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Technical Note

Anterior horizontal rafting plate to treat complex osteoporotic tibial plateau fractures: a technical note

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ABSTRACT

Complex tibial plateau fractures in elderly patients exhibiting severe osteoporosis and articular surface collapse are challenging. Decision-making is difficult when the posterior column is involved. Open reduction and internal fixation of complex tibial plateau fractures in patients with severe osteoporosis are prone to failure. In this paper, we describe a new method for the maintenance of the articular surface of complex tibial plateau fractures in elderly patients. An anterior horizontal rafting plate (3.5-mm-thick reconstruction and locking plate [Zimmer Inc., Warsaw, IN, USA]) is placed via conventional posteromedial and anterolateral incisions. The plate is inserted between the anterior bony surface of the proximal tibia and the subpatellar fat pad; plate positioning is checked under direct vision. The patient is encouraged to begin functional recovery soon after operation. Progressive weight-bearing begins at 10 weeks postoperatively and is gradually increased during fracture healing. Clinical follow-up was performed at 4, 8, and 12 weeks, 6 and 12 months, and yearly thereafter. No articular collapse or fragment displacement was evident on three-dimensional computed tomography performed 6 months after surgery. The knee range of motion was 5-130° at the last follow-up (4 years after surgery). This technique may be a good option for treating complex tibial plateau fractures, especially in elderly patients with severe osteoporosis.

Introduction

Complex tibial plateau fractures in elderly patients exhibiting severe osteoporosis and articular surface collapse are challenging; both fracture reduction and articular surface maintenance are difficult. The traditional treatment is similar to that for younger patients, i.e., articular surface restoration, bone grafting, and stabilization with external fixation, internal fixation with plates and/or screws.[1] Optimal fracture reduction and articular surface maintenance remain controversial, especially in cases with severe osteoporosis. The selection of surgical incision sites and implant placement is particularly difficult when the posterior lateral and/or posterior medial columns are involved.

Luo et al. reported a series of 327 patients aged ≥ 60 years (60.86% females).[2] Based on the three-column classification, "four-column fractures" (anterolateral, posterolateral, anteromedial, and posteromedial columns) were the second most common fracture type, being observed in 23.24% of cases; 67.58% of the fractures involved the posterior column. The prevalence rates of posterolateral and posteromedial fractures were 62.69 and 37.92%, respectively.[2] The optimal treatment strategy for complex osteoporotic tibial plateau fractures remains unclear. In this study, we introduce an anterior horizontal rafting plate that can be placed using standard approaches; the plate supports all tibial plateau fragments and prevents articular surface collapse, especially in patients with severe osteoporosis. To the best of our knowledge, this is the first report on the use of such a technique.

Methods

After approval by the institutional review board, we performed a retrospective clinical study.

A typical case

A 62-year-old female fell while riding an electric bicycle, sustaining a complex tibial plateau fracture. Radiographs (Figure 1. a, b) and three-dimensional computed tomography (3D-CT) (Figure 2. a-g) identified a four-column tibial plateau fracture, a fibular

Figure 1. a, b. Preoperative radiographs of a 62-year-old female with tibial plateau fracture, a fibular head fracture, severe osteoporosis (a, b)

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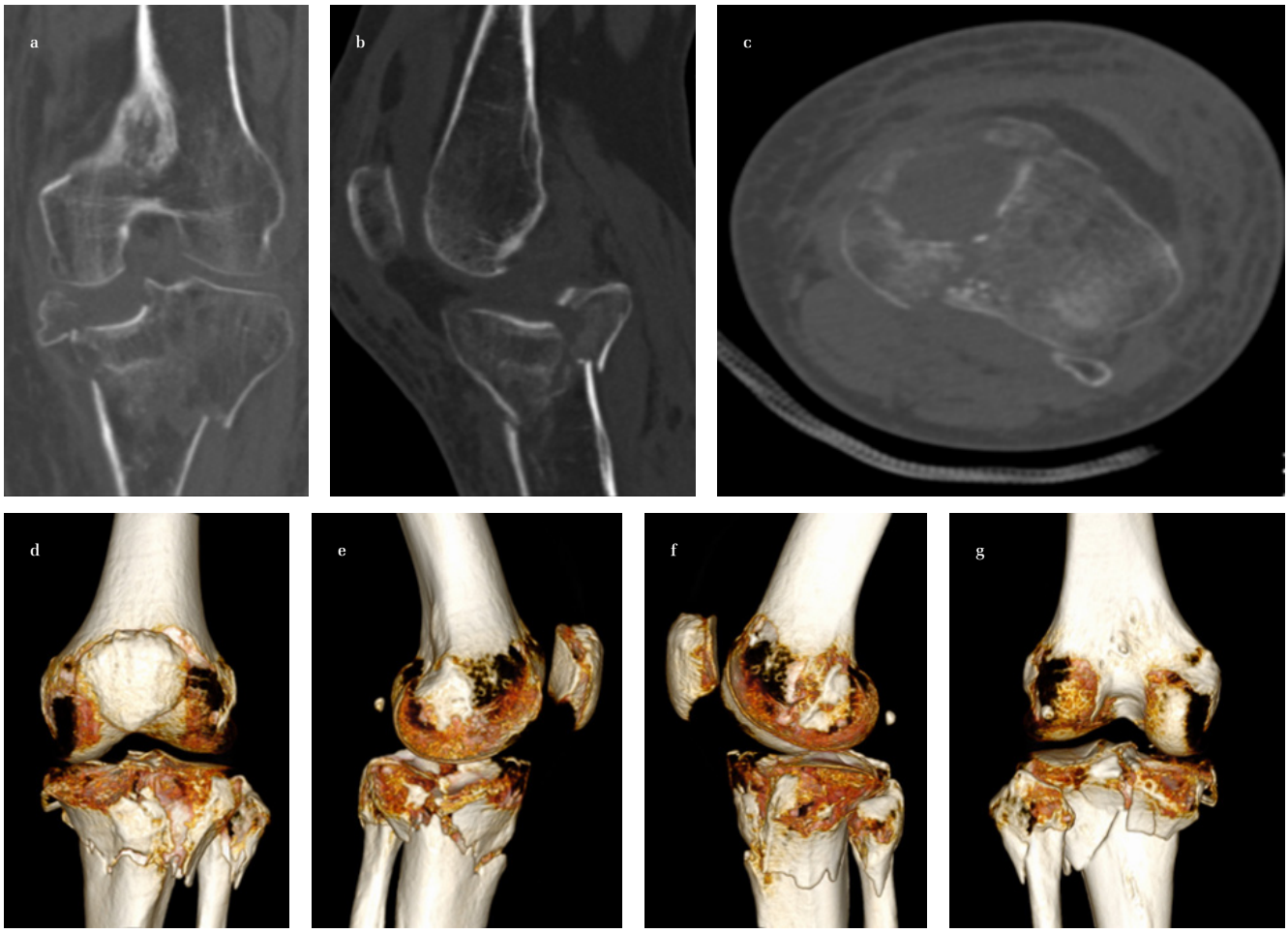

Figure 2. a-g. 3D-CT scan of a 62-year-old female with a multi-column tibial plateau fracture, a fibular head fracture, severe osteoporosis, and a huge depression of the lateral plateau (a-g)

head fracture, severe osteoporosis, and a huge depression of the lateral plateau. The knee was very unstable, but there was no evidence of vascular compromise or compartment syndrome. The patient had been bedridden following a hip fracture sustained 2 years ago. The T-score was -5.

Surgical technique

The patient was placed under general anesthesia in the supine position, and the injured knee was placed on a radiolucent operating table with a tourniquet around the proximal third of the thigh. Standard posteromedial and anterolateral incisions were created (Figure 3. a, b). The medial and posteromedial fracture fragments were reduced and held together using a malleable, 3.5-mm-thick reconstruction and locking plate (Zimmer Inc., Warsaw, IN, USA) and short screws; the plate was placed through the posteromedial incision (Figure 3c). If necessary, the tendons of the pes anserinus could be surgically detached and repaired. Next, the lateral articular surface of the tibial plateau was raised using a periosteal detacher, and the posterolateral fracture fragments were reduced and temporarily held in place by K-wires placed through the anterolateral incision. Allograft bone was densely packed under the articular surface. Next, a lateral anatomical locking plate with proximal raft screws was placed to support the lateral fracture fragments and maintain the bicondylar articular surface (Figure 3d). A tunnel was created within the anterior bone surface of the proximal tibia and the subpatellar fat pad to allow insertion of the horizontal plate (3.5-mm-thick reconstruction and locking plate), which was then bent to wrap the bone in a lateral-to-medial direction; the position was checked via direct vision. The position of the plate could be adjusted to ensure optimal screw placement. The horizontal rafting plate lay close to the anterior surface of the proximal tibia under the patellar tendon. The subpatellar fat pad protected the patellar ligament from damage caused by the plate. Screws were inserted in an anterior-to-posterior direction, either under or through the fragments, to support and maintain the entire articular surface (Figures 3. e-g, 4. a, b). Given the existence of posterior tibial slope, here anterior-to-posterior screws are emplanted at about 7 degree at the interior tibial slope and 10 degree at the exterior one according to our experience. The drill bit should be stopped when it reaches the posterior wall or just penetrate it. It not only protects the nerve vessels in the posterior from injury but also plays an important role in fixation and support. Following rigid fixation, knee stability was assessed. Finally, the incisions were closed by layers and a compressive bandage was applied.

HIGHLIGHTS

- We describe a surgical technique for the maintenance of the articular surface of complex tibial plateau fractures in elderly patients with severe osteoporosis.
- An anterior horizontal rafting plate is placed after fixation of posteromedial and anterolateral plates via standard posteromedial and anterolateral incisions.
- To the best of our knowledge, this is the first time that any such technique has been used.

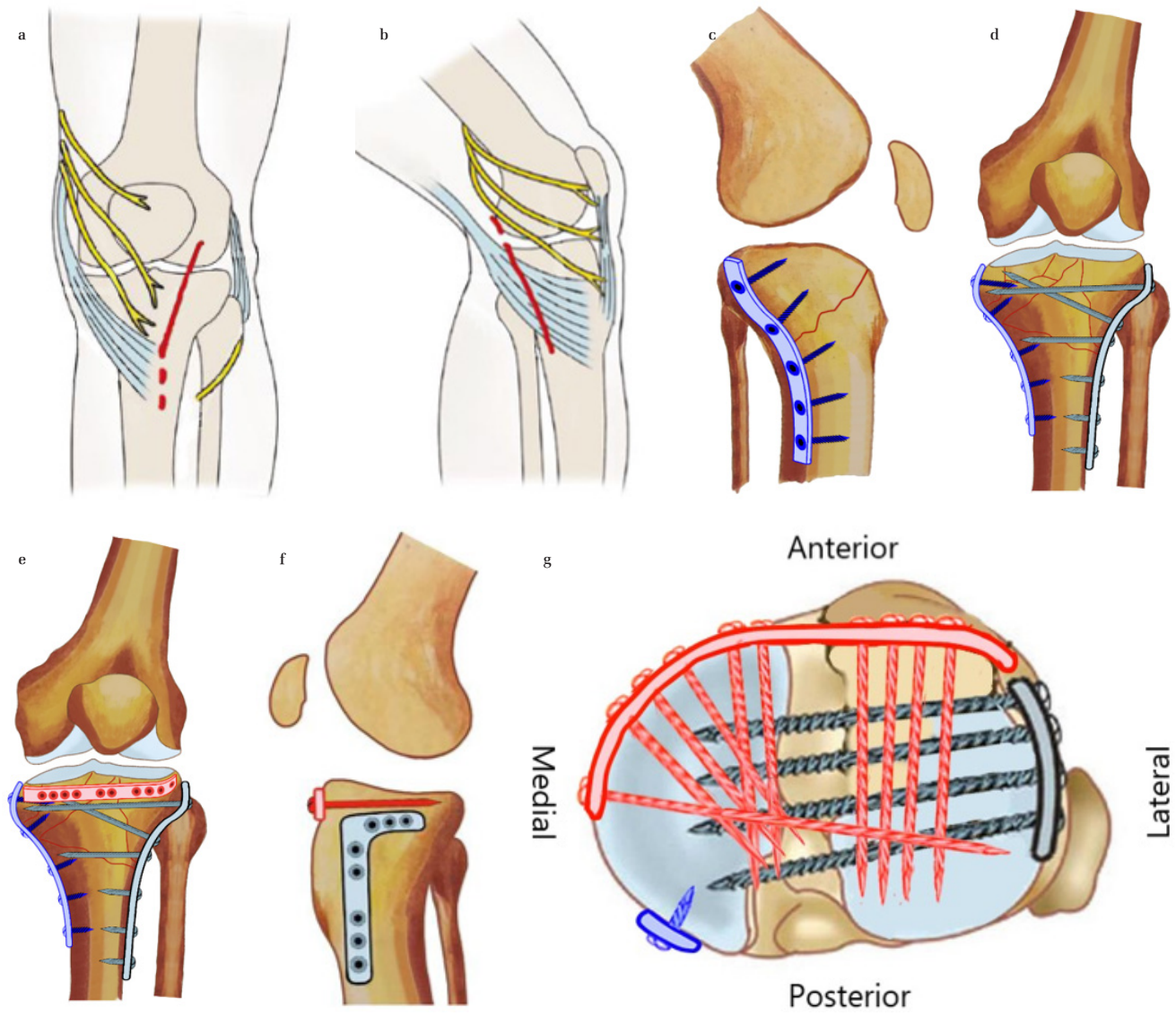

Figure 3. a-g. Standard posteromedial and anterolateral incisions (a, b). Schematic diagrams of the plates and screws (c-g)

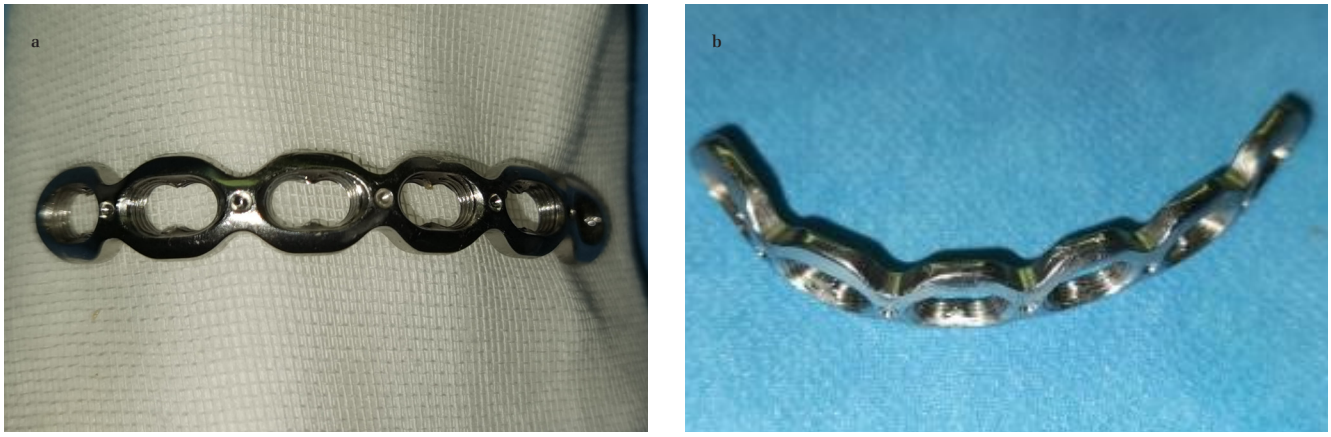

Figure 4. a, b. Anterior horizontal rafting plate (3.5-mm-thick reconstruction and locking plate [Zimmer Inc., Warsaw, IN, USA]) (a, b)

Postoperative protocol

X-ray (Figure 5. a, b) and 3D-CT (Figure 6. a-h) scans were obtained soon after surgery to evaluate articular reduction and intra-articular hardware penetration. The patient was encouraged to begin functional recovery soon after surgery. Progressive weight-bearing commenced at 10 weeks postoperatively and was gradually increased during fracture healing. Clinical follow-up was performed at 4, 8, and 12 weeks, 6 and 12 months, and yearly thereafter.

Results

The fracture healed 3 months after surgery. Unlike the preoperative CT scan, no articular collapse or displaced fragment was evident 6 months after surgery. At the 4-year follow-up, the knee range of motion was 5-130º (Figure 7. a-e), and the hardware was removed (Figure 8. a-d). There was no evidence of infection, anterior knee pain, or postoperative deformity during follow-up.

Discussion

Complex tibial plateau fractures in elderly patients with severe osteoporosis are difficult to manage. The traditional treatment is open reduction and internal fixation (ORIF)[3], external fixation[4], and/or primary total knee arthroplasty (TKA).[5,6] Bermúdez et al. described the use of a horizontal rafting plate to support and stabilize posterior fracture fragments.[1] The plate was inserted via the extensile anterolateral approach. The posterolateral complex of the knee joint was surgically dissected, detached, and repaired. The horizontal plate was applied only to the posterolateral column; this is not adequate for patients with extensive bicondylar posterior fractures. An external fixator or lower-limb plaster fixation should be used for short-term management of soft tissue. If hardware must be removed later, exposure through a scarred tissue bed may place some neurovascular structures at risk. The extensile anterolateral approach should not be used routinely.

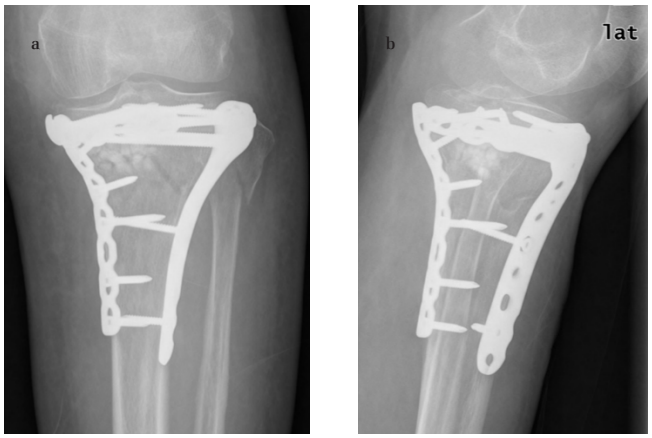

Figure 5. a, b. Postoperative radiographs reveal good reduction of tibial plateau fracture (a, b)

Giordano et al. used a "hoop-plating" technique to support the posterior rim of the tibial plateau; a horizontal, pre-contoured one-third tubular plate was wrapped around the plateau corners.[7] The lateral approach of Lobenhoffer et al. was combined with a limited posteromedial approach.[8] The hoop-plate was inserted blind, which might place some posterior neurovascular structures at risk. Further, the support of posterior fracture fragments provided by the plate alone (i.e., without screws) is inadequate. Regarding the above-mentioned technique, hardware removal is difficult, and there is a high risk of injury to neurovascular structures. Both of these techniques are relatively complicated in terms of surgical exposure and plate positioning and may not be feasible for elderly patients with severe osteoporosis. The posterior and posterolateral approaches have complications; the normal ligamentous structure is destroyed and certain neurovascular structures are at risk. Recently, some surgeons have treated posterior column fractures through an anterior approach; this permits use of the standard medial and anterolateral incisions. Feng et al. treated tibial plateau fractures involving the posterior column by placing a 3.5-mm-thick proximal tibial plate

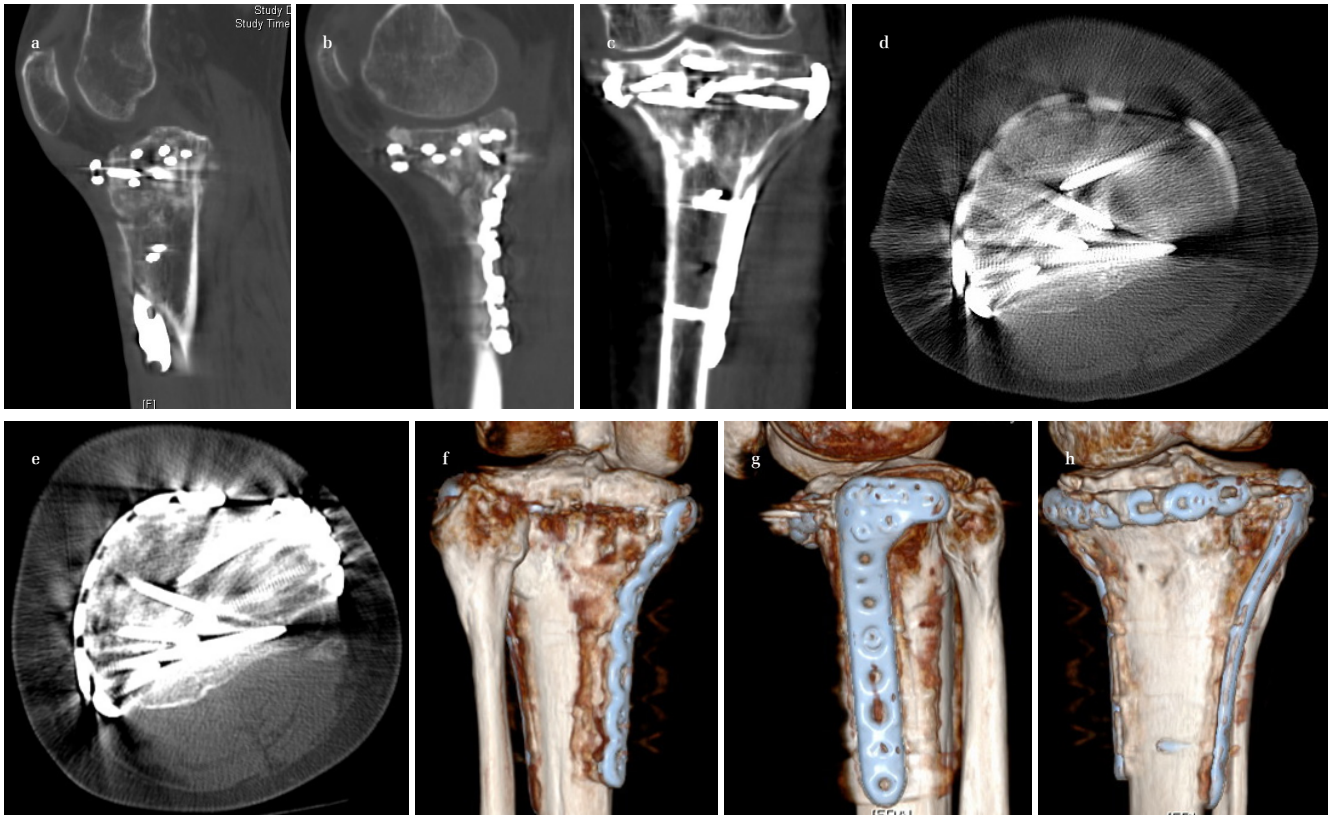

Figure 6. a-h. Postoperative 3D-CT scans reveal good reduction without any intraarticular hardware penetration (a-h)

Figure 7. a-e. Good functional recovery was evident at the 4-year follow-up (a-e)

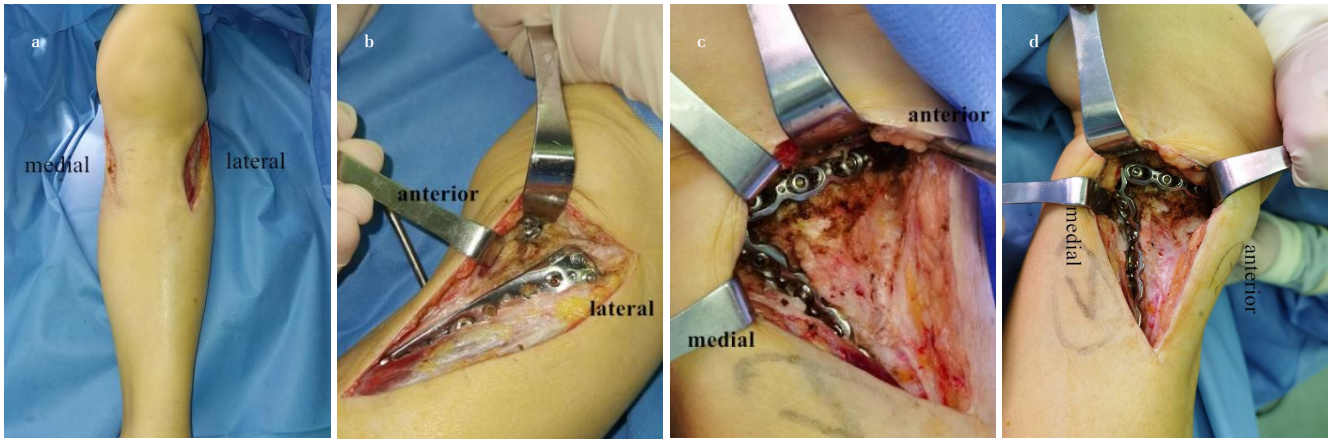

Figure 8. a-d. Hardware removal via two conventional incisions (a-d)

with a narrow head (Synthes, Oberdorf, Switzerland) via a standard anterolateral approach.[9] The protocol is simple and safe, and the approach is familiar to most clinicians. Similarly, Feng et al. treated type C3 tibial plateau fractures involving the posterior column via dual-locking plate fixation with modified anterolateral and anteromedial incisions.[10] To fix the posterolateral/posteromedial fracture column, raft screws were inserted through the plate from the anteromedial/anterolateral side to the posterolateral/posteromedial position, by moving the plate forward and outward/inward. These two studies show that anterior fixation of posterior fractures is both feasible and effective.

As per our experience, complex tibial plateau fractures in elderly patients sometimes remain unstable even after fixation with anterolateral and posteromedial plates, perhaps because of severe osteoporosis. In four-column fractures, the medial and posteromedial displacements can be reduced through the posteromedial incision. The posterolateral displacements and the articular surface can be reduced under direct vision through anterolateral incision. Although our horizontal rafting plate does not have biomechanical advantage of the buttress plate for the posterior column fragments fixation, it has the advantages of minimal surgical trauma and operated in two conventional incisions. We placed anterior-to-posterior locking screws through the plate for fixation of posterior column fractures, rather than simply placing plate-free screws, given that the patient had severe osteoporosis. Plate screws running under or through posterior fragments stabilize posterior column fragments.

Our technique has many advantages. First, four-column fractures are treated via two conventional incisions; no additional posterior or extensile anterolateral incision is required. Second, the anterior plate is convenient to place and check under direct vision. The anterior-medial-lateral screws serve as a net (Figure 3g) that sufficiently supports and maintains the articular surface, especially in patients with severe and complex osteoporotic tibial plateau fractures. Third, the approach does not expose important nerves and vessels; the risk of neurovascular injury is avoided. Fourth, hardware removal is easy if TKA is required or an infection develops.

In conclusion, our new anterior horizontal rafting plate offers a good support to maintain the joint line in safe. We advocate the use of this technique when treating elderly patients with complex tibial plateau fractures and severe osteoporosis.

Ethics Committee Approval: Ethics committee approval was received for this study from the Institutional Review Board of The First Affiliated Hospital of Zhejiang Chinese Medical University (2020-X-060-01).

Informed Consent: Informed consent for this study was obtained from patients who participated in this study.

Author Contributions: Concept - J-F.H.; Design - J-J.S., J-F.H.; Data Collection and/or Processing - J.Z., J-S.Q.; Literature Review - J.Z., J-S.Q.; Writing - J-J.S, J-F.H.

Conflict of Interest: The authors have no conflicts of interest to declare.

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