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# A PROSPECTIVE STUDY OF "FUNCTIONAL AND RADIOLOGICAL OUTCOME OF NECK OF FEMUR FRACTURE TREATED BY BIPLANE DOUBLE SUPPORTED SCREW FIXATION METHOD"

Orthopaedics

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## ABSTRACT

**Introduction:** Osteosynthesis of femoral neck fractures is related up to 46% rate of complications. The novel method of biplane double-supported screw fixation (BDSF; Filipov's method) offers better stability using three medially diverging cannulated screws with two of them buttressed on the calcar. Biomechanically, the most effective component is the distal screw placed at steeper angle and supported on a large area along the distal and posterior cortex of the femoral neck following its spiral anterior curve. Thereby, BDSF achieves the strongest possible distal-posterior cortical support for the fixation construct, which allows for immediate full weight-bearing. **Aim:** The aim of this study was to evaluate the functional and radiological outcome of femoral neck fractures treated by biplane double supported screw fixation method. **Materials And Methods:** Subject of this study were 22 patients with displaced Garden III–IV femoral neck fractures treated with BDSF. Three 6.5-mm cannulated screws were laid in two medially diverging oblique planes. The distal and the middle screws were supported on the calcar. The distal screw had additional support on the posterior neck cortex. **Results:** The outcomes in 22 patients were analysed for minimum 6 months, maximum up to 24 months follow-up. Bone union occurred in 90% of the cases (18 patients). Rate of non-union was 10%. Rate of AVN was 12.1% (males 4.8%, females 13.9%, P = 0.12). Modified Harris hip score was 90.13 (range 10–100) **Conclusion:** By providing additional cortical support, the novel BDSF method enhances femoral neck fracture fixation strength.

## KEYWORDS

BDSF, Biplane, Femoral neck fracture, Fixation, Osteosynthesis, Hip fractures.

## INTRODUCTION

Hip fractures are common injuries, especially seen in the elderly in the emergency setting. It is also seen in young patients who perform in athletics or high-energy trauma. Immediate diagnosis and management are required to prevent threatening joint complications.[1] In the United States, the economic burden of hip fractures is amongst the top 20 expensive diagnoses, with approximately 20 billion dollars spent on the management of this injury.[2][3][4] It is estimated there will be approximately 300,000 cases of hip fractures annually in the United States by the year 2030.[5]

Femoral neck fractures are a specific type of intracapsular hip fracture. The femoral neck connects the femoral shaft with the femoral head. The hip joint is the articulation of the femoral head with the acetabulum. The junctional location makes the femoral neck prone to fracture. The blood supply of the femoral head is an essential consideration in displaced fractures as it runs along the femoral neck.

Thus, the present study tried to analyse the efficacy of this procedure in NMC Hospital and comparing it with the available studies in the literature.

## AIM

The aim of this study was to evaluate the functional and radiological outcome of femoral neck fractures treated by biplane double supported screw fixation method.

## METHODOLOGY

**Sample Size:** 22 cases
**Study Duration:** August 2021 to January 2022
**Sampling Procedure:** Prospective study.

### Method

Patients with signs and symptoms, X-Ray showing femoral neck fractures and who come under the inclusion criteria were selected and admitted.

1. Detailed history and clinical examination was done.
2. Investigations required for surgery was done.
3. A pre anaesthetic evaluation was done.
4. Pre-operative preparations were performed and informed written consent was taken.
5. Follow ups - 6, 12 and 24 weeks were made

### Inclusion Criteria

1. Patients more than 18 years of age with neck of femur fractures
2. All types of femoral neck fractures (Garden types 1-4) including posterior wall comminution.
3. Patient with no other associated fractures

### Exclusion Criteria

1. Fractures with non-union changes in neck of femur
2. Patients with arthritic changes of hip joint
3. Pathological fractures

## ODI SCORING

| ITEM | SCORE |
|---|---|
| PAIN | 44 |
| FUNCTIONS | 47 |
| RANGE OF MOTION | 5 |
| DEFORMITY | 4 |
| Total | 100 |

### Technical Terminology Concepts Used In The Report

Operative procedure
Anaesthesia-General anaesthesia
Position -

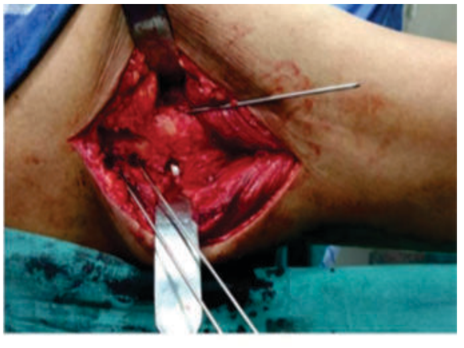
PRE OP POSITIONING ON FRACTURE TABLE

Incision straight lateral incision, starting at the level of the lower end of the greater trochanter, with a distal length of 6–10 cm. A stripping of the periosteum of the lateral diaphysis at 6–7 cm is performed.

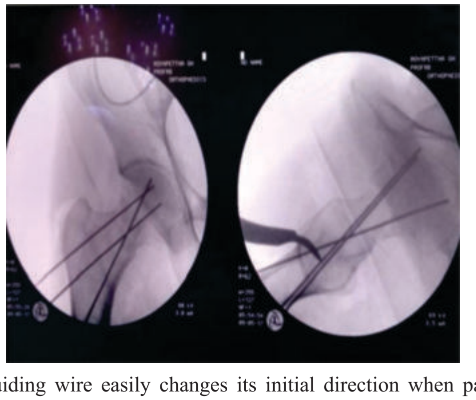
Placement of the implants: With the BDSF method, the three cannulated screws are placed in the frontal plane at a highly increased angle. Both the distal and the middle screws touch on the curve of the distal femoral neck cortex tangentially. At internal rotation of the leg, in A–P view, the projection of the distal screw crosses the projections of the other two screws, thus forming the letter F (F-technique). Via the concept of biplane positioning, developed by the BDSF, the three screws are placed in two vertical oblique planes (in lateral view). The two planes diverge towards each other in the direction of the femoral head and are oblique towards the frontal plane. The distal screw is laid in the dorsal oblique plane. The middle and the proximal screws are placed in the ventral oblique plane (Fig. 1).

Firstly, we lay the guiding wire for the distal cannulated screw. Its tip is placed 5–7 cm distally from the basis of the trochanter in the anterior one-third of the surface of the stripped-off diaphysis. It is directed proximally at an angle of 150–165° towards the diaphyseal axis, with inclination from anteriorly–distally to posteriorly–proximally, so that after it touches on the curve of the distal femoral neck cortex tangentially, the wire goes into the dorsal half of the femoral head.The middle guiding wire is placed second. The entry point is at 2–4 cm proximally from the entry point of the distal wire, in the dorsal one-third of the stripped-off surface of the diaphysis. This wire is placed at an angle of 135–140° towards the diaphyseal axis and inclined from posteriorly–distally to anteriorly–proximally, so that after it touches on the curve of the distal femoral neck cortex tangentially, the wire goes into the front one-third of the femoral head. In the frontal plane (A–P view), the tip of this guiding wire goes into the distal one-third of the femoral head.

Last to be laid is the proximal guiding wire, with its entry point at 1–2 cm proximally from the entry point of the middle wire, in the dorsal one-third of the stripped off diaphysis, close to the beginning of the trochanter. Placed parallel to the middle wire, the proximal wire goes into the front one-third and into the proximal one-third of the femoral head.



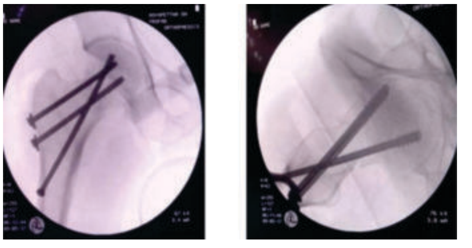
INTRAOP POSITIONING OF GUIDE WIRE



The guiding wire easily changes its initial direction when passing through the thick diaphyseal cortex, and therefore, its tip is guided into the desired direction by the operator's free hand with the help of a cannulated instrument. Next, we drill and place the screws one by one. Before placing the middle and distal screws, we over drill their holes in the lateral cortex by using a 7.0 mm cannulated reamer.

The middle and the proximal screws are placed first because they are perpendicular to the fracture surface. Next, we release the foot traction, and a several-time impaction of the fracture with an additional tightening up of the screws follows. Finally, the distal screw is placed.

INTRAOP PICTURE OF CANCELLOUS SCREWS



**AFTERCARE**

Post operatively intravenous antibiotics was given 12thhourly a n d was continued for the first 5 days. The wound was inspected at the time of drain removal on 2ndpost op day and alternate day sterile dressing done. Suture removal was done on 14th day.

Passive knee mobilization exercises and quadricep strengthening exercises were advised immediately on first postop day.

Non weight bearing for period was advised for 6 weeks from the day of surgery.

Later after 6 weeks active hip mobilization exercises and partial weightbearing was allowed after reviewing follow up x-rays of the patient

Later full weightbearing allowed after radiological union was seen.

**FOLLOW-UP**

Out of 22 patients, 20 were followed up regularly every month till 6 months and then every two months. The minimum follow up in our study was 6 months and the maximum follow up was 24 months. During the follow up period, functional outcome was assessed using Harris hip score after radiological union.

**Analysis Of Data & Interpretation**

In our study Harris hip score was analysed in all patients based on maximum follow up achieved by the individual. Analysis of Harris hip score was done in 20 patients.

**Pain**

In our study out of 20 patients,17(85%) were pain free, 2(10%) patients had mild pain, and 1(5%) patient had moderate pain.

**Gait Analysis**

In our study, 2(10%) patients had moderate limp, 2 (10%) had severe pain while 16 patients had mild limp or no limp.

**Ambulation**

14 patients (70%) were found to ambulate without help of any support and the remaining 6 patients (30%) needed some support in the form of a cane or walker for long walks.

**Distance Walked**

16 (80%) of the study patients could walk an unlimited distance at any given point of time while 2 patients (10%) could walk no more than 1000 meters at a time and 2 patients (10%) could only manage 500 meters at a time.

**Climbing Stairs**

On evaluation of the patient's ability to climb stairs, it was found that 15 patients (75%) were able to climb stairs without the use of any support or railing while the remaining 3 patients (15%) were able to do so with the support of the railing, 2 patients (10%) not able to climb.

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### Ability To Trim Nails
Our patients did not have the habit of using shoes and socks, their ability to trim their toe nails was used as a parameter for evaluation. It was found that 17 patients (85%) were able to trim their toe nails without any difficulty while 2 patients (10%) found it difficult to do so, 1 patient (5%) not able to do.

## RESULTS
Harris Hip Score evaluated at maximum follow-up of our patients averaged 90.13 with the maximum score being 96 and the minimum score being 67.8. Overall , 9 patients (45%) achieved excellent result ,6 patients (30%) achieved good result, 3 patients (15%) achieved fair result and 2 patients (10%) achieved poor result. 75% of the patients achieved either excellent or good result.

| GRADE | HHS | NO. OF PATIENTS | PERCENTAGE |
|---|---|---|---|
| Excellent | 90-100 | 9 | 45 |
| Good | 80-89 | 6 | 30 |
| Fair | 70-79 | 3 | 15 |
| Poor | <70 | 2 | 10 |

### Radiological Analysis
On analysing the antero-posterior view x ray of pelvis with hip in 15 degrees of internal rotation the radiological parameters such as fracture union, non-union changes, avascular necrosis in head, arthritic changes in the joint were analysed. Fracture union was seen in 18 patients and non-union in 2 patients. The average time of union was less than 3 months in 8 patients (44.4%), 3 to 4 months in 5 patients (27.7%), 4 to 5 months in 4 patients (22.2%) and in1patient (5.55%) union achieved at 5½months.

The position of the screws and the fracture site alignment were assessed by comparing the final follow up x-ray with immediate post op x-ray to decide about the fixation failure using following criteria:
- More than10mm displacement,
- Progression to varus angulation,
- More than 5% change between the axis of the screws,
- More than 20mm of posterior translation, and
- Femoral head perforation.

Based on this criterion, we had 2 cases of fixation failure which later resulted in non-union.

### Complications
In our study we had 2 cases of superficial wound infection, 2 cases of screw pull out which fall under minor complications.
Major complications like non-union of fracture were reported in 2cases with poor functional outcome and1case of varus mal-union.

**Table No: 1 Distribution Of The Study Subjects Based On The Gender (n=22)**

| SERIAL NO | GENDER | TOTAL | PERCENTAGE |
|---|---|---|---|
| 1 | MALE | 16 | 72.7 |
| 2 | FEMALE | 06 | 27.27 |
| TOTAL | | 22 | 100 |

The above table-01 depicted the gender distribution of the patients. It revealed that 72.7 percent (n=16) of the subjects were males and 27.27(n=06) percent of the subjects were females.The study revealed that maximum subjects were males (72.7 percent).

**Table No: 02 Distribution Of The Study Subjects Based On The Age (n=30)**

| SERIALNO | GENDER | 18-30 YEARS | 31-40 YEARS | 41-50 YEARS | ABOVE50 YEARS |
|---|---|---|---|---|---|
| 1 | MALE | 01 | 05 | 04 | 06 |
| 2 | FEMALE | 00 | 01 | 01 | 04 |
| TOTAL | | 01 | 06 | 05 | 10 |
| PERCENTAGE | | 4.5 | 27.27 | 22.72 | 45.45 |

The above table-02 indicated that 27.27 percent (n=06) of the patients were between the age group of 31-40 years, 45.45 percent of the patients fall in the category of above 50 years. Another 4.5 percent of the patients belongs to the age group of 18 to 30 years and 22.7 percent of the patients respectively belongs to the age group of 41 to 50 years.
The study revealed that majority of the patients (45.45 %) fall in the age group of above 50 years.

**Table No.03 Distribution Of The Study Subjects Based On The Occupation (n=30)**

| SERIALNO | OCCUPATION | NOOFPATIENTS | PERCENTAGE |
|---|---|---|---|
| 1 | AGRICULTURE | 8 | 36.36 |
| 2 | HOUSEWIFE | 5 | 22.72 |
| 3 | COOLIE | 3 | 13.63 |
| 4 | CLERK | 1 | 4.54 |
| 5 | MERCHANT | 3 | 13.63 |
| 6 | STUDENT | 1 | 4.54 |
| 7 | MECHANIC | 1 | 4.54 |
| TOTAL | | 22 | 100.00 |

The above table-03 highlighted the occupation of the study subjects. Out of total number of the subjects 36.36 percent (n=08) were Agricultures, 22.72 percent (n=5) were house wives, 13.63percent (n=3) were coolies, 13.63 percent (n=3) were Merchants, another 4.54 percent (n=1) were respectively Clerks, Students, Mechanics.

The studies revealed that majority (36.36 percent) of the patients were agriculturists.

**Table No :08 Distribution Of The Study Subjects Based On Test (n=22)**

| SERIAL NO | TEST | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|
| 1 | HOP TEST | 19 | 90 |
| 2 | FULCRUM TEST | 17 | 83.3 |

The above table-08 revealed that 90percent (n=19) of the patients had positive HOP TEST.

Another 83.3 percent (n=17) of the patients had positive FULCRUM TEST.

The study revealed that majority (90 percent) of the patients had positive HOP TEST.

**Table No:10 Distribution Of The Study Subjects Based On Return To Work In Weeks (n=22)**

| SERIAL NO | RETURN TO WORK | NO OF PATIENTS |
|---|---|---|
| 1 | 4-6 WEEKS | 2 |
| 2 | 8-10 WEEKS | 8 |
| 3 | 10-12 WEEKS | 12 |
| TOTAL | | 22 |

The above table-10 revealed that majority 54.54% (n=12) of the patients who were agriculturist and coolies returned to work between 10-12 weeks, 40% (n=12) of the patients who were house wives, merchant and mechanics return to work after 8-10 weeks and only 6.6% (n=2) of the patients who were students and bench clerk return to work after 4-6 weeks following surgery.

The study revealed that majority of the patient 53.3 % (n=16) who were agriculturist and coolies returned to work between 10-12 weeks following surgery.

**Table No:11 Distribution Of Results Of The Surgical Treatment**

| SERIAL NO | RESULTS | NO OF PATIENTS |
|---|---|---|
| 1 | FAIR | 04 |
| 2 | GOOD | 07 |
| 3 | EXCELLENT | 11 |
| TOTAL | | 22 |

The table-11 explained that 50% (n=11) of the study subjects showed excellent improvement after the surgical treatment, another 31.8% (n=7) of them showed good improvement and only 18.18% (n=4) of them showed poor improvement after the surgical treatment.

The study revealed that majority 50% of the patients showed excellent result after the surgical treatment.

**Table:12 Comparison Of Pre Operative And Post-operative ODI Score**

| ODIS-CORE | N | PRE-OP | | POST-OP | | | |
|---|---|---|---|---|---|---|---|
| | | MEAN | SD | MEAN | SD | t | P value |
| | 22 | 58.28 | 5.06 | 15.38 | 2.40 | 38.56 | 0.000* |

*Significant at p<0.001

The above table-12 showed mean score obtained on ODI scale among the study subjects. The pre operative mean score was 58.285.06 and post operative mean score was 15.38+2.40. The comparison of the pre and post operative mean score done with paired t test (38.56). The P

Value showed .000 (P<0.001).

The p value suggests that there is a significant improvement of ODI score (functional outcome) between pre operative and post operative level of function.

## DISCUSSION

### Gender

Males are more exposed to stress and strenuous activities in their daily life; hence they are more prone to have femoral neck fractures.

### Age

Commonest age group for femoral neck fracture is above 50 years. This is a formidable age group who are exposed to more work and stressful activities.

### Occupation

All the study subjects included in the present study had the daily activities which involves bending forwards, lifting weights, working with the locomotion machinery and strenuous work are the precipitating factors for fracture neck of femur.

Today's popular conventional methods of femoral neck fixation by three cancellous screws, placed parallel to each other and parallel to the femoral neck axis, are associated with poor results in 20–42% [6,7,8,9,10,11]. The high failure rate of conventional screw fixation methods can be explained by the presence of a few biomechanical imperfections.

(1) Lack of stability of the construction regarding varus stress. The femoral neck fracture is subject to powerful shearing forces due to the angular, spiral-like architecture of the proximal femur. In order to provide resistance to the shearing forces, in the presence of osteoporosis, the screws must be solidly fixed in the distal fragment in at least two points. This requirement is not met with conventional screw fixation methods, in which the entry points of the three screws are placed at the thin cortex of the greater trochanter or close to it. The screws are often located in the soft cancellous bone near the axis of the femoral neck, without any cortical support. Even if the distal screws (one or two) are placed close to the distal cortex of the femoral neck, they are deprived of a second solid point of support. A second point of support for them is the thin and fragile lateral cortex of the greater trochanter—their entry point. Such a construction can rely solely on the inter fragmental compression, created by the tightening of the screws intraoperatively, but the achieving of compression depends on the solidity of the cancellous bone. This leads to high failure rate in the cases of osteoporosis.

(2) Lack of sliding phenomenon.

(3) Inability to move the entry point of the screws distally into the solid diaphyseal cortex while simultaneously positioning three parallel screws. In 1961, Garden [12], like others before, further developed the concept that the implants must be placed more vertically, similar to the direction of the medial compression lamellae of the internal trabecular system, in order for resistance to the shearing forces to be provided. However, when developing this concept, classical authors used only one implant (a nail). In this way, the implant successfully provides resistance to the shearing forces but does not create compression among the fragments, because it is not a screw and is also not able to ensure reliable rotational stability of the head fragment, because the implant is just one [13,14,15].

The anatomy of the proximal femur does not allow three screws to be placed simultaneously, being parallel to each other; laying near the cortex in the periphery of the neck and at the same time having their entry point positioned distally, in the solid cortex of the diaphysis, so that the fragile lateral metaphyseal cortex is avoided. With the conventional methods of positioning of three parallel screws, if movement of the screw entry point distally is attempted, the screws will be placed at a very obtuse angle towards the diaphysis and obliquely to the femoral neck. By increasing the angle of penetration, the surface of the femoral neck cross section decreases geometrically, and practically, the placement of more than one or two screws is difficult to accomplish. Furthermore, a two-screw fixation does not provide reliable stability in all planes.

Both problems are resolved by the BDSF method through the concept of biplane positioning of three screws at an obtuse angle. The provision of two steady supporting points for the implants and the obtuse angle at which they are positioned allow the body weight to be transferred successfully from the head fragment onto the diaphysis, thanks to the strength of the screws, with the patient's bone quality being of least importance. The position of the screws allows them to slide under stress at a minimal risk of displacement. The achieved results with the BDSF method in terms of fracture consolidation are far more successful than the results with conventional fixation methods. The BDSF method ensures reliable fixation, early rehabilitation, and excellent long-term outcomes, even in non-cooperative patients. BDSF is mainly addressed to patients, who have contraindications for arthroplasty, as well as for conventional screw fixation.

## CONCLUSION

BDSF method used in femoral neck fracture fixation has given very good results in our study.

Difficulty in achieving distal screw fixation can be overcome by experience.

Though anatomical reduction is crucial, BDSF-method ensures reliable fixation, early rehabilitation, and good functional outcome especially in elderly.

### Case Illustrations:

CASE1:18/M, GARDEN TYPE 3, PAUWEL TYPE 3

IMMEDIATE POST-OP

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