

Case Series

Short term outcomes following biplane double supported screw fixation of femoral neck fractures in adults: a prospective observational study

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ABSTRACT

Femoral neck fractures are common among the elderly population. Non-union is a common complication of these fractures, despite various fixation options. Nonunion results in considerable morbidity and impaired function. Biplane double-supported screw fixation (BDSF) is a newer technique for femoral neck fractures, demonstrating superior fixation strength in biomechanical studies. We conducted this prospective observational study to evaluate the fixation strength of BDSF in adult femoral neck fractures, focusing on fracture union, loss of reduction over one year, and functional outcomes at the end of one year. Loss of fracture reduction was assessed using radiological parameters, while functional outcomes were measured with the modified Harris hip score (MHHS) and Parker mobility score (PMS). We recruited 19 patients aged 18-65 years who were treated using the BDSF technique and followed them for a year. The radiological and functional parameters were measured at regular intervals. Only 17 patients reported for final follow-up at one year. The mean neck shaft angle reduced by 6.35 degrees and the mean neck length decreased by 1.02 cm over 12 months. Two patients had expired during the follow up period and 17 patients were available for the final follow up at 1 year. Fracture union was achieved in 16 patients. No patient had fixation failure. Both the MHHS and PMS showed significant improvement at 1 year and 6 months respectively. BDSF provides strong fixation and good union rates. Although there was a reduction in neck-shaft angle and neck length, our study showed excellent functional outcomes.

Keywords: Biplane double support, Femoral neck fracture, Nonunion, Avascular necrosis

INTRODUCTION

Proximal femur fractures, especially femoral neck fractures, are common and can result from both high-energy trauma (road traffic accidents) and low-energy trauma (fall from standing height).¹ The latter is the common mechanism in elderly patients. Femoral neck fractures pose significant medical and socioeconomic challenges due to complications like fixation failure, non-union, and avascular necrosis.^{2,3} Over the years, research has focused on improving surgical techniques to reduce these complications, with methods such as cancellous screw fixation in various configurations, dynamic hip

screw, cephalomedullary nail, and plate osteosynthesis, all of which have complication rates up to 46%.²

To improve union rates and reduce complications, a modification of the conventional screw fixation technique called biplane double support screw fixation (BDSF) was introduced by Filipov et al.⁴ This technique provides stronger fixation at the subtrochanteric cortical bone and femoral neck, reducing failure rates.⁵ The BDSF technique was originally designed to treat osteoporotic femoral neck fractures in elderly patients who were unsuitable for arthroplasty. This technique describes fixation using three 7 mm partially threaded cancellous screws placed in two planes across the fracture in the femoral neck. Two screws

are positioned at an obtuse angle, with their entry point in the proximal diaphysis of the femur. This configuration provides stronger support from the proximal diaphyseal cortex compared to the thinner trochanteric cortex used in parallel screw fixation. Additionally, the oblique screws offer support to the femoral neck cortices, whereas parallel screws are positioned in the central cancellous part of the neck. The obtuse screw angle allows forces to be directly transferred from the femoral head to the shaft, bypassing the neck and reducing bending stress.⁶ This positioning also enables the screws to slide under stress, lowering the risk of displacement and screw breakage.⁷ Though technically challenging, BDSF offers superior biomechanical stability and higher load tolerance compared to standard methods⁸. Although originally described for use in elderly patients with osteoporosis, the enhanced fixation strength is expected to improve union rates and functional outcomes across all age groups. This prospective observational study aims to evaluate the radiological and functional outcomes following BDSF for femoral neck fractures in adults.

CASE SERIES

The study was designed as an observational longitudinal study with a follow up duration of 1 year. The institutional review board approval was obtained before recruiting the patients. Patients of age 18 to 65 years with acute traumatic femoral neck fractures treated with BDSF were included in the study after obtaining informed consent. Patients with comminuted fractures requiring bone grafting and those with pathological fractures were excluded.

Radiological parameters describing fracture type, fracture union, loss of fracture reduction, implant related complications, avascular necrosis were recorded from the serial standard radiographs during follow up. The functional outcomes were assessed using the modified Harris hip score (mHHS) and the Palmer Parker mobility score (PMS).^{9,10}

Surgical technique

Closed reduction was achieved during surgery using a traction table.¹¹ All patients were treated by the Biplane double supported screw fixation technique as described by Filipov.^{4,12} Using a straight lateral incision of 6-7 cm, the proximal femur distal to the lower border of greater trochanter, the vastus lateralis ridge was exposed and guide wires were placed. Subsequently, three 7 mm partially threaded cannulated cancellous screws made of surgical-grade titanium alloy were threaded over the guide wires that had been placed after drilling with a 4.5 mm cannulated drill bit. Once fracture reduction was achieved, either by closed or open means, the middle and proximal screws were placed perpendicular to the fracture plane in the anteroposterior projection. The middle screw was placed starting posteriorly in the lateral cortex and closely abutting the anterior cortex of the femoral neck in the lateral projection. The distal screw was started

approximately 5 cm distal to the vastus lateralis ridge and anteriorly on the femoral cortex, and placed closely abutting the medial cortex of the femoral neck in the anteroposterior projection and the posterior cortex in the lateral projection. Since the distal screw was placed at an extremely vertical trajectory, the pilot hole in the lateral cortex was made oblong using a burr. The wound was then closed in layers. A standard postoperative wound care and physiotherapy schedule was followed for all patients. Standard Antero posterior and Lowenstein lateral view radiographs were obtained.¹³ Weight bearing walking was initiated at 12 weeks following surgery.

Continuous variables such as age, neck-shaft angle, neck length, PMS, and modified HHS were expressed as mean±standard deviation or median with interquartile range (IQR).^{14,15} Categorical variables like gender, comorbidities, side involved, fracture classification, and complications were presented as frequencies and proportions. Normality of continuous variables was tested using the Kolmogorov-Smirnov test. For comparing means of normally distributed variables, the students paired t-test was used and for comparing medians of non-normal variables, Wilcoxon signed rank test was used. The statistical tests were carried out at 5% level of significance using IBM statistical package for the social sciences (SPSS) statistics software version 18.0.0.0.

The study included 19 participants who had sustained femoral neck fractures and were treated with BDSF technique at our institute between 2021 and 2023. The study cohort consisted of 12 males (63.2%) and 7 females (36.8%). The mean age was 46.62 years (SD: 14.02, range 25-65). Among the participants, 8 (42.1%) had coexisting illnesses, type 2 diabetes mellitus being the most common among them. Low velocity trauma was the most common mechanism of injury (63.2%). Garden type 3 (78.9%) and Pauwel type 3 (52.6%) were the most common fracture types in our study cohort. The basic traits of the study population are described in Table 1.

We assessed loss of fracture reduction by measuring the change in neck shaft angle (NSA) and neck length (NL). The change in mean NSA over 1 year between immediate postoperative assessment and final follow up was 6.35°. The difference was significant when tested with the paired t test ($p=0.022$). The change in mean NL over 1 year between immediate postoperative assessment and final follow up was 1.02 cm. A significant change was observed when tested with the paired t test ($p=0.008$) (Table 2). 17 patients were available for final follow up at 1 year. Only one patient (6.6%) had non-union at the end of 1 year (Table 3). The median mHHS increased by 22 points between 3 months and 1 year. This change was assessed using the Wilcoxon signed-rank test ($p=0.001$). The median Palmer mobility score increased by 3 points between assessment at 3 months and 6 months, which was again found to be significant by the Wilcoxon signed-rank test ($p=0.003$) (Table 4).

Table 1: Study population characteristics.

Variables	Frequency	Percentage
Age in (mean and SD)	46.42 (14.02)	-
Gender		
Male	12	63.16
Female	7	36.84
Side involved		
Right	4	21.05
Left	15	78.94
Pauwels classification		
Type 2	9	47.36
Type 3	10	52.63
Garden classification		
Type 2	2	10.53
Type 3	15	78.95
Type 4	2	10.53
Coexisting illness		
Diabetes mellitus	5	26.31
Cervical carcinoma	1	5.26
Stroke	1	
Scoliosis	1	

Screw subsidence was observed in 10 (58.8%) patients. One patient had screw penetration into the hip joint which warranted implant removal. Despite fracture union, two patients had developed avascular necrosis and collapse of the femoral head at 1 year and had undergone total hip arthroplasty a few months later.

Case 1

A 55-year-old gentleman had fallen from his motorcycle and was diagnosed with a Pauwel type 3 femoral neck fracture on the left side. He was treated with closed reduction and screw fixation using the BDSF technique. Despite fracture site comminution, serial radiographs showed good fracture union and no implant backout (Figure 1). The patient had excellent mHHS at 1 year and regained maximum PMS by 6 months.

Case 2

A 60-year-old lady had sustained a low fall at her home. She had sustained a Pauwel type 3 fracture on the right side. She was treated with the BDSF technique after achieving closed reduction. Serial radiographs showed good radiological outcomes (Figure 2). The patient had excellent mHHS and PMS scores during the follow up.



Figure 1: Radiographs of a 55-year-old male treated with the BDSF technique, (a) before surgery, (b and c) immediately after surgery, (d and e) at 6 weeks, (f and g) at 3 months, and (h and i) at 1 year following surgery.



Figure 2: Radiographs of a 60-year-old female treated with the BDSF technique, (a) before surgery, (b and c) immediately after surgery, (d and e) at 6 weeks, (f and g) at 3 months, and (h and i) at 1 year following surgery.

Table 2: Radiological parameters compared using students' t test.

S. no.	Variables	No. of patients (N)	Immediate post-operative, mean (SD)	1-year post-operative, mean (SD)	Test statistic	P value
1	Neck shaft angle	17	134.94 (7.99)	128.59 (6.89)	3.73	0.022
2	Neck length	17	4.91 (0.91)	3.89 (0.65)	5.834	0.008

Table 3: Fracture union rates.

S. no.	Time points	Union present (patients assessed, N=17)	Percentage
1	6 weeks	2	11.76
2	3 months	8	47.05
3	6 months	16	94.11
4	1 year	16	94.11

Table 4: Functional scores compared using Wilcoxon signed-rank test.

S. no.	Variable	No. of patients (N)	3-months post-operative, median (IQR)	6-months post-operative, median (IQR)	1-year post-operative, median (IQR)	P value
1	Modified Harris hip score	17	66 (9.5)	-	88 (26)	0.001
2	Palmer parker score	17	6 (3)	9 (0)	-	0.003

DISCUSSION

In our study cohort, fracture union was achieved in 94.1% of patients which is significant considering the fact that 52.6% of our study population had Pauwel type 3 fractures. The union rates are similar to the ones reported by Filipov et al, who had reported a union rate of 96.6% in their retrospective study of 207 patients.¹⁶ A. Sami et al in their

prospective cohort study showed a 92.59% union rate in 27 patients.¹⁷ Singh et al reported 83% union rate in their study of 47 Indian patients using the BDSF technique.¹⁸

While we had only one patient (6%) with nonunion at the end of 1 year, Sami et al reported 7.4% nonunion in 27 patients.¹⁷ Singh et al found 17% nonunion rate in their study of 47 patients whereas Filipov's retrospective study

of 207 patients reported a 3.4% nonunion rate.¹⁶ The reasons for difference in union and nonunion rates among different studies could be multifactorial.

We evaluated the ability of the BDSF technique to counteract the deforming forces at the femoral neck fracture site by assessing the changes in NL and NSA over time. Both NSA and NL reduced over time signifying collapse at the fracture site while it healed. These changes would suggest reduced biomechanical stability of the BDSF technique which is contrary to the reports of Filipov et al.¹⁹ This may also indicate that the technique was not executed as prescribed in some patients, leading to reduced rigidity of the construct. Notably, the technique performed better when carried out by experienced surgeons, though the sample size was too small to assess the significance of this difference. Fracture displacement in relation to the correct execution of the BDSF technique has not been reported in literature so far.

Filipov et al found a mean HHS of 86.2 (SD 18.9) at final follow up.¹⁶ Pauchari et al reported an average score of 91.35 in 20 patients.²⁰ Singh et al found a mean score of 77.04 in 47 patients, and Sami et al reported a mean score of 94.81 (SD 8.18) in 27 patients after 12 months.^{17,18} Another study involving 25 patients had reported union in all patients and a mean HHS of 81.2 at the final follow up.²¹ The mHHS score in our study improved significantly with time reaching excellent levels (88, IQR 26) at the final follow up at 1 year which is comparable to the results of similar studies. The mHHS, modified by Vishwanathan et al, was used in our study since it included squatting and cross-legged sitting, which is common in the Indian population and hence was more relevant to the study population.⁹ The PMS improved significantly and reached maximum value at 6 months, indicating excellent domestic and community ambulation.

CONCLUSION

The BDSF technique offers excellent union rates and fewer complications while treating femoral neck fractures in both young and elderly patients. While the procedure requires expertise, strong fixation, good union rates, and improved clinical and functional outcomes make it suitable for treating femoral neck fractures in the Indian population. Our study is limited in its sample size to allow for subgroup analysis and is limited in design to allow for comparison with conventional techniques. Evaluation of the BDSF technique in specific fracture types (Pauwel type 3) in comparison with the conventional screw fixation technique, femoral neck system and dynamic hip screw fixation is recommended.

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