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ORIGINAL ARTICLE

Biplane Double-Supported Screw Fixation for Femoral Neck Fractures – Radiological and Early Functional Outcomes

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ABSTRACT

Background: *Hip fractures are a major cause of disability worldwide, and intracapsular femoral neck fractures often lead to nonunion, avascular necrosis, and fixation failure. Biplane double-supported screw fixation uses two oblique planes with a dual cortical buttress to improve stability during early mobilization.* ***Methods & Materials:*** *This prospective observational study was conducted at NITOR, Dhaka, from July 2018 to June 2020. Thirty-one adults with recent closed femoral neck fractures (Garden I–II and Garden III–IV in patients <65 years) underwent biplane double-supported screw fixation. Patients were followed for six months, with outcomes assessed by radiological union, complications, pain, hip range of motion, and the Harris Hip.* ***Results:*** *Among 31 patients (mean age 42.7 years; 61.3% male), most fractures were due to motor vehicle accidents (83.9%), with Garden I–II fractures comprising 87.1%. Radiological union was achieved in 96.8% of cases, with a mean union time of 17.9 weeks, occurring faster in Garden I–II than Garden III fractures. Complications were infrequent (16.1%), including wound infection, delayed union, and one case of nonunion, with no deep vein thrombosis. Functional outcomes were favorable, with a mean Harris Hip Score of 86.5 and 74.2% of patients achieving good-to-excellent results, alongside minimal limp, limited need for walking support, and preserved hip motion.* ***Conclusion:*** *Biplane double-supported screw fixation demonstrated high rates of early union, prompt radiological healing, and favorable early functional outcomes with a low incidence of nonunion in adult femoral neck fractures. BDSF represents an effective head-preserving intervention for appropriately selected patients.*

Keywords: *Femoral neck fracture, Biplane double-supported screw fixation, Radiological union, Harris Hip Score, and Functional outcome*

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INTRODUCTION

Hip fractures constitute a significant global health issue due to their disabling consequences, elevated treatment costs, and considerable impact on functional independence. Approximately half of all hip fractures are intracapsular, with femoral neck fractures comprising a substantial proportion of these injuries [1]. Post-traumatic femoral neck fracture is a recognized cause of hip dysfunction, predominantly affecting elderly individuals with osteoporotic bone, in whom even low-energy mechanisms such as minor falls can result in injury [2]. The burden of femoral neck fractures is expected to rise markedly as the global population ages. Older adults constitute the fastest-growing demographic worldwide, and this shift is reflected directly in hip fracture epidemiology. The annual number of hip fractures worldwide increased from approximately 1.7 million in 1990 and is projected to exceed 6 million by 2050, with some estimates suggesting figures as high as 8 million if age-specific incidence continues to rise modestly each year [3]. Contemporary data indicate that nearly half of all proximal femoral fractures involve the femoral neck [1]. Although femoral neck fractures predominantly affect the elderly, they are relatively uncommon in younger individuals, accounting for only around 2% of cases in patients under 50 years of age [4]. Across age groups, the incidence is consistently higher in women, occurring two to three times more frequently than in men, largely reflecting differences in bone density and longevity [5,6]. The most common mechanism of femoral neck fracture is a simple fall, which transmits force through the greater trochanter to the femoral neck [7]. Alternative mechanisms include forced external rotation of the lower limb, in which increased tension in the anterior capsule and iliofemoral ligament leads to fracture, as the femoral head remains fixed within the acetabulum [8]. Most fractures occur at the structurally weakest region of the femoral neck, located just below the articular surface [8]. In younger patients, femoral neck fractures are typically associated with high-energy trauma, as greater forces are required to overcome normal bone strength [9]. Less frequently, repetitive cyclical loading may result in stress fractures of the femoral neck when mechanical demand exceeds the bone's adaptive capacity [10]. The goal of treatment for femoral neck fractures is restoration of pre-fracture functional status while minimizing complications such as nonunion, avascular necrosis, and implant failure [11].

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Despite the high prevalence of these injuries, considerable variation persists in treatment strategies. Management options include internal fixation, unipolar or bipolar hemiarthroplasty, and total hip arthroplasty, with each approach having specific indications based on patient age, fracture pattern, bone quality, and functional demands [7]. Among internal fixation techniques, sliding hip screws and multiple cancellous screws are the most widely accepted methods. Evidence indicates that fixation with three cancellous screws provides reliable stability and favorable outcomes in appropriately selected cases [12]. Traditionally, screws are placed in parallel or triangular configurations; however, these positions often engage weaker trabecular bone, increasing the risk of varus collapse and fixation failure. To address these biomechanical limitations, there has been a shift toward calcar-based screw placement, which provides superior cortical support [13]. Biplane double-supported screw fixation, also referred to as Filipov's method, is a biomechanically optimized advancement of cancellous screw fixation. This technique permits steeper screw insertion angles with distal cortical entry points, thereby enhancing beam function and overall construct stability [14]. By arranging screws in two oblique planes and incorporating dual calcar buttress support, the method increases resistance to axial loading and bending forces, particularly during early mobilization [15,16]. These biomechanical advantages provide the rationale for evaluating the radiological and early functional outcomes of biplane double-supported screw fixation in femoral neck fractures. The objective of this study was to assess the radiological and early functional outcomes of biplane double-supported screw fixation in the management of femoral neck fractures.

METHODS & MATERIALS

A prospective observational study was conducted at the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR) in Dhaka, Bangladesh, over a two-year period from July 2018 to June 2020. Thirty-one adult patients with femoral neck fractures were enrolled purposively. Inclusion criteria consisted of adults over 18 years with closed femoral neck fractures less than two weeks in duration. Eligible fractures included all displaced fractures (Garden types I and II) and displaced fractures (Garden types III and IV) in patients younger than 65 years, as defined by established criteria. Exclusion criteria included open or contaminated fractures, multiple fractures or polytrauma, inability to complete at least six months of follow-up, and preexisting hip pathologies such as pathological fractures, metabolic bone disease, rheumatoid arthritis, advanced osteoarthritis, Paget disease, or osteonecrosis.

Baseline variables comprised demographic data (age, sex, occupation) and clinical characteristics (mechanism of injury, side involved, fracture type, injury-to-surgery interval, hospital stay, and follow-up duration). Outcome measures included radiological union time, pain status at final follow-up, functional ability, hip range of motion, postoperative complications, and final functional outcome as assessed by the Harris Hip Score [17]. After enrollment, patients received a comprehensive preoperative evaluation, which included clinical assessment, traction immobilization, radiographic evaluation with anteroposterior and lateral hip radiographs, and standard laboratory and anesthetic investigations. Upon optimization and obtaining informed consent, all patients underwent biplane double-supported screw fixation according to standardized perioperative protocols, which included prophylactic intravenous antibiotics. Patients were discharged once clinically stable and followed at scheduled intervals for up to six months, with serial radiographs and functional assessments conducted at each visit. Weight-bearing was advanced based on radiological evidence of union.

Data collection was performed using a pretested structured questionnaire and analyzed with SPSS (V-26.0). Categorical variables were reported as frequencies and percentages, while continuous variables were summarized as means and standard deviations. Institutional Review Board approval was obtained from NITOR, and written informed consent was obtained from all participants, ensuring voluntary participation, confidentiality, and adherence to ethical standards throughout the study.

RESULTS

The study cohort included 31 patients with a mean age of 42.68 ± 16.56 years, ranging from 19 to 74 years. The most represented age groups were 33 to 46 years (10 patients, 32.26%) and 19 to 32 years (9 patients, 29.03%). Males comprised 61.29% (19 patients) of the cohort, while females accounted for 38.71% (12 patients) Table I.

Table – I: Demographic characteristics of the study cohort

Variables	Category	n (%)
Age (in years)	19-32	9 (29.03)
	33-46	10 (32.26)
	47-60	6 (19.35)
	61-74	6 (19.35)
	Mean ± SD	42.68 ± 16.56
Sex	Male	19 (61.29)
	Female	12 (38.71)

Motor vehicle accidents accounted for the majority of fractures (26 cases, 83.87%), while falls on slippery ground contributed to 5 cases (16.13%). Garden type I fractures were most common (15 cases, 48.39%), followed by type II (12 cases, 38.71%) and type III (4 cases, 12.90%). The mean interval from injury to surgery was 10.19 ± 1.76 days, with 54.84% (17 patients) undergoing surgery between 11- and 12-days post-injury. The average hospital stay was 15.0 ± 2.3 days, with durations distributed nearly equally between 11 to 15 days (51.61%) and 16 to 20 days (48.39%). The mean follow-up period was 25.7 ± 2.3 weeks, most frequently 22 to 24 weeks (41.94%) or 25 to 27 weeks (38.71%) Table II.

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Table – II: Injury profiles, fracture classifications, and perioperative characteristics

Variables	Category	n (%)
Mechanism of injury	Motor vehicle accident	26 (83.87)
	Fall on slippery ground	5 (16.13)
Fracture type (Garden)	Type I	15 (48.39)
	Type II	12 (38.71)
	Type III	4 (12.90)
Injury to surgery interval (days)	7-8	7 (22.58)
	9-10	7 (22.58)
	11-12	17 (54.84)
	Mean ± SD	10.19 ± 1.76
Hospital stays (days)	11-15	16 (51.61)
	16-20	15 (48.39)
	Mean ± SD	15.0 ± 2.3
Follow-up duration (weeks)	22-24	13 (41.94)
	25-27	12 (38.71)
	28-30	6 (19.35)
	Mean ± SD	25.7 ± 2.3

Radiological union was typically achieved early, with a mean union time of 17.9 ± 3.9 weeks (N = 30). Most patients (66.67%, 20 patients) achieved union within 14 to 18 weeks, while 23.33% united in 19 to 23 weeks, and 10.00% required 24 to 28 weeks. Union time differed by fracture type: Garden I or II fractures united more rapidly (mean 17.3 ± 3.8 weeks) compared to Garden III fractures (mean 22.0 ± 1.6 weeks) Table III.

Table III: Radiological union outcomes and time to union by fracture type

Outcome	Category	n (%)
Radiological union time (weeks)	14-18	20 (66.67)
	19-23	7 (23.33)
	24-28	3 (10.00)
	Mean ± SD	17.9 ± 3.9 (N = 30)
Union time by fracture type	Garden I or II	17.3 ± 3.8
	Garden III	22.0 ± 1.6

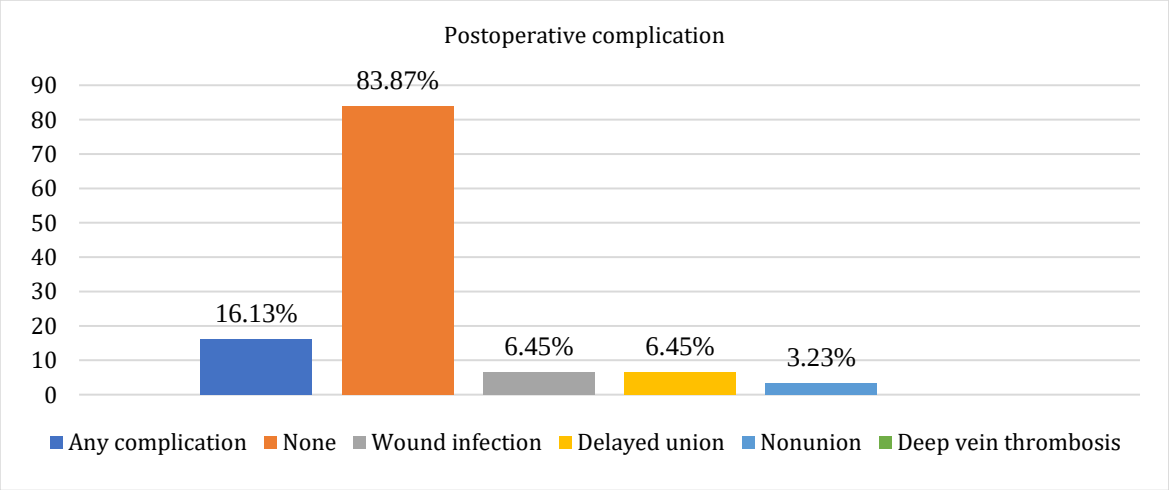

Figure – 1: Postoperative complications after biplane double-supported screw fixation

Complications were observed in 5 patients (16.13%), while 26 patients (83.87%) experienced no complications. The most frequent adverse events were wound infection and delayed union, each occurring in 2 patients (6.45%). Nonunion was reported in 1 patient (3.23%). No cases of deep vein thrombosis were identified (Figure 1).

Early functional outcomes, as assessed by the Harris Hip Score, were favorable. Slight pain was reported by 22 patients (70.97%), while 9 patients (29.03%) reported no pain. Limp was absent in 25 patients (80.65%), with slight limp observed in 16.13% and moderate limp in 3.23%. Nearly half of the patients (48.39%) required no walking support, while 35.48% used a cane for long walks. More frequent support, such as a cane most of the time (12.90%) or one crutch (3.23%), was uncommon. Mean hip range of motion was preserved: flexion 116.13 ± 11.16 degrees, abduction 31.29 ± 3.87 degrees, adduction 31.13 ± 4.02 degrees, internal rotation 28.23 ± 5.56 degrees, and external rotation 26.61 ± 3.96 degrees. The mean Harris Hip Score at the last follow-up was 86.52 ± 11.37, with most patients achieving good (32.26%) or excellent (41.94%) outcomes. Fair outcomes were observed in 16.13% and poor outcomes in 9.68% (Table IV).

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Table – IV: Early functional outcomes and Harris Hip Score components at final follow-up

Variables	Category	n (%)
Pain considered in HHS	No pain	9 (29.03)
	Slight pain	22 (70.97)
Functional ability (limp)	None	25 (80.65)
	Slight	5 (16.13)
	Moderate	1 (3.23)
Functional ability (support)	None	15 (48.39)
	Cane for long walks	11 (35.48)
	Cane for most of time	4 (12.90)
	One crutch	1 (3.23)
Hip range of motion (degrees)	Flexion	116.13 ± 11.16
	Abduction	31.29 ± 3.87
	Adduction	31.13 ± 4.02
	Internal rotation	28.23 ± 5.56
	External rotation	26.61 ± 3.96
Harris Hip Score at last follow-up	Mean ± SD	86.52 ± 11.37
	<70 (Poor)	3 (9.68)
	70-79 (Fair)	5 (16.13)
	80-89 (Good)	10 (32.26)
	90-100 (Excellent)	13 (41.94)

DISCUSSION

This prospective study demonstrates that biplane double-supported screw fixation (BDSF) achieves a high early union rate (30/31, 96.77%) and satisfactory early function (mean Harris Hip Score, 86.52 ± 11.37; good-to-excellent, 74.2%) in adult femoral neck fractures managed within two weeks of injury. These outcomes are clinically significant in a context where most injuries were high energy (motor vehicle accidents, 83.87%) and delays to definitive fixation were frequent (mean injury-to-surgery interval, 10.19 ± 1.76 days). The observed union rate aligns with larger BDSF series, such as Filipov et al., who reported a 96.6% union rate in displaced Garden III–IV fractures with a modified Harris Hip Score in the mid-80s at longer follow-up, supporting the construct's ability to provide stable fixation in higher-risk patterns [18]. In this study, the predominance of Garden I–II fractures (87.10%) likely contributed to the excellent early union and low mechanical failure rates, while the longer union time in Garden III fractures (22.0 ± 1.6 weeks versus 17.3 ± 3.8 weeks in Garden I–II) is consistent with the recognized biological and mechanical challenges associated with displacement and intracapsular vascular compromise [18,19]. Compared to other BDSF cohorts, the mean time to union in this study (17.9 ± 3.9 weeks) exceeds the 14–15-week range reported in a prospective young-adult series using BDSF and is longer than in selected elderly cohorts [20,21]. These differences are likely attributable to case-mix, follow-up duration, and system-level factors such as delayed presentation, delayed surgery, and a cautious approach to weight-bearing based on radiological evidence of union rather than immediate full weight-bearing, which is sometimes recommended for BDSF due to its inferoposterior cortical support concept [18-20]. These distinctions indicate that the functional benefits of a mechanically robust construct may not be fully realized unless rehabilitation protocols are also optimized. Early functional outcomes were favorable, with minimal limp (none, 80.65%), near-normal hip motion arcs, and a mean HHS comparable to other internal fixation series reporting mid-80s scores after screw-based fixation [18,22]. The proportion of patients reporting slight pain (70.97%) at six months suggests ongoing recovery and remodeling, and further improvement is anticipated beyond the current follow-up, as many hip function metrics continue to improve at 12 months in similar cohorts [18]. From a comparative effectiveness perspective, large randomized studies indicate that screw-based fixation is broadly comparable to sliding hip screw constructs for many intracapsular fractures in terms of reoperation, with trade-offs in perioperative morbidity and complication profiles [23,24]. The overall complication rate in this cohort (16.13%) was primarily due to superficial wound infection and delayed union (each 6.45%), with only one nonunion (3.23%) and no deep vein thrombosis. The absence of avascular necrosis should be interpreted with caution, as osteonecrosis is often a late complication and may not be detected within a six-month follow-up; even in high-quality BDSF series, AVN rates of 10–12% have been reported at longer follow-up [18,20]. Broader clinical evidence linked to biomechanics highlights that reduction quality is a key determinant of ischemic and mechanical failure. Studies examining reduction parameters and postoperative head perfusion consistently identify suboptimal reduction as a major predictor of complications after intracapsular fixation [25,26]. This is particularly relevant in Bangladesh, where delayed referral and limited access to early definitive surgery can increase the technical difficulty of closed reduction, underscoring the need for meticulous reduction assessment, rigorous intraoperative imaging, and early identification of cases requiring open reduction.

Limitations of the study

Single-center, small sample (n = 31) with purposive sampling limits generalizability. A short follow-up (about six months) may miss late events such as avascular necrosis and femoral neck shortening. The non-comparative observational design also limits causal inference and head-to-head evaluation versus other fixation method

CONCLUSION

This prospective study demonstrated that biplane double-supported screw fixation resulted in a high early radiological union rate (96.77%), a relatively short mean union time (17.9 ± 3.9 weeks), and favorable early functional outcomes (mean Harris Hip Score 86.52 ± 11.37; good-to-excellent in 74.2%), along with a low incidence of major complications and nonunion (3.23%). These results indicate that BDSF is an effective head-preserving fixation method for appropriately selected adult femoral neck fractures. However, larger comparative studies with extended follow-up are necessary to assess late complications, such as osteonecrosis, and to confirm the long-term durability of functional outcomes.

RECOMMENDATIONS

Biplane double-supported screw fixation may be recommended as a head-preserving option for adult femoral neck fractures, particularly in younger patients and in settings where minimally invasive fixation is preferred. Early surgical intervention, meticulous anatomic reduction, and standardized fluoroscopy-guided screw placement should be emphasized to optimize union and minimize failure. Future work should prioritize larger multicenter comparative studies with at least 12 to 24 months of follow-up to evaluate avascular necrosis, femoral neck shortening, reoperation rates, and sustained functional outcomes.

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