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Case Report

Strategies for Preventing Malreduction in Distal Femoral Comminuted Fractures: A Case Report

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Abstract

Background: Comminuted distal femur fractures pose a significant challenge to achieving precise reduction and stable fixation. Achieving proper alignment is critical, as malreduction can lead to functional impairment and altered gait. Careful preoperative planning and precise intraoperative technique are essential to optimize fracture reduction and ensure favorable postoperative outcomes.

Case Report: A 39-year-old man sustained a comminuted distal femur fracture [AO Foundation/Orthopedic Trauma Association (AO/OTA) 33-C2] after a 9-meter fall. Surgical fixation was performed one week later using a precontoured anatomic lateral locking plate via minimally invasive plate osteosynthesis (MIPO). Postoperative imaging demonstrated a recurvatum deformity of the knee. At three months, fracture union was achieved with functional knee motion. This case underscores careful planning and implant positioning in complex distal femur fractures.

Conclusion: Optimal management of comminuted distal femur fractures requires precise anatomical reduction, careful plate positioning, and intraoperative verification to restore alignment, length, and rotation, while avoiding intercondylar notch violation. Immediate correction of malposition is essential to prevent postoperative deformity and preserve function, even if it modestly prolongs operative time.

Keywords: Distal Femur Fractures; Comminuted Fracture; Minimally Invasive Surgery

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Background

Distal femur fractures are uncommon yet complex injuries, with an estimated incidence of 8.7 per 100000 person-years and a bimodal age distribution, characterized by high-energy trauma in young adults and low-energy falls in the elderly (1-3). These fractures often involve the metaphyseal and intra-articular regions, where comminution, osteoporotic bone, and soft-tissue compromise challenge accurate reduction and stable fixation, resulting in frequent technical complications (2, 4). Given the growing adoption of minimally invasive plate osteosynthesis (MIPO), recognition and prevention of such alignment errors remain of critical importance. Malreduction is associated with functional impairment, altered gait mechanics, and premature osteoarthritis (5-7). Common post-operative deformities include coronal plane varus or valgus malalignment, sagittal plane recurvatum, and rotational malalignment (6, 8). Intraoperative radiographic parameters, such as the anatomic lateral distal femoral angle (aLDFA ≈81° ± 2°), mechanical lateral distal femoral angle (mLDFA ≈87° ± 3°), and anatomic posterior distal femoral angle (aPDFA ≈79°-87°), serve as essential guides to ensure proper alignment (9-11).

Technical factors contributing to malreduction include suboptimal patient positioning or traction, inadequate reduction of fracture fragments, and failure to address medial comminution, which predisposes to varus collapse and implant failure (5, 12, 13). Strategies to mitigate these risks emphasize careful preoperative planning and use of intraoperative adjuncts such as femoral distractors, provisional external fixation, and joystick Kirschner wires (K-wires) for controlled reduction. Additional techniques, such as dual-plating constructs when medial support is compromised, can enhance reduction accuracy and construct stability.

This study highlights the importance of precise intraoperative technique and structured decision-making to minimize malreduction and optimize postoperative functional outcomes.

Case Report

A 39-year-old man sustained multiple traumatic injuries after falling from a height of approximately nine meters. He had no significant past medical or surgical history. On admission, evaluation revealed a right distal femoral fracture [AO Foundation/Orthopedic Trauma Association (AO/OTA) 33-C2] extending into the articular surface, a right patellar fracture, a left Lisfranc fracture-dislocation, and a combined pelvic ring fracture (Figure 1).

The patient initially underwent skeletal traction for the distal femur fracture; once hemodynamically stable, staged fixation procedures were undertaken. The Lisfranc injury was first treated with open reduction and internal fixation (ORIF) with pinning, followed by irrigation and debridement. Definitive fixation of the distal femur fracture was performed using a precontoured anatomic lateral locking plate through a MIPO technique via a lateral approach, and the patellar fracture was stabilized with ORIF.

Further surgical management included plate fixation of pubic symphysis diastasis, screw fixation for bilateral superior pubic ramus fractures, and iliosacral screw fixation for the associated sacral fracture.

Figure 1. Initial computed tomography (CT) scan demonstrating a right distal femoral fracture [AO Foundation/Orthopedic Trauma Association (AO/OTA) 33-C2]

A final revision and definitive plate-and-screw fixation of the Lisfranc injury were subsequently carried out, achieving stable alignment and soft-tissue closure.

Postoperative radiographs of the distal femur demonstrated mild posterior malposition of the distal plate segment, resulting in a subtle recurvatum deformity of the knee (Figure 2).

Figure 2. Postoperative clinical photograph and lateral radiograph demonstrating mild posterior malalignment of the distal femoral segment, resulting in a subtle recurvatum deformity

At the three-month follow-up, radiographs showed satisfactory fracture union, and the patient had regained a functional range of motion (ROM) of the knee. He reported no significant pain or limitation in daily activities (Figure 3).

Discussion

There is no clearly established radiographic threshold in the literature for revision of malunion in distal femoral fractures. Nonetheless, angular deviations exceeding 5°-10° in either the coronal or sagittal plane have been associated with altered gait and impaired knee function, and should be corrected when feasible (14). Posterior positioning of a lateral locking plate in the distal fragment increases the likelihood of screw encroachment into the intercondylar notch; this may result in intra-articular involvement and limitation of motion (15, 16), causing a posterior thrust during gait and contributing to pain and functional limitation (17, 18). Posterior displacement of the distal portion of the plate can cause medial translation of the distal fracture fragment, resulting in the "golf club" deformity (19) as observed in the present case. Additionally, in this patient, anterior positioning of the plate on the proximal fracture segment led to unicortical screw purchase in several instances, thereby compromising fixation stability (20).

Figure 3. Three-month follow-up radiographs and clinical photographs demonstrating fracture union and knee functional range of motion (ROM)

The combination of posterior distal plate placement and limited proximal screw purchase represents a biomechanical disadvantage that may undermine construct integrity and predispose to postoperative functional symptoms (19, 21). Precise intraoperative assessment of plate positioning, fragment alignment, and screw placement is essential to mitigate these risks (22-25).

Conclusion

Preventing malreduction in comminuted distal femur fractures requires a thorough understanding of local anatomy, accurate implant positioning, and meticulous application of intraoperative techniques. Plate alignment must be carefully planned to pass between the trochlear groove and Blumensaat line on a true lateral view, while avoiding entry into the intercondylar notch, thereby preventing notch compromise, impingement, and sagittal malalignment (14). Detailed preoperative planning, including computed tomography (CT) when articular extension or complex comminution is suspected, enhances surgical preparedness and allows the surgeon to anticipate the need for adjunctive reduction techniques (25).

Appropriate patient positioning in the operating room is critical to ensure unimpeded C-arm access and to obtain high-quality orthogonal and oblique images, as well as the roll-back view, to verify successful reduction and fixation (23, 24). Reduction should be achieved before definitive fixation, restoring length, alignment, and rotation using longitudinal traction, a sterile bump, pointed clamps, Schanz pin "joysticks", or a femoral distractor as needed, while avoiding the common pitfall of forcing the bone to conform to the plate (25, 26).

Optimal plate positioning is crucial for achieving proper postoperative alignment. Posterior placement of the distal fragment may result in medial deviation and the "golf club" deformity (27), whereas anterior positioning of the proximal plate segment can weaken fixation due to the use of unicortical screws (24). Intraoperative imaging is essential to verify restoration of articular congruity and safe extra-articular screw placement (19-22). If reduction or fixation is inadequate, the instrumentation should be removed, and reduction and fixation should be repeated. Although this may extend operative time, it is justified to prevent the need for subsequent revision surgery (14, 28).

Conflict of Interest

The authors declare no conflict of interest in this study.

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