

Adjunct neutralization plating in patella fracture fixation: a technical trick

Matthew D'Ambrosio, DO^{a,b}, Alex Tang, MD^{a,b}, Luke Menken, DO^{a,b}, Ahmed T. Hagag, MD, PhD^c, Frank A. Liporace, MD^{a,b}, Richard S. Yoon, MD^{a,b}

Patella fracture outcomes are positive overall; however, in some cases, traditional fixation methods result in complications, including loss of fixation and irritable hardware requiring removal. We present a technique of plate fixation that we believe has the potential to improve stability and is less offensive in more comminuted fracture patterns. Improved stability should allow unfettered advancement of rehabilitation without concern for loss of fixation. Lower profile fixation offers a potential for diminishing the presence of irritating hardware requiring removal. We present our technique for using plate fixation to augment more complex patella fracture patterns.

Keywords: patella fracture, patellectomy, tension band, mesh plate

1. Introduction

Fractures of the patella account for approximately 1% of all skeletal injuries.^[1] Most closed, nondisplaced fractures are managed successfully nonoperatively; however, surgical management is indicated when the extensor mechanism or the articular congruity is compromised.^[2] Historically, there has not been a “gold standard” surgical treatment option, and many treatments have been fraught with complications, the most notable being a consistently high removal of hardware rate.

One of the more common techniques is known as the tension band technique in which longitudinal Kirschner wires (K-wires) and 18-gauge stainless steel wire are implanted in a figure of 8 pattern looped over the anterior patella to ultimately neutralize the tension force across the patella and turn it into a compressive force.^[3] This has been modified to include the use of cannulated screws.

Cannulated screws are placed along the fracture with tension wiring wrapping through the screws and anteriorly on the patella. Initially, K-wires were replaced by cannulated screws because early studies showed biomechanical advantages in gap formation and load to failure. It has also been shown that patients undergoing K-wire tension banding are twice as likely to undergo reoperation versus those receiving cannulated screws.^[4,5] Although management of simple fracture patterns can be adequately treated with these techniques, comminuted fracture patterns are more challenging because of the technical difficulty in treatment and their higher rates of postoperative pain and functional impairment.^[6]

Although traditional tension band fixation can result in excellent outcomes in simple noncomminuted patella fractures, comminuted patella fractures are difficult to treat with this tension band technique alone. Orthopaedic surgeons are left with the option of partial or complete patellectomy in these cases, or if traditional fixation is attempted, failure of fixation and loss of reduction are more likely. We recommend fragment-specific fixation in comminuted cases, with the use of various size and shaped plates placed in neutralizing fashion to protect and prevent failure of tension band techniques and fragment-specific fixation while avoiding patellectomy in these patients.

Plate fixation of patellar fractures allows for more rigid stabilization and earlier mobilization with potential for improved functional outcomes secondary to decreased knee stiffness and a decrease in symptomatic hardware, particularly in the case of comminuted fracture patterns.^[7–10] Different types of plates have been designed and used for fixation in the more complex patellar fractures including the fixed-angle plate, basket plate, locking plate, and mesh plate.^[7,8,10–13] Several case series of patellar plating and biomechanical studies have demonstrated equal or superior fixation strength with plates as compared with tension banding.^[7,9,10,14–17]

In this study, we consider the use of plate fixation as an adjunct to open treatment of patella fractures in the setting of complex patella fractures, including osteoporotic, comminuted, and inferior pole fractures. Adjunct neutralization may allow for more reliable fixation, leading to lower failure rates and/or earlier range of motion.

2. Initial Workup and Surgical Technique

After obtaining Western Institutional Review Board (WIRB: protocol number 20171537, principal investigator: Frank A. Liporace) approval, informed consent was obtained from all patients to be

^a Division of Orthopaedic Trauma & Adult Reconstruction, Department of Orthopaedic Surgery, Saint Barnabas Medical Center—RWJBarnabas Health, Livingston, NJ, ^b Division of Orthopaedic Trauma & Adult Reconstruction, Department of Orthopaedic Surgery, Jersey City Medical Center—RWJBarnabas Health, Jersey City, NJ; and ^c Division of Orthopaedic Trauma, Department of Orthopaedic Surgery, Texas Tech University Health Sciences Center—El Paso, El Paso, TX.

*Corresponding author. Address: Orthopaedic Research, Division of Orthopaedic Trauma & Adult Reconstruction, Department of Orthopaedic Surgery, Saint Barnabas Medical Center—RWJBarnabas Health, Jersey City Medical Center—RWJBarnabas Health, 377 Jersey Ave, Suite 130, Jersey City, NJ 07302. E-mail address: yoonrich@gmail.com.

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We attest that all authors have read and complied with the ethical approval/informed consent requirements. IRB approval through the Western Institutional Review Board (WIRB: protocol number 20171537, principal investigator: Frank A. Liporace) was obtained before study initiation.

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included in this study. Determination for use of adjunct neutralization plate fixation is typically not found on plain radiographs. With advanced computed tomographic imaging, additional fracture lines can be present that may not allow for traditional screw (with or without tension band) fixation. Increasing complexity will offer the ideal fracture pattern for adjunct neutralization (see cases below).

The patient is positioned in the supine position with a towel bump under the hip. All appropriate perioperative antibiotics are administered. A midline incision is made starting approximately 1 fingerbreadth above the superior pole of the patella and extending to the distal tibial tubercle. Sharp dissection is carried down to the patella, and flaps are developed. Once the fracture is identified, the periosteum is elevated while attempting to keep the intact periosteum undisturbed.

Fracture reduction is accomplished in a standard fashion using Weber clamps to approximate the fracture ends, ensuring appropriate reduction of the articular surface if involved. K-wires are then used to provisionally hold the fracture in place. At this point, the plate is custom-contoured to the patient's anatomy using benders that protect the locking mechanism within the plate. Sharp edges of the cut plate ends were dulled down using the abrasive portion of the quick connect available on most trauma power drivers. If any additional edges are not perfect in contouring, a screwdriver shaft, bone tamps, heavy needle driver, or baby Hohmann retractor can be used after fixation to further contour the plate edges down to bone in situ and minimize plate prominence.

3. Considerations for Choosing a Plate

There are numerous plates available that are manufactured specifically for use on the patella. Owing, in part, to the fact that the patella is such a superficial structure and the propensity for hardware to irritate the patient, many of the manufacturers focus on low-profile plates. Unfortunately, it is difficult to design 1 style plate to contour to the patella and often the plates must be contoured to best fit the patient's anatomy maintaining the locking screw mechanism found in most patella plates. When considering locked versus nonlocked plates, plate location plays a significant role. Because most plates are placed on the anterior surface of the patella and the underlying surface is that of the patellofemoral joint, screws should not penetrate into the articular surface. When placing screws on the anterior surface, it is best to focus on unicortical locked screw

fixation. When screws are placed in the longitudinal direction, compression-type screws can occasionally be used as well. To capture all fragments of a highly comminuted fracture pattern, a larger or basket-style plate may often be the best choice.

4. Postoperative Rehabilitation Protocol

Patients who undergo open reduction and internal fixation for patella fractures using adjunct neutralization plating follow a postoperative rehabilitation protocol that occurs in 5 phases (0–2 weeks, 2–6 weeks, 6–10 weeks, 10–12 weeks, and 3–6 months).

During the first 2 weeks, patients are placed in a knee immobilizer and made weight-bearing as tolerated with the knee locked in extension. The knee immobilizer is to be worn at all times, taken off only for physical therapy sessions. Patients are encouraged to perform active range-of-motion (AROM), active-assisted range-of-motion (AAROM), and passive range-of-motion (PROM) exercises at 0–30 degrees. Therapeutic exercises include isometric quadriceps, hamstrings, adductor, and abductor strengthening as well as ankle exercises using resistance bands.

At 2–6 weeks, the patient is converted to a hinged knee brace at the first postoperative visit to be worn with weight-bearing activities and still locked in full extension (although this may be removed at night). The patient is continued on AROM/AAROM/PROM exercises, adding 15 degrees of flexion each week with the goal being to achieve 90 degrees of flexion by week 6 postoperatively. In addition to continuing the previous therapeutic exercises, the patient is also able to initiate straight leg raises.

At 6–10 weeks, the patient is still required to use the knee brace with weight-bearing activities; however, it is now unlocked. Patients at this time are now made full weight-bearing, and AROM/AAROM/PROM progress to full ROM by week 10 postoperatively. Therapeutic exercises remain the same. At 10–12 weeks, the knee brace is discontinued. The patient is full weight-bearing and allowed full ROM. In addition to the previous therapeutic exercises, patients are also allowed to start using the stationary bicycle. Finally, at 3–6 months, patients are able to return to full activities as tolerated.

4.1. Case 1

Case 1 is a 66-year-old female patient who tripped and fell directly onto her knee. Radiographs exhibit osteoporotic bone and a midpole

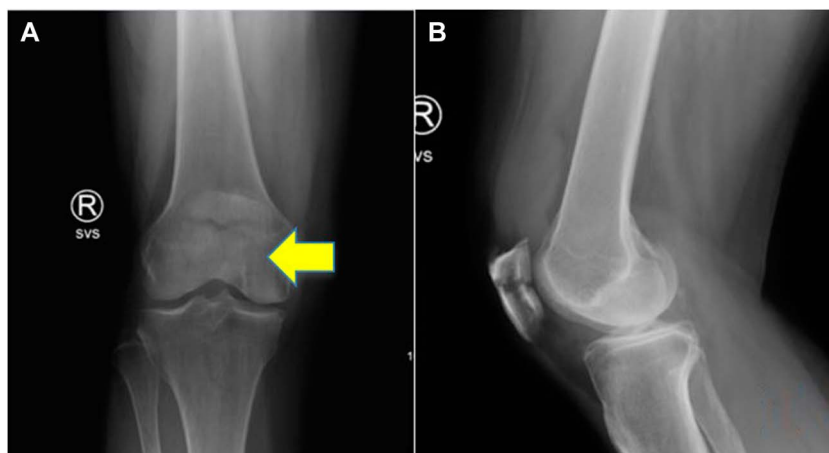


Figure 1. Anteroposterior (AP) (A) and lateral (B) radiographs of the right knee showing midpole patella fracture line with a longitudinal split in the superior pole. The yellow arrow points to the fracture comminution.

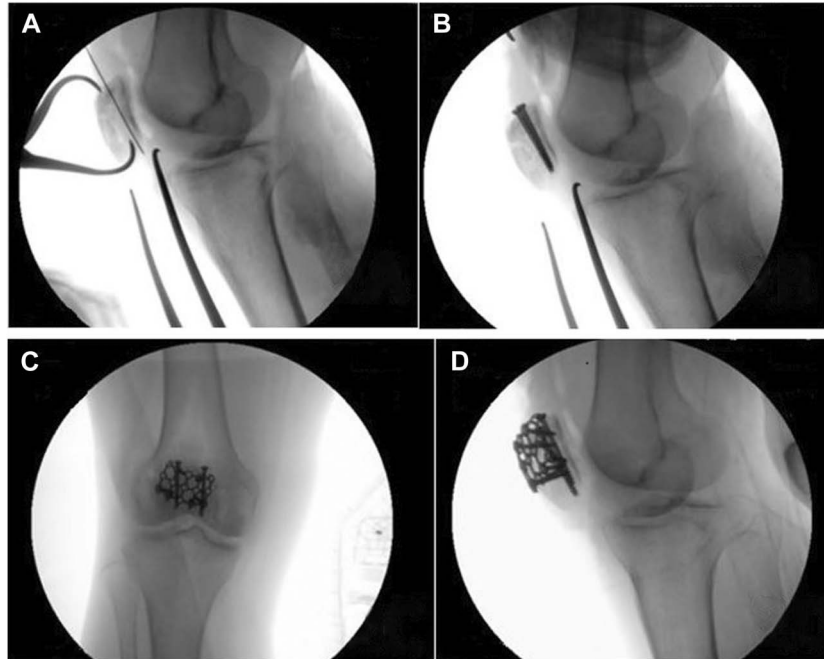


Figure 2. Initial reduction using Weber clamp and K-wires (A). Placement of cannulated screws (B). AP (C) and lateral (D) radiographs showing the application of the mesh plate.

fracture line with a longitudinal split in the superior pole with comminution (Figs. 1A and 1B). Once the fracture was visualized, it was determined that the superior pole of the patella was in 2 large fragments with cortical fracture lines. Two 4.0-mm cannulated screws were placed, but it was noted that they had poor purchase (Figs. 2A and 2B). The decision was made to plate in addition to placing cannulated screws to obtain a more robust construct. A 2.7-mm mesh-locking plate (Synthes, Paoli, PA) was contoured to the patient's anatomy and was able to align and secure the fracture pieces (Figs. 2C and 2D). It is important to note that the author routinely keeps meshed plates available for patients with osteoporotic bone to ensure adequate fixation if initial surgical plans prove unsatisfactory. No intraoperative or postoperative complications were observed.

4.2. Case 2

Case 2 is a 26-year-old male patient approximately 12 weeks out after anterior cruciate ligament reconstruction (ACL) reconstruction with bone-tendon-bone autograft. He was recovering well, and while he was getting out of bed, tripped and fell falling directly onto his patella and causing a displaced transverse fracture with a large bone void because of the previous bone-tendon-bone harvest site (Figs. 3A and 3B). Owing to this, there was limited bone available for standard fixation techniques. The large fragments were fixed with 3.0-mm headless screws (Figs. 4A and 4B), the bone void was filled with bone putty soaked in bone marrow aspirate, and then, a mesh plate (Arthrex, Naples, FL) was custom-contoured and placed (Fig. 4C). No intraoperative or

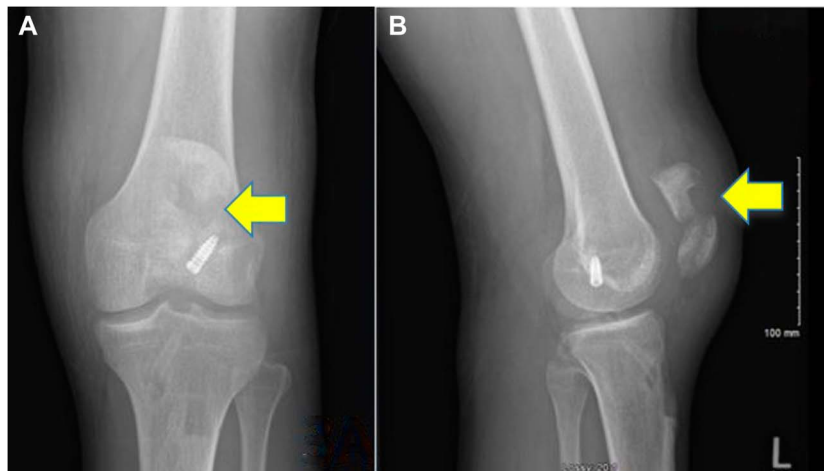


Figure 3. AP (A) and lateral (B) radiographs of the left knee showing displaced transverse fracture with a large bone void because of the previous bone-tendon-bone (BTB) harvest site. Also of note, the screw fixation for ACL graft can be seen in the distal femur. The yellow arrows point to the large bone void.

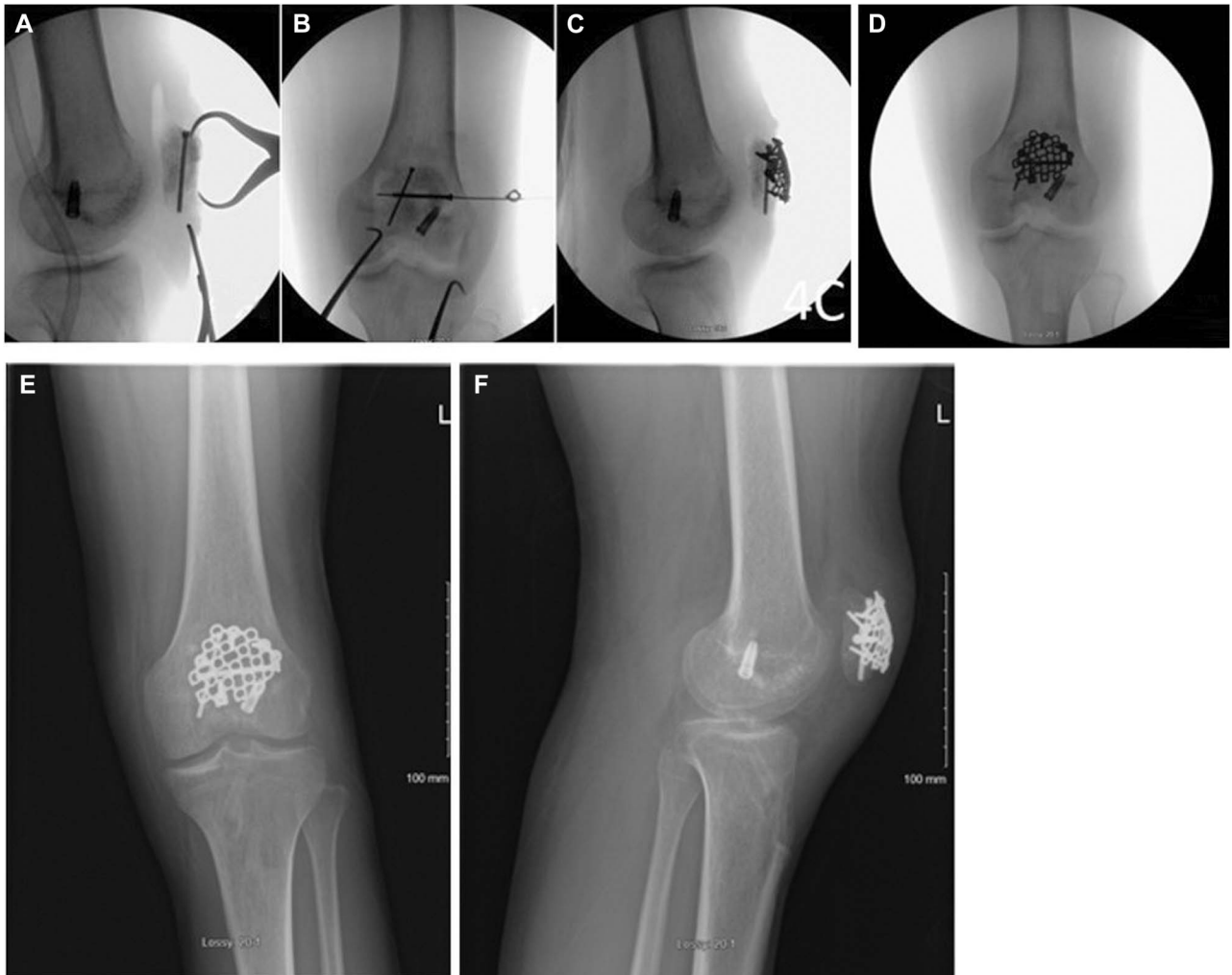


Figure 4. Initial reduction using Weber clamp and application of two 3.0-mm headless screws (A and B). Application of mesh plate (C and D). AP (E) and lateral (F) radiographs demonstrating a completely healed patella fracture with well-maintained hardware at 3-month follow-up.

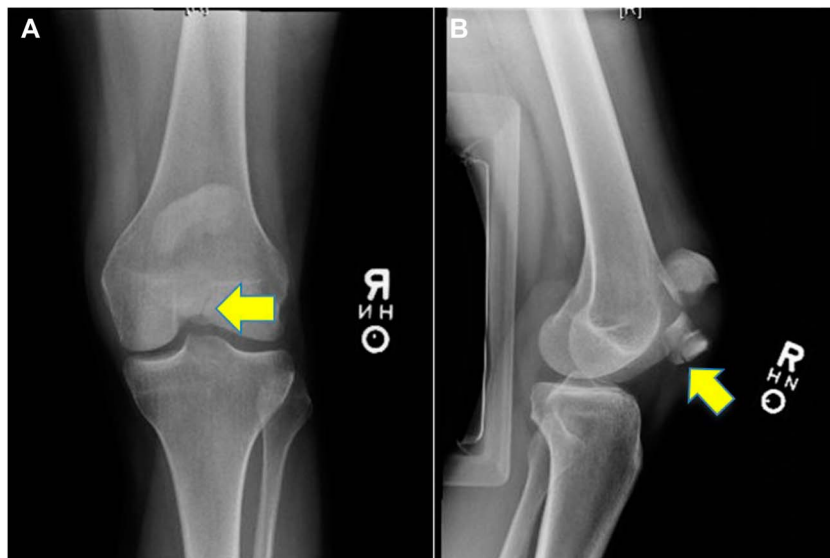


Figure 5. AP (A) and lateral (B) radiographs of the right knee showing transverse patella fracture with an inferior pole longitudinal split. The yellow arrows point to the fracture comminution.

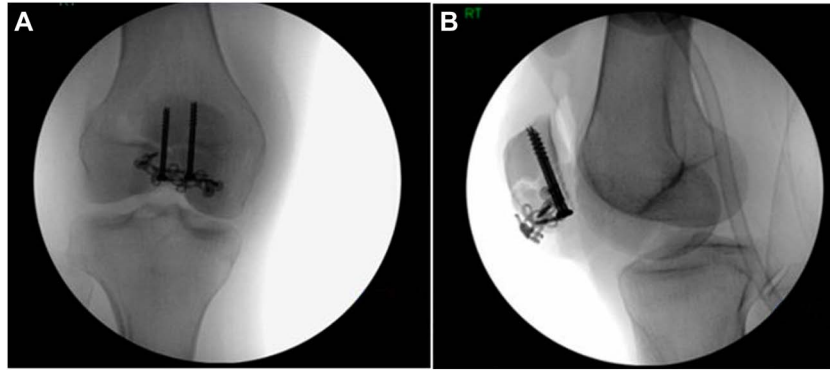


Figure 6. AP (A) and lateral (B) radiographs of the right knee showing reduced transverse fracture line with 2 cannulated screws and adjunct plating to distal pole.

postoperative complications were observed. At 3-month follow-up, the patient was able to straight leg raise and actively range his knee up to 90 degrees of flexion without pain or tenderness to palpation over the fracture. Follow-up x-rays at that time demonstrated intact patella hardware without evidence of loosening or interval change from previous x-rays. The fracture was also completely healed (Figs. 4E and 4F).

4.3. Case 3

Case 3 is a 33-year-old female patient who presented after a fall off a motorcycle. She had a transverse patella fracture with an inferior pole longitudinal split component with comminution

(Figs. 5A and 5B). While the transverse fracture line could be easily approximated with 2 cannulated screws and the bony purchase of the screws was adequate (Fig. 6A), to preserve the inferior pole, adjunct plating was included using a 2.4-mm metacarpal plate (Stryker, Mahwah, NJ) (Fig. 6B). No intraoperative or postoperative complications were observed.

4.4. Case 4

Case 4 is a 23-year-old female patient who slipped on ice and suffered a segmental inferior pole patella fracture (Figs. 7A–7D). In this case, it was determined that the inferior pole should be addressed first. This was reduced with Weber clamps and 1.6-mm

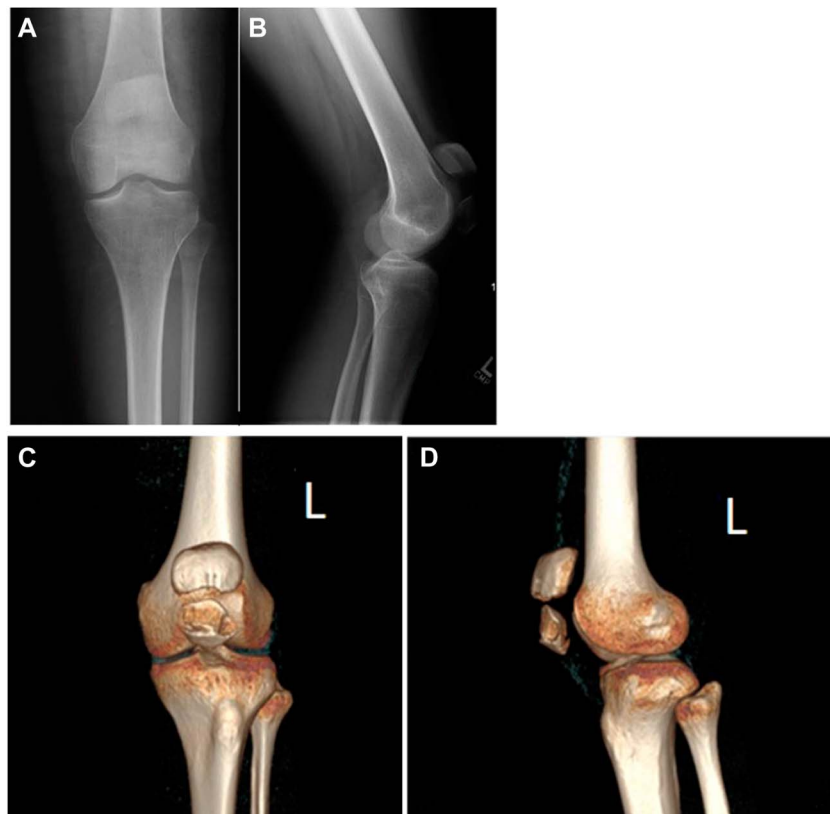


Figure 7. AP (A) and lateral (B) radiographs of left knee showing a segmental inferior pole patella fracture. AP (C) and lateral (D) 3-dimensional computed tomography scans of the left knee demonstrating the segmental inferior pole patella fracture in detail.

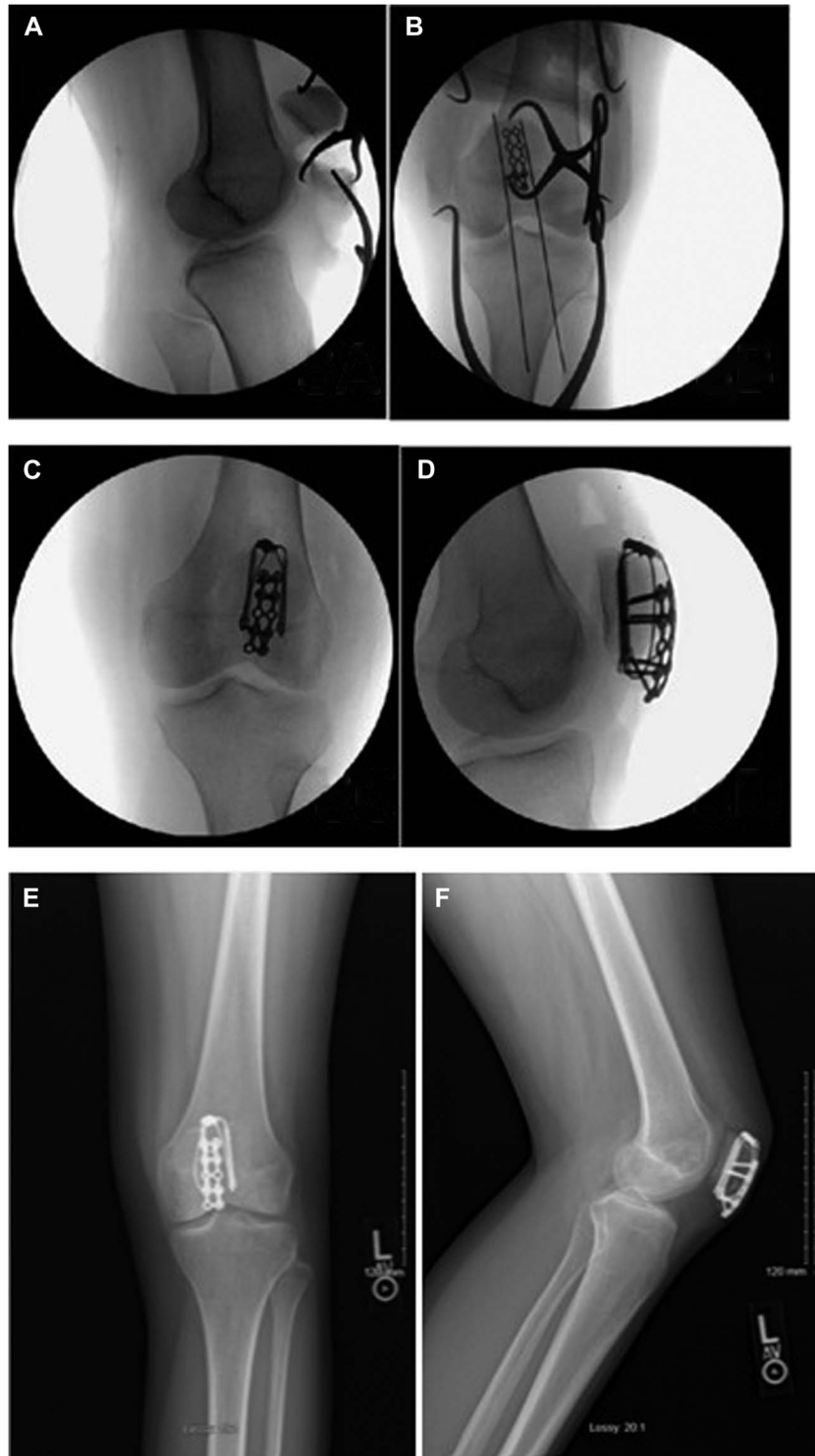


Figure 8. Initial reduction of transverse fracture line with Weber clamps (A). Application of 1.6-mm K-wires to approximate the 2 inferior pole segments (B). Application of 2.0-mm variable-angle metacarpal plate (C and D). AP (E) and lateral (F) radiographs of the final construct with plate augmented tension band construct. AP (E) and lateral (F) radiographs demonstrating a completely healed patella fracture with well-maintained hardware at 6-month follow-up.

K-wires to approximate the 2 inferior pole segments (Fig. 8A). Once secure, a second Weber clamp was used to approximate the inferior pole construct to the superior pole fragment. A 2.0-mm variable-angle metacarpal plate (Synthes, Paoli, PA) was custom-contoured to the patient's anatomy. Distal locking screws affixed the plate to the patella (Figs. 8A and 8B). Two 4.0-mm cannulated

screws were then used to approximate the inferior and superior poles followed by the proximal locking screws into the plate. The plate allowed for a stable platform so that a tension band cable could be placed through the cannulated screws in a figure of 8 pattern to compress the fracture further (Figs. 8C and 8D). No intraoperative or postoperative complications were observed. At

6-month follow-up, the patient was able to fully weight-bear with no restrictions and perform exercises independently. She has full strength. Follow-up x-rays at that time demonstrated a completely healed fracture and intact patella hardware without evidence of loosening or interval change from previous x-rays (Figs. 8E and 8F).

5. Discussion

In our case series of 4 patients, we present the surgical technique that we used for patellar fracture fixation with a mesh plate typically used for metacarpal fractures as an adjunct to cannulated screw fixation. Although mesh plating with cannulated screws for patella fracture fixation has been well described in previous literature and reports excellent outcomes, to the best of our knowledge, this is the first description of a metacarpal plate for adjunct neutralization in the operative management of complex patella fractures.^[8,9,14] Because the metacarpal mesh plate is low profile, it is contourable and offers earlier mobilization with potential for improved functional outcomes secondary to decreased knee stiffness and symptomatic hardware. Of the patients with follow-up data available in our case series, none experienced any postoperative complications, including the need for hardware removal. In addition, our patients were able to begin early range of motion and return to full strength within 6 months postoperatively. These limited results offer promising clinical and radiographic outcomes and support the utilization of fragment-specific fixation in comminuted cases, with the use of various size and shaped plates placed in neutralizing fashion to protect and prevent failure of tension band techniques and fragment-specific fixation.

Although patella fracture outcomes are generally positive overall, many of the traditional fixation methods are fraught with removal of hardware complications.^[4,5] Aside from some studies demonstrating higher than expected removal rates, most patella fractures can be largely treated with tension band wiring and modified tension band wiring.^[3] Osteoporotic bone, comminuted fractures, and inferior pole fractures, as demonstrated in our case series, are scenarios where plates can function as an adjunct to more common fixation methods.^[7-13]

Inferior pole fractures are challenging fractures to treat because there are only 2 main options available. One of the options is resection of the inferior pole and reconstructing the patella tendon. Resection of the inferior pole of patella is associated with postoperative alteration in length of the patella and a decrease in quadriceps power, and it often requires prolonged immobilization before knee range of mobilization is started. The second option for inferior pole fractures is to promote osteosynthesis at the inferior pole by using some of the more common procedures mentioned in the literature. Tension band wiring and cerclage wiring fall short in treating inferior pole fractures because they do not provide adequate stability in comminuted inferior pole fractures and are associated with loss of reduction.^[6]

Comminution and osteoporosis also present challenging scenarios for the classic tension band wiring fixation for patella fractures. Comminution can make anatomic reduction difficult with tension band wiring which can lead to pain and post-traumatic arthritis for the patient at longer-term follow-up points. Osteoporotic bone does not provide the same stability as healthy bone, and a known complication of K-wire fixation is cut out of the construct. Locking plates and mesh plates offer more options to allow for anatomic reduction and locking options to ensure stability in osteoporotic bone, making these great alternatives in difficult fracture patterns and bone quality.^[10,12,18,19]

While our limited clinical results show promise using low-profile metacarpal mesh plates for adjunct neutralization in patella fractures, it is difficult to infer superior results from this representation of a technique in small numbers. Our sample size is small because the indications for using the mesh plate are limited to complex patella fracture cases such as osteoporotic bone, comminution, and complicated inferior pole fractures because of the higher cost of the mesh plate compared with traditional fixation methods. However, we would argue that the costs related to failure and reoperation using the technique could balance out or potentially be less than the cost of using traditional methods that may fail in these specific patient populations. Future studies should conduct cost analyses that account for the improved clinical outcomes with the mesh plate and locking screws in providing cost-effective treatment for patella fractures compared with traditional implant choices.

Small locking plates, mesh plates, and in particular, plates originally designed for applications in the hand can be extremely useful when fragment-specific fixation is required. These may provide the necessary stability to allow for adequate osteosynthesis to take place with minimal loss of reduction over time.

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