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ORIGINAL ARTICLE

Incidence and Patterns of Postoperative Complications Following Biplane Double-Supported Screw Fixation in Femoral Neck Fractures: A Cross-Sectional Analysis

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ABSTRACT

Background: *Femoral neck fractures pose a substantial difficulty in orthopedic trauma, especially in younger patients, when preserving the femoral head is critical. The purpose of this study was to assess the incidence and patterns of postoperative problems associated with BDSF in femoral neck fractures.* ***Methods & Materials:*** *This cross-sectional study was carried out at the National Institute of Traumatology and Orthopedic Rehabilitation in Dhaka from July 2018 to June 2020. 50 adult patients with acute traumatic femoral neck fractures (Garden Types I-III) who presented within 14 days of injury received BDSF with three 6.5-mm cannulated screws in a biplane configuration. Patients were monitored for 25.8 ± 2.4 weeks. The primary outcomes were radiological union time and postoperative complications. The Harris Hip Score was used to assess functional results. Data were entered and analyzed using SPSS version 26.* ***Results:*** *The mean patient age was 43.2±15.4 years, with a male majority (62%). Motor vehicle accidents caused 84% of injuries. Radiological union occurred at 18.4±4.2 weeks. The overall complication rate was 28%, which included wound infection (10%), delayed union (8%), nonunion (4%), deep vein thrombosis (2%), avascular necrosis (2%), and implant failure. The average HHS at final follow-up was 85.9±10.9, with 74% obtaining good-to-excellent results. Multivariate analysis revealed that increasing age (OR=1.06, p=0.029), Garden Type III fractures (OR=4.75, p=0.043), and union duration of more than 18 weeks (OR=6.40, p=0.005) were independent predictors of problems.* ***Conclusion:*** *BDSF has manageable complication rates and satisfactory functional outcomes in femoral neck fractures. Advanced Garden categorization, rising age, and delayed union all predict surgical problems, necessitating increased monitoring in high-risk patients.*

Keywords: *Femoral neck fracture, Biplane double-supported screw fixation, Postoperative complications, Harris Hip Score*

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INTRODUCTION

Femoral neck fractures make up about 50% of hip fractures and are themselves a significant cause of both morbidity and mortality, especially among younger patients with high-energy trauma and the elderly with osteoporotic bones [1]. Management of these fractures has remained highly disputed, with the type of management based on the age of the patient, the presence of displacement, and bone quality. In younger patients, the head should be conserved with internal fixation to avoid the long-term implications of arthroplasty procedures in the hip joint region for the patient [2]. In spite of the different improvements on the surgical procedures, some of the severe complications that accompany the fracture of the femoral neck include the likelihood of nonunion between 10 and 30 percent and the risk of the avascular necrosis between 15% and 33% [3]. Whereas a host of traditional fixation methods has been proposed using parallel screw configurations, several biomechanical shortcomings have been established, especially in resisting rotational and shear forces at the fracture site [4]. Consequently, this paper emphasizes the biplane double-supported screw fixation technique, which incorporated multiple planes of screws, with strategic positioning to maximize cortical support, most especially utilizing the calcar femorale and posterior cortex [5]. Indeed, biomechanical studies have determined that BDSF is associated with superior stability compared to traditional parallel screw configurations, because of enhanced resistance against both axial and torsional loads [6]. This is achieved by the placement of three cannulated screws in a non-parallel fashion: an inferior screw angled at 150-165° engaging the postero-inferior cortex, a middle screw placed at 130-135° supported by the calcar, and a superior screw in the standard

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position [7]. Though BDSF showed theoretical benefits and mechanical proofs of efficacy, clinical information regarding the pattern of complications and functional results is scarce, especially in the South Asian populace, who show marked differences in patient profiles, mechanism of injury, and healthcare systems, unlike those of Western countries [8]. Research hitherto has mainly focused on the rates of radiographic unions and the development of AVN, with less concentration upon the whole spectrum of complications and the factors responsible for the adverse outcome [9]. Knowledge regarding the whole spectrum and determining factors of complications is critical for patient selection and the provision of precise information. Garden classification has remained the most accepted technique in fracturing femoral neck fractures into different types, with Types I and II referring to undisplaced/misplaced fractures and Types III and IV referring to completely displaced fractures [10]. However, displacement has remained a continuous factor in increasing complications in many studies, while its exact role in complications after BDSF has yet to be clarified in more detail [11]. This study aimed to evaluate the postoperative complications in BDSF for femoral neck fractures and independent predictors of complications in a prospectively analyzed group of patients in a trauma center in Bangladesh.

METHODS & MATERIALS

This prospective cross-sectional study was carried out in the National Institute of Traumatology and Orthopedic Rehabilitation, Dhaka, Bangladesh, between July 2018 and June 2020. 50 adult patients with acute traumatic femoral neck fractures were included in the study after obtaining institutional review committee approval and tightening the inclusion and exclusion criteria. Inclusion criteria included age ≥18 years, presence of closed acute fracture with Garden Grades I, II, or III, presenting for treatment within 14 days of the injury, and internal fixability. Patients also had to have sufficient mental faculty and be able to follow up on the postoperative rehabilitation regimen and times for follow-up. Exclusion criteria included the presence of pathological fractures secondary to malignancy or metabolic bone disease, open fractures, neurovascular involvement, polytrauma with an Injury Severity Score above 16, unwilling or poor surgical risk recognized by American Society of Anesthesiologists' physical status IV-V, existing ambulatory impairment, significant impairment of mental faculty influencing outcome ascertainment, or pregnancy. All patients underwent biplane double-supported screw fixation, done under spinal or general anaesthesia. Patients were placed supine on a fracture table, and a closed reduction was achieved using fluoroscopy. Through a lateral approach, three 6.5 mm cannulated screws were placed following guidewire use, with the lowest screw positioned at 150° to 165°, aiming at the postero-inferior cortex, the second screw positioned at 130° to 135°, supported by Calcar femorale, and the superior screw placed in standard position. Post-operative care included prophylactic antibiotics for 24 hours, thromboprophylaxis for six weeks, and early mobilization, allowing partial weight-bearing from two weeks, then gradual progression to complete weight-bearing as tolerated based on symptoms and radiologic healing. Follow-up visits were set at 2, 6, 12, and 24 weeks, assessing both radiologic healing, as indicated by callus crossing at three or more cortices, and implant success using the Harris Hip Score. Data were analyzed using SPSS version 26, including mean and standard deviation for continuous variables, and frequency and percentage for discrete variables. T-test and chi-squared tests were used, and binary logistic regression was used to distinguish independent predictors of complication, with a significance threshold set at $p<0.05$.

RESULTS

Table I results indicate the mean age was 43.2±15.4 years, with predominant involvement of young to middle-aged adults, since 60% were below 45 years. Male patients constituted 62% of cases. Motor vehicle accidents represented the overwhelming majority of injury mechanisms, at 84%, while the rest involved falls on slippery ground. The majority of fractures presented as undisplaced or only slightly displaced, with Garden Type I representing the highest proportion at 46%, followed by Type II at 38% and Type III at 16%. [Table I]

Table – I: Baseline Demographic and Injury Characteristics (*n* = 50)

Variable	Category	n (%)
Age (years)	Mean ± SD	43.2 ± 15.4
	18-30	13 (26)
	31-45	17 (34)
	46-60	11 (22)
	>60	9 (18)
Sex	Male	31 (62)
	Female	19 (38)
Mechanism of Injury	Motor vehicle accident	42 (84)
	Fall on slippery ground	8 (16)
Garden Classification	Type I	23 (46)
	Type II	19 (38)
	Type III	8 (16)

The perioperative details of study participants are presented in Table 2. The median time from injury to surgery was 10.3±1.8 days, and most (54%) patients underwent surgery at 11-12 days from injury. The average duration of hospital stay was 14.7±2.1 days, with a majority of patients distributed fairly evenly across the 11-15 days (52%) and 16-20 days (48%) ranges. Patients were followed up for a median period of 25.8±2.4 weeks, and most patients (82%) completed follow-up between 22-27 weeks, which shows a very good compliance rate and low dropout rate. [Table II]

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Table – II: Perioperative Characteristics and Follow-Up Profile (*n* = 50)

Variable	Category	n (%) / Mean ± SD
Injury-to-surgery interval (days)	Mean ± SD	10.3 ± 1.8
	78	11 (22)
	9-10	12 (24)
	11-12	27 (54)
Hospital stay (days)	Mean ± SD	14.7 ± 2.1
	11-15	26 (52)
	16-20	24 (48)
Follow-up duration (weeks)	Mean ± SD	25.8 ± 2.4
	22-24	21 (42)
	25-27	20 (40)
	28-30	9 (18)

Table III represents radiological union features and postoperative complications. The mean time taken for radiological union was 18.4±4.2 weeks, with 64% patients having radiological union between 14 and 18 weeks. The complication rate was 28%. Wound infection was the chief complication at 10%, with delayed union at 8%, nonunion at 4%, deep vein thrombosis at 2%, avascular necrosis at 2%, and implant failure at 2%.

Table – III: Radiological Union Characteristics and Postoperative Complications

A. Radiological Union Time (*n* = 50)

Parameter	Category	n (%) / Mean ± SD
Union Time (weeks)	Mean ± SD	18.4 ± 4.2
	14-18	32 (64)
	19-23	12 (24)
	24-28	6 (12)

B. Postoperative Complications (*n* = 50)

Complication Type	n (%)
Any complication	14 (28)
None	36 (72)
Wound infection	5 (10)
Delayed union	4 (8)
Nonunion	2 (4)
Deep vein thrombosis (DVT)	1 (2)
Avascular necrosis (AVN)	1 (2)
Screw back-out or implant failure	1 (2)

Table IV revealed that 70% had slight pain and 30% had no pain at final follow-up. The majority (80%) had no limp. Fewer than half (46%) had no walker support during walking; 36% used a cane with prolonged walking. Unlimited walking was possible in 42% and up to six blocks in 46%. Hip motion was 115.6°±10.8° for flexion, 30.9°±4.1° for abduction, 30.7°±4.3° for adduction, 28.1°±5.9° for internal rotation, and 26.4°±4.0° for external rotation. This revealed that the hip was mobile, as the values [Table IV]

Table – IV: Functional Status and Hip Range of Motion at Last Follow-Up (*n* = 50)

Variable	Category	n (%) / Mean ± SD
Pain	No pain	15 (30)
	Slight pain	35 (70)
Limp	None	40 (80)
	Slight	8 (16)
	Moderate	2 (4)
Support	None	23 (46)
	Cane for long walks	18 (36)
	Cane most of the time	6 (12)
	One crutch	3 (6)
Distance walked	Unlimited	21 (42)
	Six blocks	23 (46)
	Indoors only	6 (12)
Sitting (1 hr)	Yes	44 (88)
Stairs	Normal	26 (52)
Shoes/Socks	Easily	29 (58)
Deformity	Absent	28 (56)
Hip ROM (degrees)	Flexion	115.6 ± 10.8
	Abduction	30.9 ± 4.1
	Adduction	30.7 ± 4.3
	Internal rotation	28.1 ± 5.9
	External rotation	26.4 ± 4.0

Table V unveils the distribution and recovery trajectory of the Harris Hip Score. Mean HHS at final follow-up was 85.9±10.9, with 74% of patients achieving good-to-excellent outcomes (HHS≥80). The distribution of the outcome was as follows:

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38% excellent results (HHS 90-100), 36% good results (HHS 80-89), and 18% and 8% corresponding to fair and poor outcomes, respectively. HHS progression showed linear improvement from second follow-up to third follow-up and to the final assessment-45.1, 74.6, and 85.9, respectively-indicating consistent functional recovery throughout the postoperative period. [Table V]

Table – V: Harris Hip Score Distribution and Recovery Trajectory (*n* = 50)

Parameter	Category	Value / n (%)
HHS at last follow-up	Mean ± SD	85.9 ± 10.9
HHS Category	Poor (<70)	4 (8)
	Fair (70-79)	9 (18)
	Good (80-89)	18 (36)
	Excellent (90-100)	19 (38)
HHS Progression	Second follow-up	45.1
	Third follow-up	74.6
	Last follow-up	85.9

Table VI demonstrates the association of patient and perioperative variables with postoperative complications. Complications occurred in significantly older patients with a mean age of 51.2±15.2 years compared to 40.3±14.7 years without any complications (p=0.021). Garden Type III fractures were significantly associated with complications, occurring in 35.7% of complicated cases against 8.3% when no complication developed (p=0.048). Union time of more than 18 weeks was strongly associated with complications in 64.3% against 16.7% in the non-complicated group (p=0.001). Poor functional outcomes, as depicted by HHS<80, are significantly higher in the complication group, that is 50.0% versus 16.7% with p=0.011.

Table – VI: Association of Patient and Perioperative Variables with Postoperative Complications (*n* = 50)

Variable		No Complication (n = 36)	Complication (n = 14)	p-value
Age (years)	mean ± SD	40.3 ± 14.7	51.2 ± 15.2	0.021
Sex	Male	20 (55.6%)	11 (78.6%)	0.139
	Female	16 (44.4%)	3 (21.4%)	
Garden Classification	Type I	19 (52.8%)	4 (28.6%)	0.048
	Type II	14 (38.9%)	5 (35.7%)	
	Type III	3 (8.3%)	5 (35.7%)	
Injury-to-surgery interval	≤10 days	19 (52.8%)	4 (28.6%)	0.141
	>10 days	17 (47.2%)	10 (71.4%)	
Union time	>18 weeks	6 (16.7%)	9 (64.3%)	0.001
Hospital stay	>15 days	15 (41.7%)	9 (64.3%)	0.154
HHS	< 80 at last follow-up	6 (16.7%)	7 (50.0%)	0.011

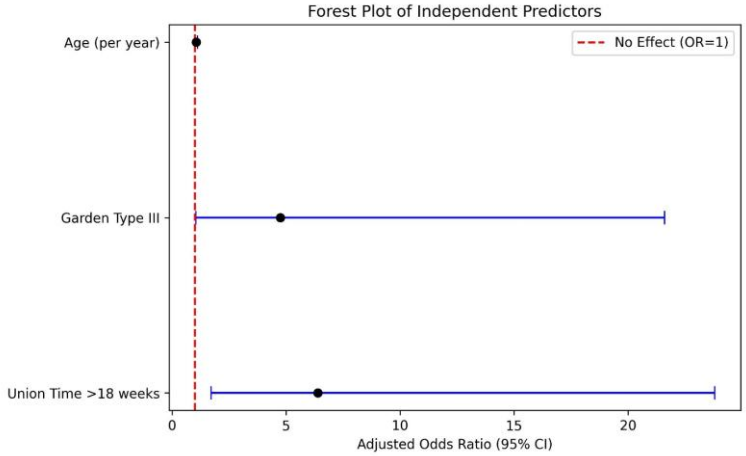

Figure – 1: Binary Logistic Regression Analysis of Independent Predictors of Postoperative

Figure 1 depicts three autonomous predictors of postoperative complications. With each additional year of age, there was a 6% increase in the likelihood of complications (OR=1.06, 95% CI: 1.01-1.12, p=0.029). Garden Type III fractures had 4.75 times higher likelihood of complications compared to Types I-II fractures (95% CI: 1.05-21.6, p=0.043). Union times greater than 18 weeks had the strongest positive relationship with complications.

DISCUSSION

The present cross-sectional study highlights that biplane double-supported screw fixation (BDSF) leads to 28% complication rate, and functional success with the treatment of the fracture of the neck of the femur. It is interesting to mention that 37 patients achieved a good-to-excellent HarrisHipScore, and a 18.4 week mean union time with remarkably low AVN that were associated with BDSF with only

2% as compared to other techniques such as traditional fixation techniques [12]. All these observations substantiate the logic that BDSF, which has a non-parallel orientation of screws, enhances the stability and removes graft failure caused by rotation, as characterized by Filipov et al. in its surgical action, which is to give extra cortical support [13]. It emerged that age, Garden Type III fracture and union time of over 18 weeks were predictors of complications. Each age increment increased the risk of complications by 6% which is a correlation with the findings reported by Koval et al., who demonstrated the correlation between the higher the age levels the worse the quality of bone, and this contributes towards the risks of complications in form of AVN, joint inflammation, or fracture [14]. Garden Type III fracture was associated with a higher risk of complications by 4.75 times, which is in agreement with Nikolopoulos et al., who revealed the known relationship between fracture relocation, low vascularity of the fracture area, and likelihood of complications in the format of AVN [15]. The complications were strongly associated with time of union greater than 18 weeks (OR = 6.40) in the shape of AVN, joint inflammation, or implant loosening [16]. The rate of infection of 10% may be viewed as rather high, particularly when it is compared to the Western population, yet it may be regarded as being in line with the values of the resource-deficient institutions, where the level of surgical asepsis, the character of antibiotics application and post-operative care tend to be different [17]. In an effort to reduce the rate of infections, it is believed that increased compliance with patient demands with regard to the asepsis, antibiotics, and post-operative management may be effective. The 8% and 4% Delayed Union and Non-union at the management of this study are more advantageous than the 10-30% Non-union illustrated by Papakostidis et al. as long as the fracture was of the neck of the femur, displaced, and the operation had been conducted by use of parallel screwfixation, which further supports the healing of BDSF [18]. The AVN incidence of 2% in the cohort under study is quite insignificant in relation to the average of 15-33% observed of internal fixation by Pauyo et al. [19]. One might explain this by the prevalence of Garden I-II type of fracture in the population under investigation (84%), in which the probability of injury to the vascularity of the femoral head is not as great. Also, the meantime interval of 10.3 days, although somewhat late due to logistic constraints, is still favourable with respect to meta-analyses, which reported unclear AVN risk mitigation of surgery that occurred within 12-24 hours, though additional research would be required to establish the relationship in the situation of BDSF [20]. The functional outcome also presents good results with the final value of HHS at 85.9, and it is clear that there was an increase in HHS since 45.1 at the second follow-up that is equated to a successful healing of the fracture which results in an acceptable restoration of functions. This is equal, or even greater, to the values obtained by means of conventional methods of fixation, which proves that BDSF not only results in fixation, but also in preservation of hip joints [21]. This is also confirmed by the ROM values in 115.6° in hip flexion. The demographic profile, mean age 43.2 years, and predominantly high-energy trauma, reflect injury patterns of developing nations, contrasting with the low-energy fall mechanisms common in elderly populations in the West [22]. This observation is context-specific, underlining the importance of local data generation that guides clinical decisions. Among the strengths of this study, the prospective design stands out, besides standardized surgery and a robust analysis; however, the relatively short follow-up time of 25.8 weeks limits long-term evaluation, particularly for AVN, which may emerge after 2-3 years.

LIMITATIONS OF THE STUDY

This study's single-center design and relatively short follow-up duration may not capture late-onset complications, particularly avascular necrosis, which can manifest up to 2-3 years post-injury, potentially underestimating the true complication burden. The absence of a comparative control group limits definitive conclusions regarding BDSF's superiority over conventional fixation methods.

CONCLUSION

With femoral neck fractures, biplane, double-supported screw fixation has acceptable complication rates and good functional outcomes, with 72% of the heals being complications free and 74% of good to excellent functional outcomes. The independent predictors of postoperative complications are old age of patients, type III Garden fracture and the length of healing which is more than 18 weeks, and these factors should be closely monitored and treated with alternative management plans in high-risk patients. The former biomechanical property is beneficial in preventing vascularity and stability of the fracture by femoral head as well as nonunion and avascular necrosis which are low.

RECOMMENDATION

Multicenter randomized controlled trials with extended follow-up (minimum 2-3 years) comparing BDSF with conventional parallel screw fixation are warranted to definitively establish the technique's long-term efficacy and complication profile. Cost-effectiveness analyses and applicability studies across diverse healthcare settings would facilitate broader clinical implementation and evidence-based treatment algorithm development.

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