Fixation Modalities for Medial Void in Distal Femur Fractures: A Narrative Review

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Abstract

Medial void in distal femur fractures—resulting from metaphyseal comminution, cortical bone loss, or segmental defects—predisposes constructs to varus collapse, non-union, and hardware failure if left unsupported. This narrative review synthesises current fixation strategies to address the medial defect, including: (1) lateral locked plating with augmentation (subchondral rafting, kickstand/medial column screws, bone graft and substitutes, and cement augmentation), (2) dual plating with a medial buttress, (3) nail–plate combination constructs, and (4) emerging concepts such as far cortical locking and linked constructs. Across biomechanical and clinical studies, strategies that restore a medial buttress or create a stable load-sharing environment reduce varus collapse, improve radiographic parameters, and may shorten time to union in comminuted, osteoporotic, or peri-articular patterns. Technique selection should be individualised by patient factors (bone quality, soft tissue, comorbidities), fracture morphology (AO/OTA 33-A3/C3, periprosthetic, non-union), and intra-operative reduction behaviour. We propose a pragmatic, reduction-first algorithm prioritising medial column support, balanced construct flexibility, adequate working length, and biological preservation. Future work should include comparative trials of dual plating versus nail–plate constructs with standardised indications and patient-reported outcomes.

Keywords: Distal femur fracture, Medial void, Dual plating, Nail–plate construct, Cement augmentation, Far cortical locking, Kickstand screw

Introduction

Distal femur fractures in adults frequently exhibit medial metaphyseal comminution, creating a "medial void" that compromises construct stability under varus loading. Lateral locking plates (LLP) popularised with minimally invasive techniques achieve reliable fixation; however, failures remain concentrated in highly comminuted, osteoporotic, or very distal patterns where the medial column is absent or malreduced. Addressing this defect—either by reconstituting a buttress or by converting the construct to a more favourable load-sharing environment—is central to preventing varus collapse and non-union.

Pathomechanics and Assessment of the Medial Void

The medial void reflects the loss of cortical continuity on the compression side of the distal femur. Without a buttress, eccentrically placed lateral implants are subjected to bending moments, concentrating stress at the proximal segment and at the distal cluster. Risk of failure increases with wider metaphyseal gaps (≈30 mm), short working lengths, poor bone quality, and malreduction. Pre-operative planning should characterise: (i) location/extent of medial comminution on AP/lateral radiographs and CT; (ii) articular involvement (AO/OTA 33-A vs 33-C patterns); (iii) bone quality, periprosthetic status, and soft-tissue conditions. Intra-operative fluoroscopy should confirm restoration of the medial cortex (or an alternative load path) and assess fracture motion after provisional fixation.

Fixation Modalities for the Medial Void

1) Lateral Locked Plate with Augmentation (Figure 4)

Augment an LLP construct when medial comminution is limited or soft-tissue constraints preclude a medial plate. Options include:

- Subchondral rafting and polyaxial screws directed into the medial condyle to maximise spread.
- "Kickstand"/medial column screws: percutaneous lag or locking screw placed from medial to lateral (or posteromedial to anterolateral) to buttress the medial cortex.
- Bone grafts and substitutes: autograft or calcium-phosphate cement to fill contained defects; PMMA in select osteoporotic/periprosthetic contexts where biological incorporation is secondary to immediate stability.
- Far cortical locking screws to reduce construct stiffness and encourage callus while maintaining strength.

Technical pearls: restore coronal alignment before locking, avoid over-stiff constructs, ensure adequate plate length and working length, and protect the distal cluster from screw convergence conflicts.

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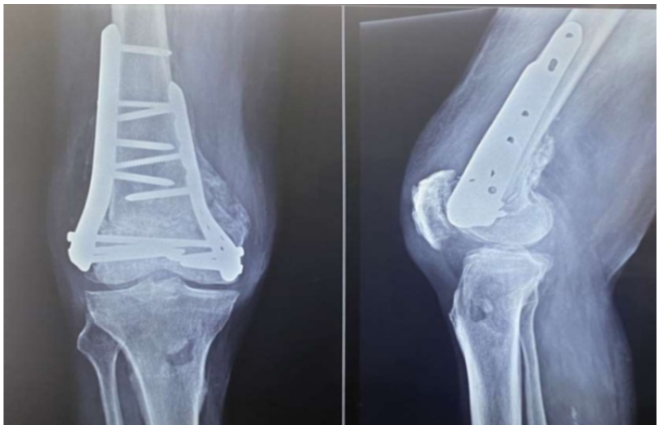

Figure 1: Fixation of distal femur fracture with dual plate

2) Dual Plating (Lateral + Medial Buttress) (Figure 1)

A dedicated medial plate re-establishes a buttress and converts eccentric bending into a more symmetric load path. It is particularly valuable for extensive medial comminution, AO/OTA 33-C3, periprosthetic fractures, and non-unions. Medial-first reduction can facilitate restoration of length and coronal alignment prior to lateral fixation. When soft tissues allow, a low-profile, locking medial plate via minimally invasive or limited exposure offers robust control of varus and sagittal plane deformity.

3) Nail–Plate Combination (NPC / Linked Constructs) (Figure 2 and Figure 5)

Combining a retrograde intramedullary nail with a lateral plate increases axial load sharing and may shorten time to weight-bearing in osteoporotic bone or in very distal, unstable patterns. Linked NPCs (interconnecting the distal plate screws with the nail) further integrate the construct. NPC is useful when the articular block can accept a nail trajectory and when a medial plate is undesirable due to soft-tissue concerns.

Figure 3: Fixation of distal femur fracture with nail + plate and cement augmentation

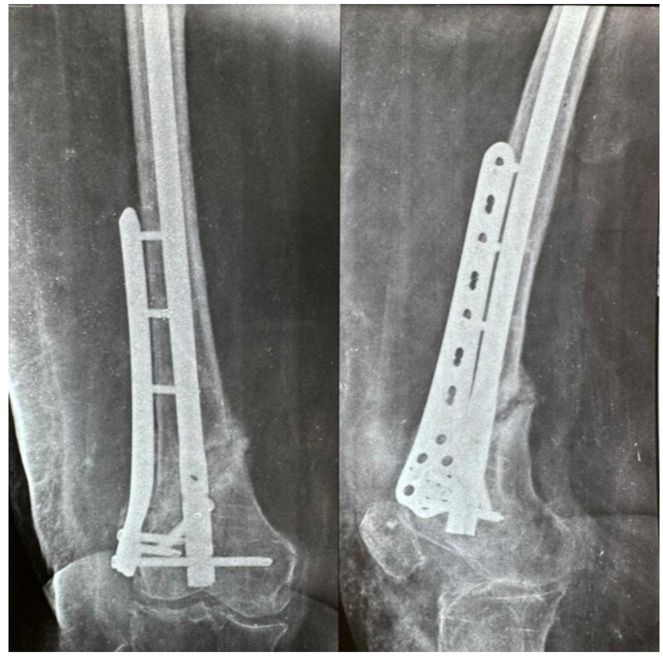

Figure 2: Fixation of distal femur fracture with nail + plate construct

4) Cement Augmentation and Bone Void Fillers (Figure 3)

Calcium-phosphate cement can augment subchondral support and screw purchase in contained metaphyseal defects, while PMMA may be used to enhance screw fixation in severe osteoporosis or periprosthetic bone. Fenestrated locking screws permit targeted cement delivery. Augments do not substitute for reduction or a medial buttress when comminution is uncontained.

5) Special Situations

• Periprosthetic distal femur fractures: consider NPC or dual plating depending on stem stability and bone stock.

• Non-union/failed LLP: supplemental medial plating or conversion to NPC with grafting.

• Severe osteoporosis: early protected weight-bearing with NPC or dual plating plus augmentation.

• Infection or compromised soft tissue: staged protocols with temporary external fixation and delayed definitive reconstruction.

A Pragmatic Algorithm (Reduction-First) (Table 1, 2)

1. Achieve articular reduction and restore length/alignment.
2. Assess the medial column: if reducible and contained → LLP with augmentation; if uncontained/segmental loss → add medial plate or consider NPC.
3. Balance construct stiffness: prefer longer plates, adequate working length, and dynamic fixation strategies (e.g., far cortical locking) when biology permits.
4. Fill contained defects with graft/substitute; use cement or fenestrated screws selectively in osteoporotic bone.
5. Escalate to dual plating or NPC when intra-operative assessment shows persistent varus instability or wide metaphyseal gaps.

Figure 4: Fixation of distal femur fracture with single plate and fibular strut graft

Figure 5: Fixation of distal femur fracture with TENS nail + plate and bone graft augmentation

Evidence Summary

Dual plating: Systematic reviews and recent cohorts demonstrate reduced varus collapse and improved radiographic parameters compared with single lateral plating in comminuted patterns; medial-first approaches aid reduction quality. Nail–plate constructs: Early comparative series and systematic reviews suggest favourable union times and complication profiles in osteoporotic and complex fractures, with linked constructs enhancing integration. Cement augmentation: Biomechanical work supports calcium-phosphate or cementable fenestrated screws to enhance subchondral support in contained defects. Far cortical locking: Randomised and cohort studies indicate improved callus formation via construct dynamisation without compromising strength when appropriately selected.

Post-operative Protocol and Rehabilitation

Weight-bearing should reflect construct stability and bone quality. NPC or robust dual-plate constructs often permit earlier progressive loading. Monitor for coronal plane collapse, screw back-out, and delayed union with serial radiographs at 6–8 and 12–14 weeks. Early knee motion with swelling control minimises stiffness; quadriceps activation and progressive closed-chain exercises are introduced as pain and fixation allow.

Table 1: Modality Selection by Scenario

Scenario	Preferred Modality	Why	Notes
Limited medial comminution; contained void	LLP + rafting/kickstand; graft/substitute	Restores subchondral support; preserves soft tissues	Confirm coronal alignment; avoid over-stiffness
Extensive medial column loss; 33-C3	Dual plating (medial buttress + lateral)	Reconstitutes medial buttress; controls varus	Medial-first reduction often helpful
Osteoporotic/periprosthetic; need early WB	Nail–plate combination (linked if feasible)	Axial load sharing; robust fixation in poor bone	Ensure nail path; manage screw conflict
Contained metaphyseal cavity	Ca-phosphate cement ± fenestrated screws	Improves screw purchase/subchondral support	Not a substitute for buttress in uncontained loss
Failed single-plate fixation/non-union	Add medial plate or convert to NPC + graft	Addresses varus pathway; improves biology	Plan for grafting and infection work-up

Table 2: Advantages, Pitfalls and Technical Pearls

Modality	Advantages	Common Pitfalls / Pearls
LLP + Augmentation	Less invasive; familiar instrumentation; preserves biology	Short working length and over-stiff constructs; ensure plate length, rafting into medial condyle, consider far cortical locking
Dual Plating	Restores buttress; strong coronal/sagittal control	Soft-tissue risk medially; use low-profile plates, minimally invasive corridors, medial-first reduction
Nail–Plate Combination	Load sharing; earlier weight-bearing; rescue option	Screw conflict; ensure sequence (nail then plate), consider linking for integration
Cement Augmentation	Improves purchase in poor bone; targeted support	Thermal injury with PMMA; use fenestrated screws cautiously; cement is not a reduction tool
Far Cortical Locking	Promotes callus via controlled motion	Maintain overall stability; avoid excessive flexibility in segmental or highly unstable patterns

Complications and Risk Reduction

Common issues include varus collapse, non-union, hardware failure, infection, and stiffness. Risk reduction emphasises: restoration of the medial column or alternative load path; adequate plate length and working length; balanced stiffness (dynamic fixation where appropriate); meticulous soft-tissue handling; and optimisation of host factors (glycaemic control, smoking cessation, nutrition).

Conclusion

The medial void is the biomechanical Achilles' heel of distal femur fracture fixation. Reliable strategies centre on recreating a medial buttress (dual plating), converting to a load-sharing construct (nail–plate), or augmenting a lateral construct with targeted support (rafting, kickstand screws, graft/cement) while avoiding excessive construct stiffness. Selection should be individualised and reduction-driven. Future multicentre trials should compare dual plating versus nail–plate constructs with standardised indications and patient-reported outcomes.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

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