Proximal Humeral Internal Locking System Plating in Proximal Humeral Fractures – Avoiding Failure – Narrative Review

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Abstract

Proximal humerus fractures remain a challenging entity, especially in elderly patients with osteoporotic bone or in multifragmented fracture patterns. The proximal humeral internal locking system (PHILOS) system continues to be a reliable fixation method, but reported failure rates may reach 30–40% when biomechanical principles or biological preservation are compromised. Common causes of failure include loss of medial buttress, improper screw placement, varus malreduction, vascular compromise, and poor implant choice in unsuitable bone stock.

This review highlights evidence based techniques to minimize failure, including restoration of medial support, optimized calcar screw placement, tuberosity fixation with sutures, selective use of augmentation in osteoporotic bone, and biological-friendly surgical approaches. Attention to these principles can substantially improve outcomes, reduce complications, and prevent failure of fixation.

Keywords: Proximal humerus fracture, Proximal humeral internal locking system plate, Fixation failure, Medial buttress, Calcar screw, Osteoporotic bone, Arthroplasty alternatives

Introduction

Locked plating using the proximal humeral internal locking system (PHILOS) plate has revolutionized fixation of proximal humeral fractures, offering angular stability and early mobilization potential. Despite these advantages, clinical failure remains a significant concern, particularly in osteoporotic or comminuted fractures. Reported complications include screw cut-out, plate pull-out, varus collapse, and avascular necrosis. These failures often result not from the implant design itself but from technical errors, biological compromise, or poor surgical judgment in indications.

The aim of this article is to provide a structured guide to common reasons for PHILOS failure and practical strategies to prevent them, based on current evidence and surgical experience.

Methods/Causes of Failure and How to Avoid Them

Inadequate restoration of medial buttress (Fig. 1)

• Problem: Varus alignment without medial support is one of the strongest predictors of fixation failure [1]. The medial calcar functions as a hinge preventing collapse; if not reconstructed, loads transfer entirely to the implant.

• Prevention:

1. Achieve stable valgus or neutral head-shaft alignment, never leave a varus reduction
2. Reconstruct medial cortex when possible
3. Employ inferomedial calcar screws as "kick-stand" support [2]
4. Use bone grafts or strut allografts when the medial hinge is deficient.

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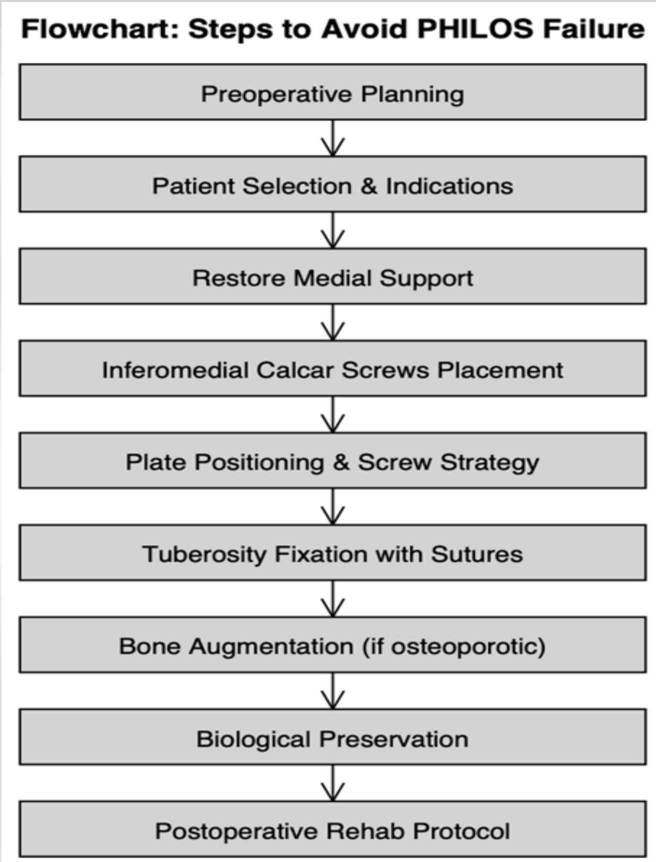

Figure 1: Inadequate restoration of medial buttress.

Improper screw strategy (Fig. 2)

• Problem: Absent or misplaced calcar screws reduce construct stability and increase risk of head collapse. Incorrect screw length leads to articular penetration or loss of purchase.

• Prevention:

1. Use 6–8 divergent locking screws in the humeral head, always include 1–2 inferomedial calcar screws [3]
2. Place screws under fluoroscopy in multiple views (anteroposterior, axillary, and outlet) to confirm intra-articular avoidance
3. Control screw length carefully – aim for subchondral purchase within 5–10 mm of joint line.

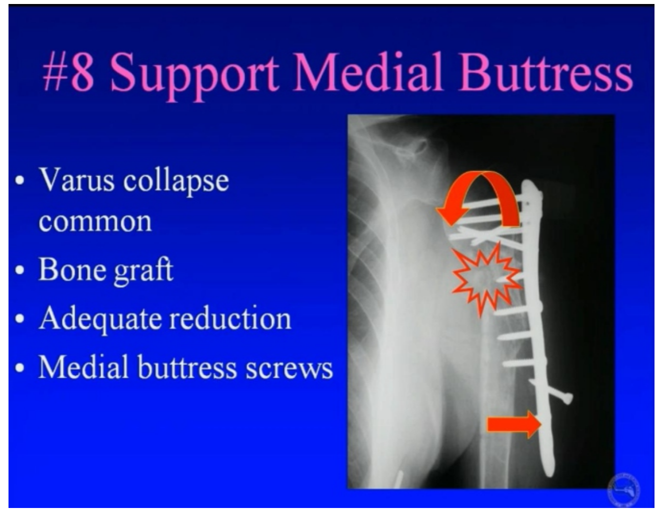

Figure 2: Improper screw strategy.

Screw cut-out due to poor length/control (Fig. 3)

• Problem: Screw perforation into the joint is one of the most common PHILOS failures [4]. Occurs if screw length is overestimated, if subchondral bone is too weak, or if head collapses into varus.

• Prevention:

1. Calibrate screw measurement intraoperatively with depth gauge
2. Target "surrounding spread" rather than all screws into one region
3. Consider cement augmentation for improved hold in osteoporotic bone.

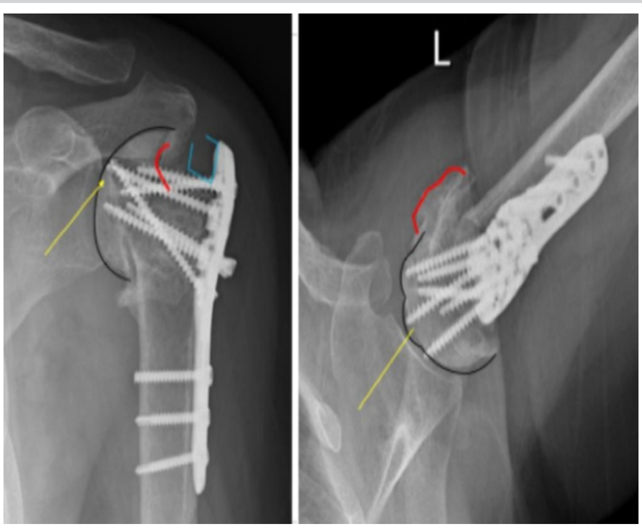

Figure 3: Screw cutout.

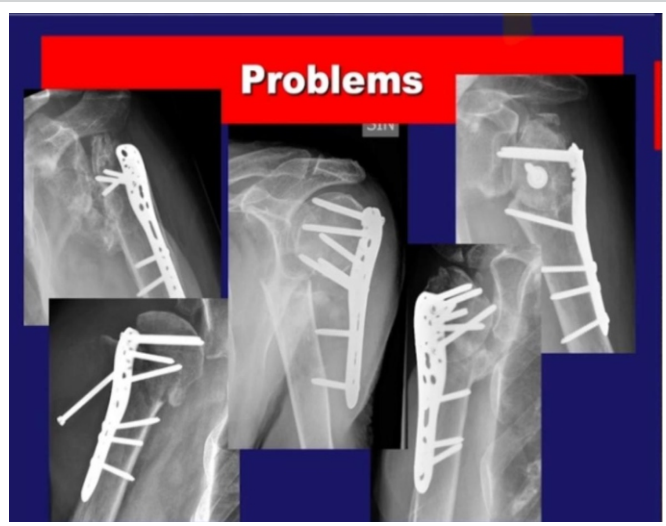

Figure 4: Excessive varus reduction.

Figure 5: Osteoporotic bone complication.

Excessive varus reduction (Fig. 4)

• Problem: Varus malalignment significantly lowers implant survival, concentrating stress on the lateral plate and screws [5].

• Prevention:

1. Aim for physiological neck–shaft angle (130–140°)
2. Accept mild valgus but never varus
3. Temporary K-wires and laminar spreaders can help achieve reduction before plate placement.

Osteoporotic bone complications (Fig. 5)

• Problem: Poor screw purchase in fragile bone leads to loosening, backing out, or plate pull-out [6].

• Prevention:

1. Augment key screws with PMMA cement or fibular strut grafts for medial support
2. Avoid overtightening locking screws which can strip fragile bone
3. Use augmentation selectively in critical zones, not universally.

Plate malposition (Fig. 6)

• Problem: Misplaced plate may cause subacromial impingement or inadequate fixation [7].

• Prevention:

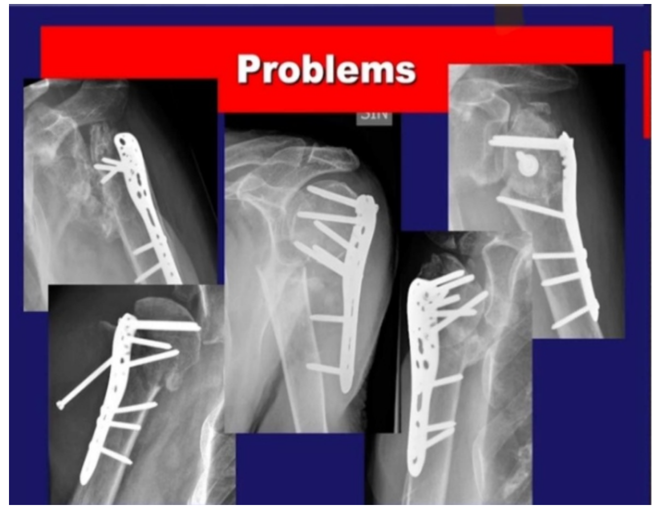

Figure 6: Plate malposition.

1. Plate should sit 5–8 mm inferior to greater tuberosity tip, lateral to bicipital groove
2. Always confirm arm motion under fluoroscopy to rule out impingement.

Tuberosity nonunion or secondary displacement (Fig. 7)

• Problem: GT and LT fragments are critical for cuff function and plate stability. If inadequately fixed, they tend to displace secondarily [7].

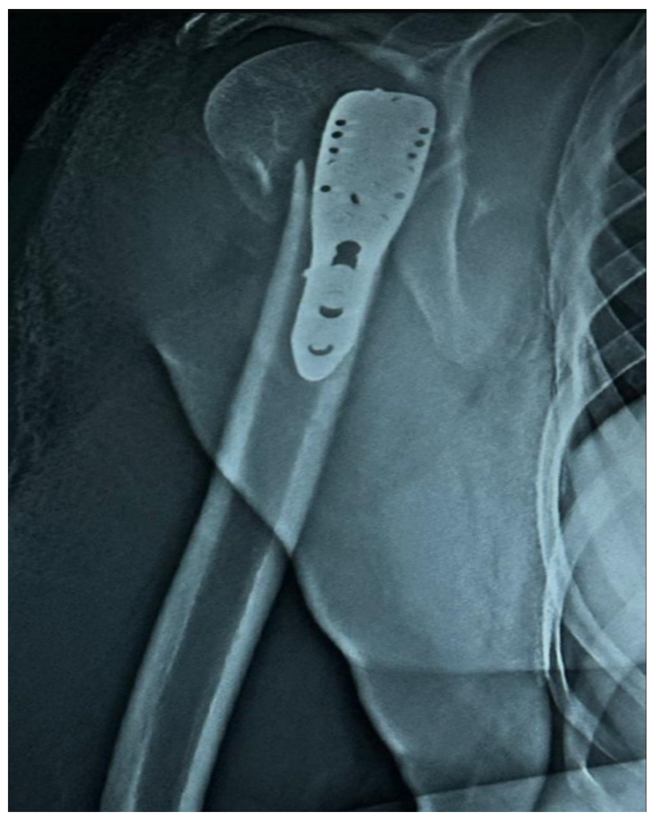

Figure 7: Tuberosity non-union and secondary escape.

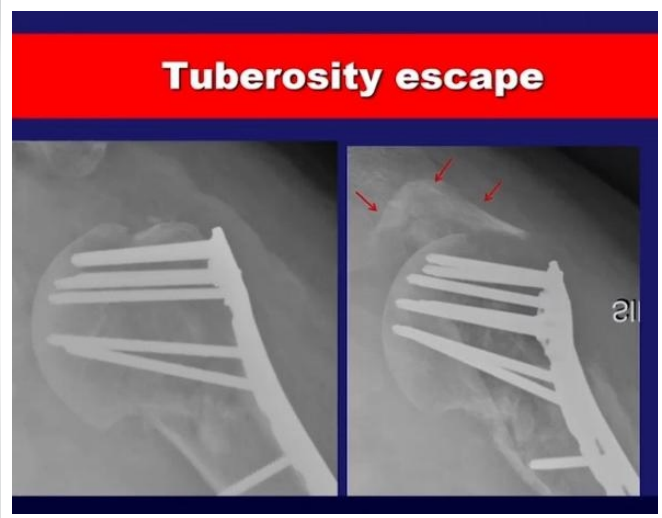

Figure 8: Tuberosity escape

• Prevention:
1. Secure tuberosities early with strong, non-absorbable sutures passed through rotator cuff and tied to plate/tendon holes
2. Avoid relying solely on screws for tuberosity fixation.

Loss of vascularity from aggressive exposure
• Problem: Excessive soft-tissue stripping, prolonged dissection, or manipulative handling of humeral head risks avascular necrosis [8].
• Prevention:
1. Use the minimally invasive deltopectoral approach whenever feasible
2. Preserve anterior circumflex artery branches
3. Gentle handling of bone fragments and avoid prolonged manipulation of the head fragment.

Poor Patient Selection
• Problem: Attempting PHILOS fixation in severely osteoporotic bone, head-splitting fractures, or unconstructible 4-part fractures often leads to early failure [9].
• Prevention:
1. Ideal Indications: 2-part and 3-part displaced fractures, selected 4-part fractures in relatively younger patients.
2. Avoid PHILOS: Fragile bone with absent medial support, comminuted head-splitting fractures → consider arthroplasty instead.
3. Always have contingency plans: Intramedullary nail or reverse shoulder arthroplasty.

Discussion

Preventing PHILOS failure requires a balance between mechanical stability and biological preservation. Most failures are preventable with meticulous technique and sound surgical judgment. Restoring medial buttress with proper reduction, supplementing fixation with calcar screws, and securing tuberosities are the true biomechanical foundations. Equally important is biological care – gentle handling, minimal periosteal stripping, and respect for blood supply.
Another crucial component is patient selection. Surgeons must distinguish between patients suitable for fixation versus those better served with primary arthroplasty, especially elderly patients with poor bone stock and unconstructible fracture patterns. Rehabilitation must also be timed properly: too early risks fixation loss, too delayed causes stiffness.

Table 1: Common causes and prevention strategies in PHILOS failure

Cause of failure	Evidence-informed strategy to prevent failure
Inadequate restoration of medial buttress	Achieve valgus or neutral alignment; reconstruct medial cortex; use calcar screws or strut graft if deficient
Improper screw strategy	Employ 6–8 divergent screws including at least 1–2 calcar screws; confirm screw position and length under fluoroscopy
Screw cut-out due to poor length control	Measure screw lengths carefully; consider cement augmentation or strut support in weak bone
Excessive varus reduction	Maintain physiological neck-shaft angle; use reduction tools as needed; avoid varus
Loss of vascularity due to aggressive dissection	Use minimally invasive approaches; preserve soft-tissue and blood supply; gentle handling of fragments
Poor patient selection (severe comminution, poor bone)	Reserve PHILOS for suitable 2-/3-part fractures; avoid in severely osteoporotic/comminuted cases – consider arthroplasty
Tuberosity fixation errors	Secure greater and lesser tuberosities early using non-absorbable sutures through cuff to plate
Augmentation in osteoporotic bone	Selective cement augmentation or fibular strut graft for purchase; avoid overtightening locking screws
Plate malposition	Position 5–8 mm below greater tuberosity tip, lateral to groove; confirm arm motion to prevent impingement

Conclusion (Table 1)

The PHILOS system remains an effective tool for proximal humerus fracture fixation. Avoiding failure hinges on:
• Restoring medial support and maintaining valgus/neutral alignment,
• Secure screw strategy with true calcar fixation,
• Judicious augmentation in osteoporosis,
• Biological preservation of vascularity, and
• Respecting patient- and fracture-based indications.
When applied with discipline, these principles reduce complication rates and provide durable 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 consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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