

Original Research Article

Role of additional lateral wall buttressing in the management of unstable trochanteric fractures treated by internal fixation: a prospective observational study

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ABSTRACT

Background: Unstable trochanteric fractures have a high risk of biomechanical failure, particularly when the lateral femoral wall is compromised. This study evaluated the clinical and radiological outcomes of cephalomedullary fixation augmented with an additional lateral buttress plate.

Methods: This prospective, single-centre observational study included 50 patients aged 25–80 years with unstable trochanteric fractures (AO/OTA 31A2.2, 31A2.3 and 31A3) treated between March 2022 and July 2024. Fractures were stabilised with a cephalomedullary nail supplemented by a lateral buttress plate selected according to availability. Patients were evaluated at 6 weeks, 3 months and 6 months. Functional outcomes were assessed using the Harris Hip Score (HHS), while radiological evaluation included union, alignment and implant-related complications.

Results: Mean age was 59.36 ± 11.61 years, and falls accounted for 76% of injuries. Mean operative time was 107.7 ± 14.4 minutes and blood loss was 228.6 ± 14.3 ml. Mean HHS improved from 46.38 ± 4.17 at 6 weeks to 82.58 ± 6.81 at 6 months. At final follow-up, 90% achieved good-to-excellent outcomes. All fractures united, with a mean union time of 13.3 weeks. Superficial infection occurred in 4% and implant impingement in 6%. No varus malunion, Z-effect, screw cut-out, implant breakage or non-union occurred.

Conclusion: Lateral buttress plate augmentation with cephalomedullary fixation provided favourable functional and radiological outcomes with a low complication rate in unstable trochanteric fractures.

Keywords: Unstable trochanteric fracture, Lateral wall, Buttress plate, Proximal femoral nail, Harris Hip Score

INTRODUCTION

An unstable trochanteric fracture may be defined by one or more of the following features: a reverse oblique fracture line, intertrochanteric comminution, a large posteromedial fragment involving the lesser trochanter, a fractured greater trochanter, or a breach in the lateral cortex.¹ Unstable trochanteric fractures fixed with internal fixation alone exhibit a high incidence of biomechanical failure: excessive collapse with varus malunion, Z-effect and implant breakage are well-documented complications. The

lateral femoral wall is recognised as a crucial predictor of reduction quality in intertrochanteric fractures. A biomechanical study by Li et al demonstrated that the failure load of the fractured medial wall is significantly lower than that of the lateral wall, suggesting that integrity of both walls is essential to maintain the bone-implant construct.² When the posteromedial buttress is unstable, the lateral wall becomes critical for high-quality intra-operative reduction; conversely, a deficient lateral wall predisposes the construct to failure even when the medial buttress is intact. Dynamic hip screw (DHS) fixation

without lateral support is associated with unsatisfactory results in unstable patterns. Locking plate technology coupled with an in-built metaphyseal contour permits minimally invasive plate osteosynthesis but has shown no consistent superiority over the DHS. Intramedullary nailing with the proximal femoral nail (PFN) has become the implant of choice for unstable trochanteric fractures because the nail itself supports the posteromedial wall and resists excessive fracture collapse. However, even the PFN is not free from complications: lag-screw migration, Z-effect, screw cut-out and implant breakage continue to occur, particularly when the lateral trochanteric wall is compromised.³

Unstable trochanteric fractures with a coronal split or posteromedial comminution therefore continue to challenge orthopaedic surgeons. Near-anatomical reduction and optimal implant positioning are paramount for a good outcome. Authors hypothesized that supplementing internal fixation with an additional lateral wall buttress plate increases the stiffness of the bone-implant construct, reduces the rate of biomechanical complications, and aids in functional recovery of the hip.

The present study was therefore undertaken to evaluate the clinical and radiological outcomes of additional lateral wall buttressing in unstable trochanteric fractures managed by internal fixation. The primary objective was to assess the efficacy of lateral wall buttressing as an adjunct to standard cephalomedullary fixation secondary objectives were to evaluate functional recovery of the hip, time to ambulation, range of motion and incidence of implant-related complications.

METHODS

Study design and setting

This was an institution-based prospective observational study conducted in the Department of Orthopaedics at IPGME&R and SSKM Hospital, Kolkata a tertiary-care referral centre in Eastern India from March 2022 to July 2024 (study duration 18 months). The study protocol was approved by the Institutional Ethics Committee and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrolment.

Participants

Fifty consecutive patients of either sex, aged 25–80 years, presenting to the orthopaedic out-patient department or emergency with unstable trochanteric fractures (AO/OTA 31A2.2, 31A2.3 and 31A3) confirmed on digital radiography were recruited. Unstable trochanteric fractures were defined as fractures with significant comminution of the posteromedial buttress beyond a simple lesser trochanteric fragment, fractures with a compromised lateral wall, fractures with subtrochanteric extension, or reverse oblique intertrochanteric fractures.

Exclusion criteria

Open fractures, stable intertrochanteric fractures (AO/OTA 31A1 and 31A2.1), pathological fractures, fractures more than six weeks old, pre-existing femoral deformity, ipsilateral fractures of the lower limb, patients with comorbid conditions precluding surgery, and patients unwilling to undergo operative management.

Pre-operative evaluation

All patients underwent thorough clinical examination including assessment of limb alignment, neurovascular status, and identification of associated injuries. Standard anteroposterior and cross-table lateral radiographs of the affected hip were obtained, and three-dimensional CT was performed where the fracture configuration was unclear, to enable accurate AO/OTA classification. Routine pre-operative investigations included haemogram, blood biochemistry, viral markers, electrocardiography and chest radiography. Physician clearance was obtained in all patients prior to surgery. The injured limb was immobilized in a Böhler-Braun splint and analgesia was administered until surgery.

Surgical technique

All operations were performed under spinal or general anaesthesia, with the patient placed supine on a fracture table. Closed reduction was attempted in all cases under image-intensifier guidance and confirmed in both anteroposterior and lateral views. Reduction was held temporarily with a 3 mm K-wire to prevent loss of position during nail insertion.

A standard entry point was made over the tip of the greater trochanter using an awl, and the canal prepared with sequential reaming where necessary. A short PFN (180–240 mm) was used in 31A2 fractures and a Long PFN or PFNA-II in 31A3 fractures with subtrochanteric extension. The lag and antirotation screws were positioned with appropriate tip-to-apex distance (TAD <25 mm) and the construct distally locked using the jig (short nail) or free-hand technique under image-intensifier control (long nail).

After cephalomedullary fixation, the lateral buttress plate was introduced. The trochanteric buttress plate (TBP) described by Ganjale et al although biomechanically ideal, was not commercially available at our institution; we therefore used commonly available alternative implants based on intra-operative requirement: the proximal tibia posteromedial T-plate (used in the majority of cases), reconstruction plate, PHILOS plate, or trochanteric stabilisation plate. The plate was introduced by sliding it along the lateral cortex after temporarily detaching the outer arm of the jig and re-attaching it once the plate was correctly positioned. Three to four unicortical screws were used to fix the plate to the lateral femoral wall, ensuring the lag-screw and antirotation-screw heads of the cephalomedullary nail compressed the plate against the

lateral cortex, creating a rigid construct. In the early phase of the study an extended lateral incision was used; with experience the plate was passed via a minimally invasive plate osteosynthesis (MIPO) technique. The wound was closed in layers over a vacuum drain.

Post-operative protocol

Intravenous antibiotics were continued for 48 hours followed by oral antibiotics until suture removal. The drain was removed at 48 hours. Static quadriceps exercises were begun on the first post-operative day, followed by active hip and knee mobilisation from the second day. Touchdown weight-bearing with a walker was permitted from two weeks. Progressive weight-bearing was started at one month and full weight-bearing at three months, depending on radiological progress of union and patient tolerance. Sutures were removed at 14 days.

Outcome measures and follow-up

Patients were reviewed clinically and radiologically at 6 weeks, 3 months and 6 months. Functional outcome was assessed using the HHS, which evaluates pain (44 points), function (47 points), absence of deformity (4 points) and range of motion (5 points). Scores of ≥ 90 were classified as excellent, 80–89 as good, 70–79 as fair and < 70 as poor. Radiographic evaluation at each visit assessed reduction, neck-shaft angle, fracture union, and implant-related complications including varus malunion, Z-effect, screw

cut-out, implant breakage, peri-implant fracture and non-union. Operative time, intra-operative blood loss, requirement of postoperative transfusion, time to weight-bearing and time to radiological union were also recorded.

Statistical analysis

Data were entered into Microsoft Excel and analysed using SPSS version 27.0 (IBM Corp., Armonk, NY) and GraphPad Prism version 5. Numerical variables are expressed as mean $\pm$ standard deviation (SD) and categorical variables as frequencies and percentages. Within-group comparison of HHS at successive follow-up intervals was performed with paired t-tests. A two-tailed p value ≤ 0.05 was considered statistically significant.

RESULTS

Patient demographics and fracture characteristics

A total of 50 patients with unstable trochanteric fractures were included and completed the scheduled follow-up. The mean age was 59.36 $\pm$ 11.61 years (range: 28–76 years), with the highest frequency observed in the 61–70 years age group (38%). Low-energy falls were the predominant mechanism of injury, accounting for 76% of cases, while road traffic accidents contributed 24%. According to AO/OTA classification, 31A2.2 fractures constituted the majority (64%), followed by 31A2.3 (24%) and 31A3 fractures (12%).

Table 1: Baseline demographic and fracture characteristics.

Variables	Value
Sample size	50
Mean age (in years)	59.36 $\pm$ 11.61
Fall from standing height	38 (76)
Road traffic accident	12 (24)
AO/OTA 31A2.2	32 (64)
AO/OTA 31A2.3	12 (24)
AO/OTA 31A3	6 (12)

Table 2: Operative parameters.

Parameters	Mean $\pm$ SD / n (%)
Operative time (in min)	107.7 $\pm$ 14.4
Blood loss (ml)	228.6 $\pm$ 14.3
Open reduction	6 (12)
Blood transfusion	12 (24)

Table 3: Harris hip score components at successive follow-up intervals (mean $\pm$ SD).

HHS components (max)	6 weeks	3 months	6 months
Pain (44)	23.40 $\pm$ 4.79	30.00 $\pm$ 0.00	38.80 $\pm$ 4.95
Limp (11)	4.60 $\pm$ 1.37	6.62 $\pm$ 1.51	8.48 $\pm$ 1.13
Support (11)	3.58 $\pm$ 1.53	4.64 $\pm$ 0.88	7.64 $\pm$ 1.38
Distance walked (11)	3.80 $\pm$ 1.48	5.48 $\pm$ 1.11	7.58 $\pm$ 1.65
Sitting (5)	2.66 $\pm$ 1.39	3.32 $\pm$ 0.74	4.56 $\pm$ 0.94

Continued.

HHS components (max)	6 weeks	3 months	6 months
Public transport (1)	0.10±0.30	0.40±0.49	0.76±0.49
Stairs (4)	1.54±0.50	1.74±0.75	2.10±0.47
Shoes/socks (4)	1.36±1.43	1.48±1.39	3.40±1.16
Absence of deformity (4)	0.56±1.48	1.12±1.10	3.68±1.10
Range of motion (5)	4.70±0.46	4.92±0.27	5.00±0.00
Total HHS (100)	46.38±4.17	59.72±3.09	82.58±6.81

Table 4: Functional outcome at final follow-up.

HHS Category	N (%)
Excellent (≥90)	9 (18)
Good (80–89)	36 (72)
Fair (70–79)	5 (10)
Poor (<70)	0

Table 5: Radiological outcome.

Variables	Value
Union rate	100%
Mean union time	13.3 weeks
Union ≤12 weeks	14%
Union 13–16 weeks	68%
Union >16 weeks	18%
Varus collapse	0
Non-union	0

Table 6: Postoperative complications.

Complications	N (%)
Superficial infection	2 (4)
Implant impingement	3 (6)
Deep infection	0
Z-effect	0
Screw cut-out	0
Varus malunion	0
Implant breakage	0
Non-union	0

Table 7: Comparison of the present study with published series of lateral wall augmentation in unstable intertrochanteric fractures.

Study	Sample size	Construct	Mean HHS / Outcome
Ganjale et al ⁶ , 2018	32	PFN+TBP	Salvati-Wilson 36/40 in 87.5%, union 12.6 weeks
Jain et al ⁷ , 2022	60 (RCT)	PFN vs PFN+TBP	HHS 87.9 vs 94.1; union 13.4 vs 11.6 weeks
Zhao et al ⁸ , 2022	41	IM nail+plate or cable	HHS 83.6 (plate) / 83.8 (cable)
Gadegone et al ⁹ , 2017	82	PFN+screw or cerclage	Salvati-Wilson 32/40 in 88%; union 14.2 weeks
Ravindranath et al ¹⁰ , 2023	—	PFN+TBP	No varus fixation, union 12.6 weeks
Present study	50	Cephalomedullary nail+buttress plate (variable)	HHS 82.58±6.81; union 13.3 weeks; no varus /Z-effect/cut-out

Operative parameters

All fractures were stabilized using a cephalomedullary device supplemented with a lateral wall buttress plate. The mean operative time was 107.7 ± 14.4 minutes and the mean intraoperative blood loss was 228.6 ± 14.3 ml. Open reduction was required in six patients (12%). Postoperative blood transfusion was necessary in 12 patients (24%).

Functional outcome

Mean Harris Hip Score improved progressively throughout follow-up. The mean score increased from 46.38 ± 4.17 at 6 weeks to 59.72 ± 3.09 at 3 months and 82.58 ± 6.81 at 6 months.

At final follow-up, 90% of patients achieved good-to-excellent functional outcomes. Excellent results (HHS ≥ 90) were observed in 18% of patients, good outcomes (HHS 80–89) in 72%, and fair outcomes (HHS 70–79) in 10%. No patient had a poor outcome. Repeated-measures analysis demonstrated a statistically significant improvement in Harris Hip Score across successive follow-up visits ($p < 0.001$). Post-hoc pairwise comparisons confirmed significant improvement between 6 weeks and 3 months, 3 months and 6 months, and 6 weeks and 6 months (all $p < 0.001$).

Radiological outcome

Fracture union was achieved in all patients (100%). The mean time to radiological union was 13.3 weeks (range 11–17 weeks).

Seven patients (14%) achieved union within 12 weeks, while the majority (68%) united between 13 and 16 weeks. The remaining 18% united after 16 weeks. No loss of reduction or secondary varus collapse was observed. The neck-shaft angle remained within 5° of the contralateral side in all patients.

Complications

The overall complication rate was low. Superficial surgical site infection occurred in two patients (4%), while implant prominence-related impingement was observed in three patients (6%). No major implant-related mechanical complications were encountered. Overall, augmentation with a lateral wall buttress plate resulted in a 100% union rate, 90% good-to-excellent functional outcomes, and complete absence of major implant-related failure during the study period.

DISCUSSION

The principal finding of this prospective study is that augmentation of cephalomedullary fixation with an additional lateral buttress plate in unstable trochanteric fractures yields excellent to good functional results in 90% of patients at 6 months, with universal bony union and a

striking absence of the implant-related complications varus collapse, Z-effect, screw cut-out and implant breakage that have historically plagued the management of these injuries.

The biomechanical rationale for lateral wall buttressing is well established. The lateral femoral wall, particularly its thickness, has been shown to be an independent predictor of post-operative reduction loss.^{2,4} A deficient lateral wall converts an otherwise mechanically sound 31A2 fracture into a functionally unstable construct in which the lag screw retains insufficient bony support, predisposing to medialization of the shaft, lateral migration of the lag screw and ultimately implant cut-out. Gupta et al were among the first to argue formally for surgical reconstruction of the lateral wall as part of the primary procedure rather than as a salvage measure.⁵

The TBP described by Ganjale et al a 3 mm anatomically contoured plate with cephalad holes designed to accommodate the cephalomedullary nail screws, represents a purpose-built solution; in their series of 32 patients with lateral-wall-deficient unstable intertrochanteric fractures, all united by 12.6 weeks with good Salvati and Wilson scores in 87.5% and only minor complications.⁶

Subsequent investigators have confirmed the value of lateral wall augmentation using a variety of constructs. Jain et al randomised 60 patients with lateral-wall-deficient intertrochanteric fractures to PFN alone or PFN+TBP and reported a shorter mean time to union (11.6 vs 13.4 weeks) and higher mean HHS (94.1 vs 87.9) in the buttressed group, with substantially fewer mechanical complications.⁷ Zhao et al compared plate and cable augmentation of the intramedullary nail in 41 patients and found comparable HHS in both groups, with no requirement for revision in either.⁸ Gadegone et al using either an additional cephalad screw or cerclage wire as the buttress element, found bone healing in all 82 cases at a mean of 14.2 weeks and Salvati-Wilson scores of 32/40 in 88%.⁹

The cumulative weight of these data supports the principle that any rigid lateral support whether anatomical plate, generic plate, or cerclage converts the cephalomedullary construct from one that depends on the lateral wall for stability to one that supplements it. The results are broadly comparable to these published series (Table 7). The mean union time of 13.3 weeks and mean HHS of 82.58 at 6 months are within the range reported by Jain et al and Zhao et al and the complete absence of varus malunion, Z-effect and screw cut-out reproduces the most clinically meaningful benefit reported for the buttressed construct. Mean operative time (107.7 min) and blood loss (228.6 ml) in the study were modestly higher than in series using a single anatomical TBP, which is to be expected given that we used a wider range of plates not specifically contoured for the lateral femoral wall and required intra-operative shaping in some cases.

A distinctive feature of the study is the deliberate use of multiple plate types proximal tibia posteromedial T-plate, reconstruction plate, PHILOS plate and trochanteric stabilisation plate as lateral buttresses, dictated by the non-availability of the purpose-designed TBP at our institution. This pragmatic approach yielded results comparable to those obtained with the dedicated implant and suggests that the principle of lateral wall buttressing matters more than the specific implant employed. Given that the dedicated TBP is not universally available and adds incremental cost, the use of commonly available, low-cost alternatives substantially increases the feasibility of this technique in resource-limited settings a particularly relevant consideration in much of South Asia. We additionally observed that, with experience, the buttress plate could be slid along the lateral cortex through the existing PFN incision via a minimally invasive plate osteosynthesis (MIPO) technique, reducing operative time, blood loss and the risk of surgical site infection.

Further evidence supports the clinical relevance of lateral wall reconstruction and supplementary fixation in unstable trochanteric fractures. Ravindranath et al demonstrated favourable outcomes following trochanteric buttress plate augmentation with proximal femoral nailing, emphasizing the importance of restoring lateral wall integrity in pertrochanteric fractures.¹⁰ Functional recovery following such procedures can be objectively assessed using the HHS, originally described by Harris and incorporating pain, function, deformity and range of motion.¹¹ Saudan et al in a prospective randomised study of 206 patients, compared proximal femoral nailing with dynamic hip screw fixation for pertrochanteric fractures, providing important evidence regarding intramedullary and extramedullary fixation strategies.¹²

Jain et al subsequently reported outcomes of a buttress plate–nail construct used specifically for reconstruction of a broken lateral wall in intertrochanteric fractures, further supporting lateral wall restoration as an adjunct to fixation.¹³ Kulkarni et al evaluated augmentation of intramedullary nailing with cerclage wiring and lag screws in unstable intertrochanteric fractures, demonstrating another approach to supplementary stabilisation.¹⁴ Agrawal et al further explored lateral support using a trochanteric support plate combined with a dynamic hip screw, extending the principle of augmentation to extramedullary fixation constructs.¹⁵ Collectively, these studies support the rationale for supplementary fixation and restoration of lateral wall integrity in unstable trochanteric fracture patterns.

Limitations

This study has several limitations. First, the follow-up of six months is relatively short; longer-term complications such as late peri-implant fracture and avascular necrosis cannot be excluded. Second, the absence of a control group treated with cephalomedullary fixation alone limits the strength of inferences about the incremental benefit of

buttressing. Third, the sample size is modest and the study was conducted in a single tertiary-care centre, raising the possibility of referral bias. Finally, the heterogeneous mix of plates used precludes formal comparison between implant types. A multi-centre randomised controlled trial comparing isolated cephalomedullary fixation with the buttressed construct, with longer follow-up, would address these limitations.

CONCLUSION

Augmentation of standard internal fixation with an additional lateral buttress plate in unstable trochanteric fractures increases the biomechanical stability of the bone-implant construct, prevents excessive telescoping and lateralization of the fracture fragments, permits earlier ambulation and weight-bearing, and yields excellent to good functional outcomes in 90% of patients at six months. Implant-related complications such as Z-effect, screw cut-out, varus malunion and implant breakage were not observed in the cohort. Although the technique is associated with modest increases in operative time and blood loss, it does not appear to lead to significant peri-operative morbidity. There is a learning curve associated with the procedure, but once mastered particularly the MIPO insertion technique it provides a reproducible solution to a long-standing problem and is feasible with a variety of commonly available plates, making it well-suited to low- and middle-income surgical settings.

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