Words:** Indications for locked plating—Comminuted fractures—Osteoporosis—Locked plating—Distal femur fractures—Proximal tibial fractures—Percutaneous plating—Proximal humerus fractures—Periprosthetic fractures—Elderly fractures.

Although the advent of locked plating has given the orthopaedic surgeon a valuable tool, one must still follow principles of fracture management. In intra-articular injuries, the surgeon must achieve anatomic reduction and compression with absolute stability thus leading to primary bone healing without visible callus formation. An extra-articular injury, the surgeon anatomically aligns the shaft and fixates the shaft with relative stability to promote secondary healing with callus formation. Achieving stability in an anatomically aligned periprosthetic or distal femur fractures can be problematic in the elderly.[1,2,6,8,10–14]

With the graying of America, periprosthetic fractures have risen faster than any other fracture. These typically occur in the elderly with poor bone quality. Furthermore elderly are being more active being involved in activities that potentially lead to comminuted fractures. Acceptable screw purchase cannot be achieved with conventional plates therefore locked plates seem like the logical solution. Locked plates have effectively treated osteoporotic fractures involving the distal radius,[11] proximal humerus,[9] distal humerus,[7] proximal tibia, and distal femur.[12] The same biologic friendly surgery can be applied to the elderly enabling continued periosteal blood flow and hopefully healing before hardware failure. Percutaneous plating of periprostheic fractures around knee and hip implants with unicortical locked plating systems has been successful.[1,8] Fractures around hip implants usually require revision of the femoral prosthesis but can be stabilized with a locked plate with either unicorical screws or cerclage wire where the femoral prosthesis exists ensuring there is no open area of bone where stress shielding may occur (Fig. 1).

METAPHYSEAL/COMMINUTED FRACTURES

Metaphyseal bone often has a narrow cortex acting like osteoporotic bone. This weakened bone with segmental comminution at a fracture site in the distal femur or proximal tibia can challenge the surgeon to obtain adequate fixation often requiring both medial and lateral plate fixation to prevent varus or valgus collapse. Examples of this include osteoporotic periarticular fractures of the knee. The articular component must first be reduced (often with direct open clamping) and fixed with lag screws providing interfragmentary compression. This is

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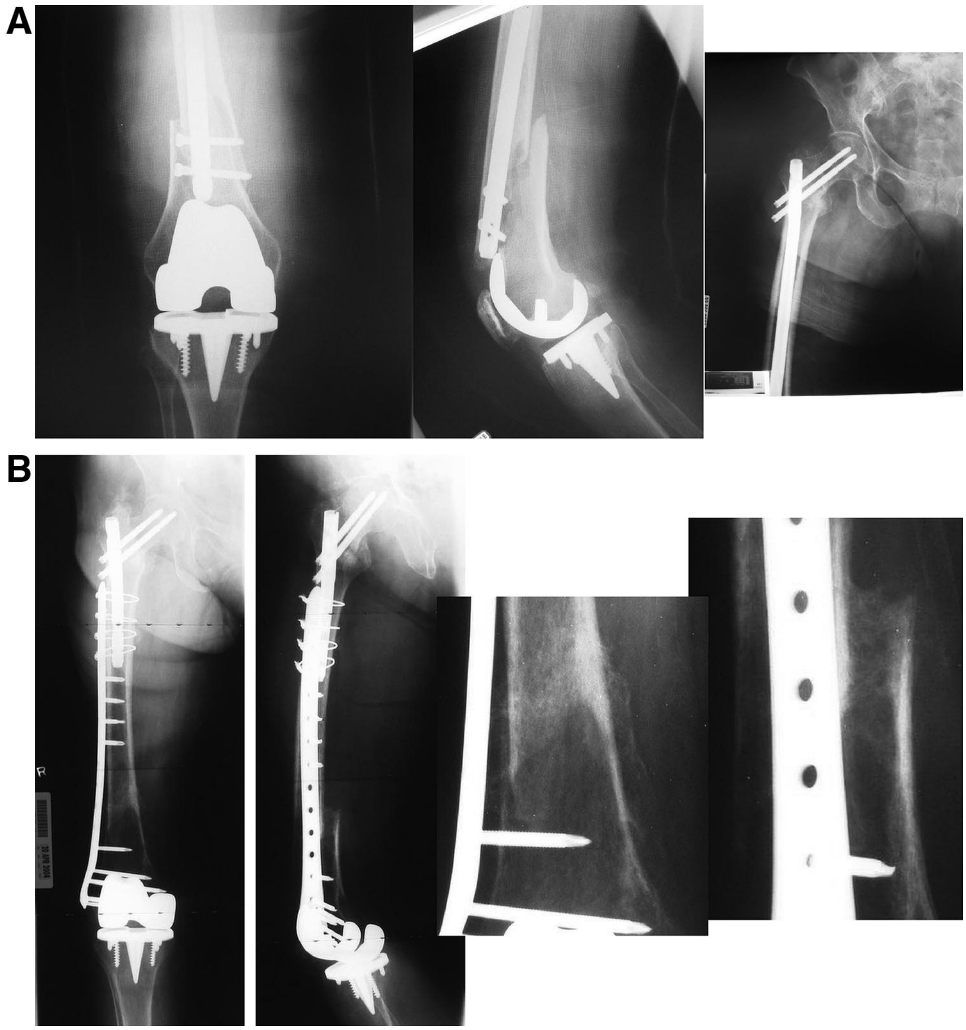

FIG. 1. (**A**) Elderly patient with reported initially nondisplaced periprosthetic fracture who now has an unstable fracture (AP and lateral of knee and AP of hip). (**B**) Treatment with a LISS plate and cables 4 weeks postoperative (AP and lateral of entire femur and coned down view showing the presence of callous).

followed by anatomic reduction of the alignment of the shaft (often done percutaneously with traction and/or Schanz pins as joysticks) and fixation with a percutaneous locked plate. The order is first compression screws and second locked screws. A surgeon cannot place a lag screw in a fragment that is already fixed by a locked screw and expect compression to occur. By achieving anatomic reduction of the intra-articular component, the surgeon can place the internal external fixator to span the metaphyseal comminution. This will create an environment where the intra-articular component heals by absolute stability (no motion) and the comminuted metaphyseal area by relative stability (some motion). It must be stressed that locked plating is not a substitute for anatomic reduction. One must first reduce then apply the plate. Multiple reduction techniques can be used. Patient positioning with the aid of bumps and traction that take advantage of ligamentotaxsis are key. Either manual traction or mechanical, using distractors or external fixators, can be of benefit. Schanz pins to manipulate the fracture fragments can provide provisional reduction. Once reduced temporary K-wire fixation, clamps, and push-pull devices through an anatomically contoured plate can help align the bone and achieve minor changes in alignment.[5] A surgeon must realize that once locked screws have been placed the plate cannot aid in the reduction.

Interestingly, the author feels in distal femur fractures, despite treating these with conventional plates, antegrade and retrograde nails, and various forms of external fixa-

FIG. 2. (**A**) Elderly patient with a distal femur fracture and significant peripheral vascular disease (clinical photo 4 weeks postoperative). (**B**) Treatment with a LISS plate 4 weeks postoperative (AP and lateral of femur and coned down view to show callous).

tion (including Ilizarov), the gold standard in his hands is the distal Femoral LISS. No other method has shown reproducible callous at 4 weeks even in compromised hosts (i.e., patients with diabetes, osteoporosis, and peripheral vascular disease) (Fig. 2). Another situation where locked plating has shown promise is in bicolumnar tibial plateau fractures. Previously dual plating was required to provide a buttress for the medial column. Biomechanically, it has been shown that lateral locked plating, under repetitive loads, is just as effective in controlling this injury.[3,4,10] Locked plating can allow fixation in these situations with one plate without failure. However, there are rare clinical occasions where segmental comminution occurred both medially and laterally with significant depression of the joint where the author has used a locked plate both medially and laterally (after initial lag screws) to raft the articular surface and prevent settling (Fig. 3).

Proximal humerus and distal radius fractures frequently have comminution at the fracture site and/or poor screw purchase in the bone. The proximal locking humerus plate has allowed much easier fixation of the three part and four part head splitting fractures. These injuries still require suture fixation of the tuberosities to the plate but the stability obtained with locked fixation into the head is significantly improved over conventional techniques (Fig. 4). In distal radius fractures, the locked screw functions similar to locked plating in tibial plateaus maintaining articular alignment and hopefully preventing collapse of impacted articular fractures after elevating them into anatomic position.

FIG. 3. (**A**) Significantly comminuted open distal femur and proximal tibia referred in after a spanning external fixator and provisional screws (not recommended) (AP X-ray and computed tomography of distal femur–top and proximal tibia–bottom). (**B**) Distal femur fixed with a LISS plate and proximal tibia fixed with medial and lateral locked plate with a good reduction of the joint (AP and lateral of the knee postoperative). (**C**) Four months postoperative AP and lateral of the knee showing healing of the metaphyseal diaphyseal bone; however, despite a medial locked plate, some collapse of the medial tibial plateau occurred.

SURGICAL TECHNIQUE

In general, the use of locked plates usually involves percutaneous placement of the locked plate after anatomic open reduction and fixation of a joint and closed anatomic alignment of the shaft. This is usually accomplished by closed manipulation (traction) and the use of joysticks in the 2 main fragments. Anatomically contoured plates can help with the reduction by push/pull devices that go through the targeting jig and can move the bone closer or farther away from the plate. However, in general, the surgeon should obtain a good reduction of the shaft before using these techniques for minor adjustments. Lag screws can be used initially to pull the bone closer to the plate but once locked screws are used, no further lag screws should be applied nor can any further reduction be obtained. The use of lag screws through the plate after a locked screw will only weaken the purchase of the locked screw in the bone potentially causing the locked screw to fail. After 1 or 2 locked screws have been placed on both sides of the fracture, the surgeon should verify anatomic alignment and centering of the plate on the bone by radiographs. A common problem exists in the distal femur fractures proximally where the locked plate can be anterior or posterior to the center of the bone. A locked screw can be placed with a good purchase into the plate, however, skiving the cortex and with no real purchase into bone. These constructs may achieve a little contact with the bone but will eventually fail. After verifying anatomic alignment and centering of the plate on the bone, additional screws can be added. No further reduction can be performed once a locked screw is in place. A change of reduction requires all locked screws to be removed. Inappropriate placement and sequence of screws can lead to

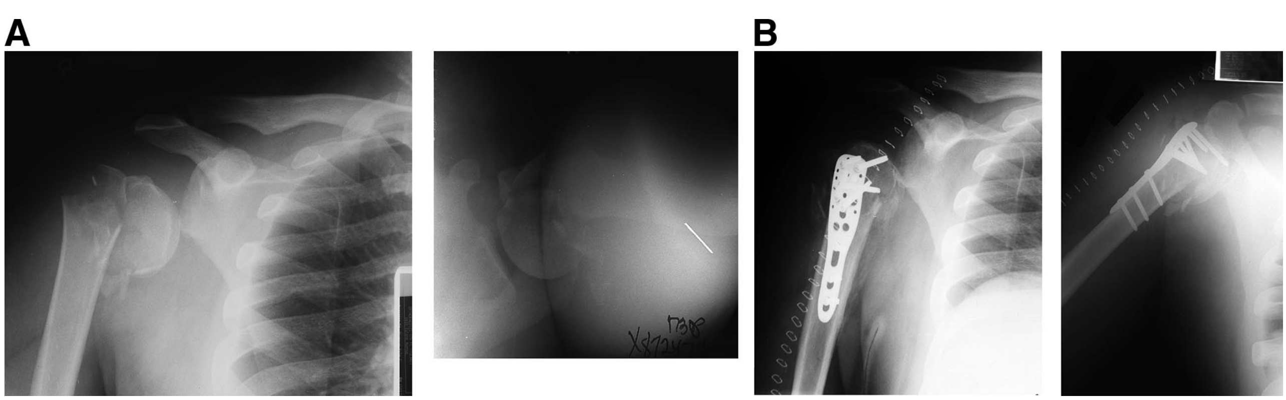

FIG. 4. (**A**) AP and axillary view of a four-part comminuted fracture of the proximal humerus. (**B**) AP and transcapular view postoperatively with a proximal humerus locked plate with the tuberosities sutured into the plate.

poor reduction and inadequate stability with resultant alterations in fracture healing.[14] In fracture patterns with hybrid components, that is, epiphyseal fractures with metaphyseal extension, the surgeon can use the "combi" features of locked plating initially using lag screw to achieve anatomic alignment followed by locking screws to maintain the reduction. The number of screws required is difficult to determine and depends on fracture stability, what region of the bone is fractures, which bone is fractured, and whether bicortical or unicortical screws are used. In general, the author tries to get 6 to 8 cortices on both sides of the fracture. In distal femurs, long plates with unicortical locked screws are preferred. In proximal humerus and distal radius fractures shorter plates with bicortical locked screws are used. Proximal tibial fractures are usually in between these two extremes generally extending at least 2 or 3 screws beyond metaphyseal bone. The surgeon, despite percutaneous insertion, needs to insure the soft tissue (especially around the zone of injury, i.e., proximal tibial plate) can tolerate an incision. We reported a 14% incidence of skin problems requiring a flap at the proximal tibial insertion site because we wrongly felt that we could do the surgery earlier because we were doing a percutaneous technique.[16] The surgeon must ensure the skin can tolerate an incision even if it is simply the plate insertion site.

CONTRAINDICATIONS

Just as important as deciding when to use a locked plate, a surgeon must decide when other options for fixation may be better. In general, factures that are stable with minimal fracture gap and occur in young healthy bone patients are likely to heal with other means of fixation. An example includes a young patient with a simple transverse or oblique diaphyseal fracture.[15] Using conventional compression plating of a both bone forearm fractures with or without lag screw fixation remains the standard of care. Fractures with a small gap treated with conventional plates use the bone plate friction and bone–bone contact to maintain stability and achieve reliable healing. In this situation, placing locking screws close to the fracture might decrease strain by decreasing motion and causing the construct to be too rigid thus delaying boney healing. Other examples include hypertrophic nonunions where conventional compression plating is required. Locked plating is not indicated where other forms of fixation are more amenable, that is, intramedullary nails or external fixators.

SUMMARY

Locked plating offers the surgeon a fixed angle construct with good axial and angular stability. It can be a helpful tool in the management of high-energy fractures with extensive comminution and fractures involving poor bone quality. These types of injuries will only increase with a large aging population continuing active lifestyles. If used appropriately, locked plating can result in good patient outcomes with recreation of bony architecture and restoration of function. Still the surgeon must abide by basic principles in their use and not consider them "magic bullets" in the Orthopaedic surgeons' armamentarium.

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