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Original Article

Valgus Intertrochanteric Osteotomy for Neglected Femoral Neck Fractures: Clinical and Radiological Outcomes

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ABSTRACT

Background: Neglected and ununited femoral neck fractures in younger patients remain a surgical challenge. Valgus intertrochanteric osteotomy (VITO) converts shear forces into compressive loading across the fracture site and may preserve the native femoral head. **Objectives:** To evaluate the clinical and radiological outcomes of VITO for neglected femoral neck fractures treated at NITOR between January 2021 and June 2025. **Methods & Materials:** This prospective observational study included 20 patients with neglected intracapsular femoral neck fractures (Garden III/IV) treated with VITO. The primary outcome was Harris Hip Score (HHS); secondary outcomes included radiographic union, time to union, Pauwels angle correction, and postoperative complications. **Results:** Twenty patients (13 male, 7 female; mean age 35.5 years, range 10–50) were followed for a mean of 36 months. HHS improved from 46.6 preoperatively to 88 at final follow-up ($p<0.001$). Union occurred in 18 patients (90%) at a mean of 14.7 weeks. Mean Pauwels angle decreased from 66° to 33.3° ($p<0.001$). Complications included superficial infection (15%), implant cut-through (10%), osteonecrosis (10%), nonunion (10%), limb shortening (15%), and secondary total hip arthroplasty (10%). **Conclusion:** VITO achieved high union and significant functional improvement in this cohort and represents a viable head-preserving option for carefully selected younger patients, although the complication rate warrants careful patient selection.

Keywords: *femoral neck fracture; valgus intertrochanteric osteotomy; neglected fracture; neck deformity correction; fracture union.*

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INTRODUCTION

Femoral neck fractures in younger patients present a distinct therapeutic dilemma. Preservation of the native femoral head is desirable to maintain hip joint function and avoid early arthroplasty; however, nonunion and avascular necrosis frequently compromise long-term outcomes. Femoral neck nonunion is associated with multiple etiological factors including unfavorable mechanical conditions, initial fracture displacement, progressive bone stock loss, and potential compromise of femoral head blood supply. The increasing prevalence of neglected femoral neck fractures in developing nations underscores the need for effective salvage procedures.

The biomechanical rationale for valgus intertrochanteric osteotomy derives from the classical Pauwels concept: a steep femoral neck fracture line generates substantial shear forces that are biomechanically unfavorable for healing and prone to collapse. Valgus-producing osteotomy at the intertrochanteric level changes the orientation of the proximal femur, reducing the shear component at the fracture site and converting forces into a predominantly compressive loading environment more conducive to union. This principle has been validated in biomechanical studies and supported by extensive clinical outcome data.

Contemporary literature reports union rates following VITO ranging from 80% to 95%, though heterogeneity exists due to differences in patient selection, fracture morphology, residual bone stock, degree of valgus correction, implant construct, and management of osteonecrosis. The technical challenge remains balancing adequate valgus correction to achieve union while avoiding excessive valgisation, which may alter femoral offset, medialize the proximal femoral shaft, lower the greater trochanter, and adversely affect hip biomechanics and long-term functional outcomes.

Recent systematic reviews have synthesized published series but noted the heterogeneity of outcomes and the need for prospective single-centre cohorts to provide contemporaneous outcome data and refine patient selection criteria. This study aims to contribute to the existing literature by reporting the prospective outcomes of VITO in a cohort of 20 neglected femoral neck fractures treated at a tertiary orthopaedic centre in a South Asian setting, with emphasis on both radiological and functional outcomes and transparent description of complications.

OBJECTIVES

To evaluate the clinical and radiological outcomes of valgus intertrochanteric osteotomy for neglected femoral neck fractures treated at NITOR between January 2021 and June 2025.

METHODS & MATERIALS

Study Design and Setting

This was a prospective observational cohort study conducted at NITOR, Dhaka, Bangladesh, and Shahid Jakir Hossain Border Guard Hospital, Pilkhana, Dhaka, Bangladesh, from January 2021 through June 2025. The institutional ethics committee approved the study protocol prior to patient enrollment. NITOR is a 1000-bed tertiary orthopaedic centre managing trauma and musculoskeletal

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disorders in a referral setting. All consecutive patients meeting eligibility criteria and treated by VITO during the study period were prospectively enrolled.

Study Population

Inclusion criteria: Patients aged less than 50 years with neglected or ununited intracapsular femoral neck fractures (minimum 8 weeks untreated), Garden type III/IV, Pauwels type I/II/III, with radiographic evidence of femoral head viability. Exclusion criteria: Age 50 or older, radiographic or MRI evidence of femoral head osteonecrosis at presentation, severe femoral neck resorption, medical contraindications to surgery, or pathological fractures.

Preoperative Assessment

Clinical assessment documented injury history, duration of symptoms, prior treatment, comorbidities, and functional status. Radiological evaluation included high-quality anteroposterior and lateral radiographs measuring Pauwels angle, neck-shaft angle, fracture displacement, and limb shortening. MRI was obtained in 15 of 20 patients to assess femoral head vascularity and exclude occult osteonecrosis.

Surgical Technique

All procedures performed by senior orthopaedic surgeons using an anterolateral approach. After fracture reduction and careful preservation of the medial femoral circumflex artery, osteotomy angle was planned to achieve Pauwels angle of 30-40 degrees and neck-shaft angle of 130-140 degrees. Fixation used either DHS with 120–130-degree angle plate (10 patients), fixed-angle blade plate with 110-138.6-degree angle (6 patients), or alternative constructs (4 patients). Autologous iliac crest bone graft was placed in 10 patients (50%). Postoperative radiographs verified reduction quality and implant alignment.

Postoperative Management

Early hip mobilization commenced within 48 hours. Weight-bearing progression: touchdown bearing at 6 weeks, partial bearing at 8-10 weeks, full bearing at 12-16 weeks pending radiographic callus formation. Thromboprophylaxis provided per protocol. Follow-up conducted at 6 weeks, 12 weeks, 6 months, 12 months, and final visit with serial radiographs.

Outcome Measures

Primary: Harris Hip Score (0-100 scale) at baseline and final follow-up. Secondary: Radiographic union (bridging callus on 3 of 4 cortices), time to union, Pauwels angle correction, postoperative neck-shaft angle, and complications (infection, implant cut-out, osteonecrosis, nonunion, limb shortening, secondary arthroplasty).

Statistical Analysis

Descriptive statistics for all variables. Continuous variables expressed as mean (SD, range). Categorical variables as counts and percentages. Paired t-tests for preoperative-postoperative comparisons with $p<0.05$ considered significant. SPSS version 26.0 used for all analyses.

RESULTS

Twenty consecutive patients were enrolled. Thirteen (65%) male, 7 (35%) female; mean age 35.5 years (SD 12.3, range 10-50). Mean neglect duration 30 weeks (SD 18.2, range 3-70). Mean follow-up 36 months (SD 14.1, range 6-48). Right-sided fractures 12 (60%), left 8 (40%). Neck resorption in 2 (10%). Garden classification: Type III 9 (45%), Type IV 11 (55%). Pauwels classification: Type I 2 (10%), Type II 13 (65%), Type III 5 (25%). Preoperative AVN absent in all patients.

Table I

Demographic and Fracture Characteristics.

Characteristic	Value
Patients, n	20
Male, n (%)	13 (65)
Female, n (%)	7 (35)
Mean age, years (SD, range)	35.5 (12.3, 10–50)
Mean neglect duration, weeks (SD, range)	30 (18.2, 3–70)
Mean follow-up, months (SD, range)	36 (14.1, 6–48)
Right-sided, n (%)	12 (60)
Left-sided, n (%)	8 (40)
Neck resorption, n (%)	2 (10)
Mean BMI, kg/m² (range)	24.5 (18–32)
Preoperative HHS, mean (range)	46.6 (35–55)
Garden Type III, n (%)	9 (45)
Garden Type IV, n (%)	11 (55)
Pauwels Type I, n (%)	2 (10)
Pauwels Type II, n (%)	13 (65)

Clinical Outcomes

Harris Hip Score improved significantly from mean 46.6 (range 35-55) preoperatively to 88 (range 75-95) at final follow-up, mean improvement 41.4 points (95% CI 46.6-88, $p<0.001$). Limb shortening decreased from 1.5 cm (1-5 cm) preoperatively to 0.5 cm (0-1 cm) postoperatively. Independent walking increased from 2 patients to 18 (90%). Eighteen of 20 patients (90%) achieved good/excellent outcomes (HHS ≥80). Pain scores decreased from mean 7.2 to 1.8 on 0-10 scale ($p<0.001$).

Radiological Outcomes

Mean Pauwels angle decreased significantly from 66 degrees (SD 10.2, range 50-90 degrees) preoperatively to 33.3 degrees (SD 8.5, range 28-45 degrees) at final follow-up, mean correction 32.7 degrees (95% CI 28.5-36.9, $p<0.001$). Mean neck-shaft angle corrected from 104.3 degrees (SD 12.4, range 80-120 degrees) preoperatively to 132 degrees (SD 8.9, range 120-145 degrees) postoperatively, mean correction 27.7 degrees ($p<0.001$). Radiographic union achieved in 18 of 20 patients (90%) with mean time to union 14.7 weeks (SD 4.1, range 10-26.7 weeks). Two patients (10%) remained nonunited at final follow-up.

Table II
Clinical and Radiological Outcomes.

Outcome	Preoperative	Final Follow-up	Change (p-value)
Harris Hip Score	46.6 (35–55)	88 (75–95)	+41.4 (p<0.001)
Pain score, 0–10	7.2	1.8	-5.4 (p<0.001)
Limb shortening, cm	1.5 (1–5)	0.5 (0–1)	-1.0 (p<0.001)
Independent walking, n	2	18	+16 (p<0.001)
Good/excellent outcome, %	—	90	—
Pauwels angle, degrees	66 (50–90)	33.3 (28–45)	-32.7 (p<0.001)
Neck-shaft angle, degrees	104.3 (80–120)	132 (120–145)	+27.7 (p<0.001)
Fracture union, n (%)	0	18/20 (90)	—

Postoperative Complications
Complications occurred in 12 of 20 patients (60%), with some experiencing multiple adverse events. Superficial surgical site infection in 3 (15%), resolving with antibiotics and local care; no deep infections. Implant cut-through in 2 (10%), both with severe preoperative neck resorption, requiring revision surgery. Femoral head osteonecrosis developed in 2 (10%) at 8 and 12 months postoperatively. Fracture nonunion in 2 (10%) despite adequate radiographic positioning, managed with revision osteotomy and augmented bone grafting. Postoperative limb shortening (1-2 cm) in 3 (15%). Secondary total hip arthroplasty required in 2 (10%) at 24 and 36 months due to progressive osteonecrosis.

Table III
Postoperative Complications.

Complication	Number (n)	Percentage (%)
Superficial infection	3	15
Deep infection	0	0
Implant cut-through	2	10
Femoral head osteonecrosis	2	10
Fracture nonunion	2	10
Limb shortening (>1 cm)	3	15
Secondary total hip arthroplasty	2	10
Any complication	12	60

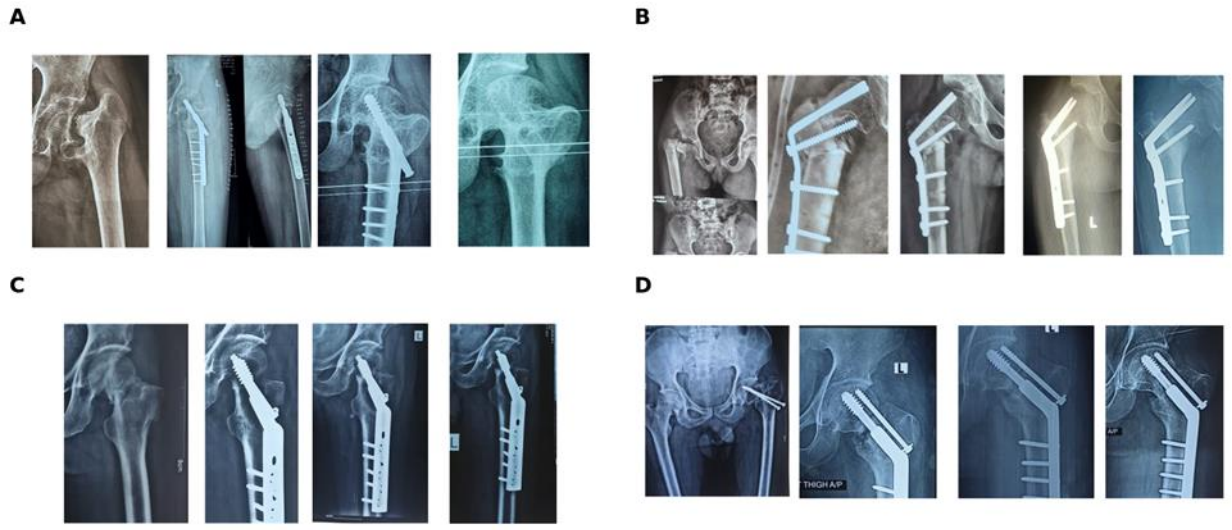


Figure 1 Representative serial radiographs from four patients treated with valgus intertrochanteric osteotomy for neglected femoral neck fractures. Panels A–D represent individual illustrative cases, showing the preoperative fracture, postoperative fixation, and subsequent radiographic follow-up with progressive healing.

Panels show four individual cases (A–D) with preoperative fractures, immediate postoperative fixation, and radiographic follow-up demonstrating progressive healing with callus formation and union. Pauwels angles are measured and compared. Note the transition from steep angles (preoperatively) to corrected valgus angles (postoperatively) with progressive osseous bridging.

DISCUSSION

Management of neglected femoral neck fracture represents one of the most challenging problems in orthopaedic trauma surgery, particularly in younger patients where native femoral head preservation is desirable. The combination of established nonunion, compromised fracture biology, and unfavorable mechanical conditions creates a hostile healing environment. Valgus intertrochanteric osteotomy offers a biomechanically sound solution by converting shear forces into compressive loading, improving union probability and preserving hip joint function.

The Pauwels principle that fracture line orientation determines fracture stability and healing potential has been validated across clinical experience and biomechanical analysis. Our study demonstrates substantial fracture line correction (mean Pauwels

angle reduction 66 degrees to 33.3 degrees), achieving the primary biomechanical objective. The significant Harris Hip Score improvement (41.4 points, $p<0.001$) and high union rate (90%) align favorably with published series.

Khan and colleagues reported union in 14 of 16 patients (87.5%) with mean union time of 14.7 weeks in their cohort. Our study demonstrates comparable results with 18 of 20 patients (90%) achieving union at similar mean time to union (14.7 weeks). Our Harris Hip Score improvement from 46.6 to 88 (mean improvement 41.4 points) demonstrates significant functional restoration, consistent with published series reporting substantial functional gains following VITO. Gadegone and colleagues achieved 95.1% union using fibular strut grafting combined with dynamic hip screw fixation. Schwartsmann and colleagues reported 90.4% union in 42 patients. A recent meta-analysis of 18 studies (481 patients) reported pooled union 92% at mean follow-up 48.6 months, with postoperative osteonecrosis in 8.3%, consistent with our 10% rate.

Our 90% rate of good/excellent Harris Hip Score demonstrates functional restoration potential. Pain decreased significantly (mean 5.4 points on 0-10 scale), and 90% achieved independent walking. These results underscore VITO potential to restore hip function in populations with nonunion-related limitation.

Excessive valgus correction requires careful avoidance. Varghese and colleagues demonstrated that postoperative neck-shaft angles exceeding 140 degrees were associated with poorer functional outcomes. Our mean postoperative angle of 132 degrees (range 120-145 degrees) avoided excessive valgisation. Our two-implant cut-through cases occurred with severe preoperative neck resorption, highlighting that adequate bone stock is essential.

The 60% complication rate warrants consideration. While 90% union was achieved, complications including infection, implant cut-through, osteonecrosis, and late arthroplasty reflect biological and mechanical challenges inherent to this population. Two patients developed osteonecrosis at 8 and 12 months despite absence at presentation, suggesting operative trauma or underlying vascular compromise may lead to delayed femoral head necrosis even in carefully selected candidates.

This study strengths include prospective design with longitudinal follow-up, standardized outcome assessment, and comprehensive complication reporting from a tertiary South Asian centre. Weaknesses include small sample size (20 patients), single-centre design, fixation heterogeneity (DHS vs. blade plate), and variable bone graft use (50%). Longer follow-up (greater than 5 years) would provide insight into late functional outcomes and arthroplasty-free survival.

LIMITATIONS

This study has several important limitations. Small sample size (20 patients) limits power for subgroup analysis or multivariable regression. No concurrent control group available for comparison with alternative strategies. Single-centre design may limit generalizability to other settings. Heterogeneity of fixation constructs and bone graft use reflects real-world practice but introduces potential confounding. Some radiological variables were not uniformly recorded, precluding detailed subgroup analysis. Selection of patients without baseline osteonecrosis limits extrapolation to cohorts with established femoral head necrosis. Follow-up duration, while sufficient for union and early complication assessment, may be insufficient to characterize late functional trajectories and cumulative arthroplasty need beyond 5-10 years.

CONCLUSION

In this prospective cohort of 20 patients with neglected femoral neck fractures treated with VITO, we observed high radiographic union rates (90%), significant functional improvement (mean HHS increase 41.4 points, $p<0.001$), and substantial biomechanical correction (mean Pauwels angle reduction 32.7 degrees). The procedure achieved dual goals of fracture healing and functional restoration in most patients. However, complications remain frequent (60%), including superficial infection (15%), implant cut-through (10%), femoral head osteonecrosis (10%), and late arthroplasty (10%).

VITO represents a viable head-preserving surgical option for carefully selected younger patients with neglected femoral neck fractures and adequate femoral head blood supply. Success requires meticulous preoperative planning, individualized osteotomy angle selection, careful blood supply preservation, adequate fixation, and consideration of bone grafting in poor bone stock cases. Future prospective, multi-centre comparative studies with longer follow-up (10 or more years) are needed to establish VITO role relative to alternative salvage strategies and identify characteristics predicting favorable outcomes. Until such evidence is available, VITO should remain part of the surgical armamentarium for neglected femoral neck fractures, applied judiciously in appropriately selected cases with realistic expectations regarding benefits and limitations.

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DECLARATIONS

Ethics approval and consent to participate: This prospective observational study was approved by the Institutional Review Board of NITOR, Dhaka, Bangladesh. Written informed consent was obtained from all participants prior to enrollment.

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Author contributions: All authors contributed meaningfully to this study. Lead Author conceived the study, supervised patient enrollment, performed surgical procedures, and drafted the manuscript. Second Author contributed to data collection and manuscript critical revision. Third Author performed statistical analysis and manuscript preparation.

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