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Original article

Femoral Neck Fracture Osteosynthesis by The Biplane Double Supported Screw Fixation Method (BDSF)

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Abstract

Background: Osteosynthesis of femoral neck fractures is related up to 46% rate of complications. **This study aimed to** evaluate clinical, radiological and functional outcome of Biplane Double supported screw Fixation (BDSF) in femoral neck fractures. **Methods:** This prospective case series study included 20 patients with recent femoral neck fractures. All studied cases were subjected to history, examination, X-ray views (AP and lateral views) hip was obtained. **Results**: Out of the total 20 cases included in the study, 45% of the cases were followed up for 2-4 months after surgery. The average time lapse before surgery was 26 h (range 6-36h). Nineteen patients were united within 6 months after the operation. 85% without complications, 15% with complications. According to Harris score, Final results were considered: excellent in 7 (35 %) patients. Good in 10 (50%) patients. Fair in 1 (5%) patient. Poor in 2 (10%) patients. RUSH score was with median (IQR) of 23 (16.5-25). **Conclusion:** This new method of fixation of femoral neck fractures using Biplane double-supported screw fixation [filipov method} enhance femoral neck fracture fixation strength, reveals excellent clinical outcome and is a vaild alternative to other fixation methods. Provides satisfactory results in 85% of cases and unsatisfactory results in 15% of cases. Early intervention within 24h, anatomical reduction, cortical screw support and intraoperative impaction are the most important steps. This method provides union rate of 95% without incidence of femoral neck shortening or failure of fixation.

Keywords: Femoral Neck Fracture; Osteosynthesis; Biplane Double Supported Screw Fixation.

Introduction

Osteosynthesis of femoral neck fractures is related up to 46% rate of complications (1, 2).While the late avascular necrosis (AVN), ranging from 9 to 32%, depends on various biological and surgical factors, the other common complication—fixation failure, rating between 9 and 30%—is mainly due to insufficient fixation strength in osteoporotic bone (3, 4). The latter could be reduced by optimizing the primary stability of the internal fixation construct.

The recently introduced novel method of biplane double-supported screw fixation (BDSF; Filipov's method) provides improved cortical screw support and increased fixation strength (5, 6). The concept of biplane positioning makes it feasible to place three cannulated screws at steeper angles to the diaphyseal axis with entry points located much more distally within the thicker cortex of the proximal diaphysis, thus improving their beam function and cortical support. The three screws are laid in two vertical oblique planes that medially diverge toward the femoral head on lateral. BDSF implements two calcar -buttressed screws, oriented in different coronal inclinations and intended to provide sufficient stability during various physical activities.

Their medial supporting points are located 10–20 mm apart, thereby distributing the axial load over a larger cortical area. Moreover, achieving posterior cortical support using an obtusely placed screw improves construct resistance to anteroposterior bending forces.

The purpose of this study was to evaluate clinical, radiological and functional outcome of Biplane Double supported screw Fixation (BDSF) in femoral neck fractures.

Patients and methods

The study was a prospective case series study. The study period is from January 2022 until January 2023 in Benha university Hospital.

This prospective case series study included 20 patients with recent femoral neck fractures.

An informed written consent was obtained from the patients. The study was done after being approved by the Research Ethics Committee, Faculty of Medicine, Benha University.

Inclusion criteria were age group was 20 -60 years old, recent fractures less than 2 weeks, according to Garden classification: Age group 20- 40 (type 1,2,3,4) and age group 40-60 (type 1,2).

Exclusion criteria were age group was less than 20 years or more than 60 years, neglected fractures more than 2 weeks, according to Garden classification: Age group 40-60 years old (type 3,4).

All studied cases were subjected to the following: History, examination, X-ray views (AP and lateral views) hip was obtained.

Surgical techniques:

- **Anesthesia:** Spinal anesthesia.
- **Position:** figure 34 Supine position on a radio-lucent traction table action table.
- **Implants:** 7.3 mm self -tapping cannulated screws
- **Reduction:** Closed /open

Approach: lateral incision, starting at the level of the lower end of 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 screws with the BDSF method, the three screws are placed in two vertical diverging planes (in lateral view) the distal screw is laid in the dorsal oblique plane, the middle and proximal screws are placed in the ventral oblique plane.

The first step is to put guide wire for the distal cannulated screw. Its tip is placed 5-7 cm distally from the base of the greater trochanter in the anterior one-third of the surface of the femoral diaphysis. It is directed proximally at an angle of 150-165o with inclination from anteriorly–distally to posteriorly–proximally, so that after it touches on the curve of the distal femoral neck cortex, the wire goes into the posterior half of the femoral head.

The middle guide wire is placed next. The entry point is at 2-4 cm proximally from the entry point of the distal wire in the posterior one-third of femoral shaft.

This wire was placed at an angle of 135-140o and inclined from posteriorly-distally to anteriorly-proximally, so that after it touches the curve of the distal femoral neck cortex, the wire goes into the anterior one-third of the femoral head in the lateral view and in A-P view, the guidewire rests in distal one third of femoral head. The proximal guidewire was laid in the last. The entry point is 1-2 cm proximally from the entry point of middle wire in the posterior one-third of femoral shaft. It was placed parallel to the middle wire and is directed posterior-distally to anterior proximally, so that in the A-P view, the guidewire lies in proximal one-third of femoral head and in the lateral view, it lies in anterior one-third of femoral head. Being perpendicular to fracture surface, the middle and proximal screws are placed first followed by insertion of the distal screw.

Post-operative radiographs were obtained on the first postoperative day. Limited weight bearing for 4- 6 months. All the patients followed up clinically and radiologically.

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Statistical analysis

Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA).

Quantitative variables were presented as median (IQR). Qualitative variables were presented as frequency and percentage (%).

Results

Table 1 shows age, gender distribution, smoking habit, affected side, and mechanism of injury.

Table 2 shows the type of fracture, associated injury, and associated medical conditions.

Out of the total 20 cases included in the study, 45% of the cases were followed up for 2-4 months after surgery. The average time lapse before surgery was 26 h (range 6-36h). Nineteen patients were united within 6 months after the operation. 85% without complications, 15% with complications. According to Harris score, Final results were considered: excellent in 7 (35 %) patients. Good in 10 (50%) patients. Fair in 1 (5%) patient. Poor in 2 (10%) patients. **Table 3**

RUSH score was with median (IQR) of 23 (16.5-25). **Table 4**

Female patient aged 39 years old, presented to the emergency unit at our hospital with left hip pain, inability of weight bearing and external rotation deformity of the left lower limb after motor vehicle accident. Plain x ray reveals displaced fracture of the left neck of femur Garden type III. The surgery was performed twelve hours after trauma. Patient started range of motion on the second day postoperative and started partial weight bearing 3 weeks later. **Figure 1**

Table 1: Age, gender distribution, smoking habit, affected side, and mechanism of injury

Age in years	Number	Percent
20-30	4	20%
30-40	4	20%
40-50	7	35%
50-60	5	25%
Male	15	75.00%
Female	5	25.00%
Heavy smokers	3	15.00%
Moderate smokers	8	40.00%
Mild smokers	1	5.00%
Non-smokers	8	40.00%
Affected side		
Right	11	55.00%
Left	9	45.00%
Mechanism of injury		
Car accident	12	60.00%
Simple fall	4	20.00%
Fall from height	4	20.00%

Table 2: Type of fracture, associated injury, and associated medical conditions

	Number	Percent
Garden I	1	5.00%
Garden II	7	35.00%
Garden III	11	55.00%
Garden IV	1	5.00%
Associated injury		
Patient with associated fracture acetabulum	1	5.00%
Patient with associated fracture calcaneus	1	5.00%
Patient with associated fracture both bone for arm	1	5.00%
Patient with associated fracture spine	1	5.00%
Patient without associated injuries	16	80.00%
Associated medical conditions		
Patient with medical conditions	7	35.00%
Patient without medical conditions	13	65.00%

Table 3: Duration of follow up after injury, time lapse before surgery, duration of follow up after injury, postoperative complications and final end results according to Harris score

	Number	Percent
4-6 months	9	45.00%
6-9 months	7	35.00%
9-12 months	4	20.00%
Time lapse before surgery		
6h	2	10.00%
10h	1	5.00%
12h	3	15.00%
12h-18h	2	10.00%
18h-24 h	4	20.00%
24-30h	1	5.00%
30-36h	2	10.00%
36-48h	2	10.00%
48-72h	3	15.00%
Duration of follow up after injury		
United	19	95.00%
Non united	1	5.00%
Total	20	100%
Postoperative complications		
Non-union	1	5.00%
In one case chronic kidney diseases patients highly comminuted fracture		
Wound infection	1	5.00%
Matal failure	0	0.00%
AVN	0	0.00%
LLD	0	0.00%
Coxa Vara	1	5.00%
Mal union in one case because of medial cortex comminution		
No complications	17	85.00%
Final end results according to Harris score		
Excellent	7	35.00%
Good	10	50.00%
Fair	1	5.00%
Poor	2	10.00%
Total	20	100%

Table 4: Final end results according to RUSH score

RUSH score	Median	23
	IQR	16.5 - 25

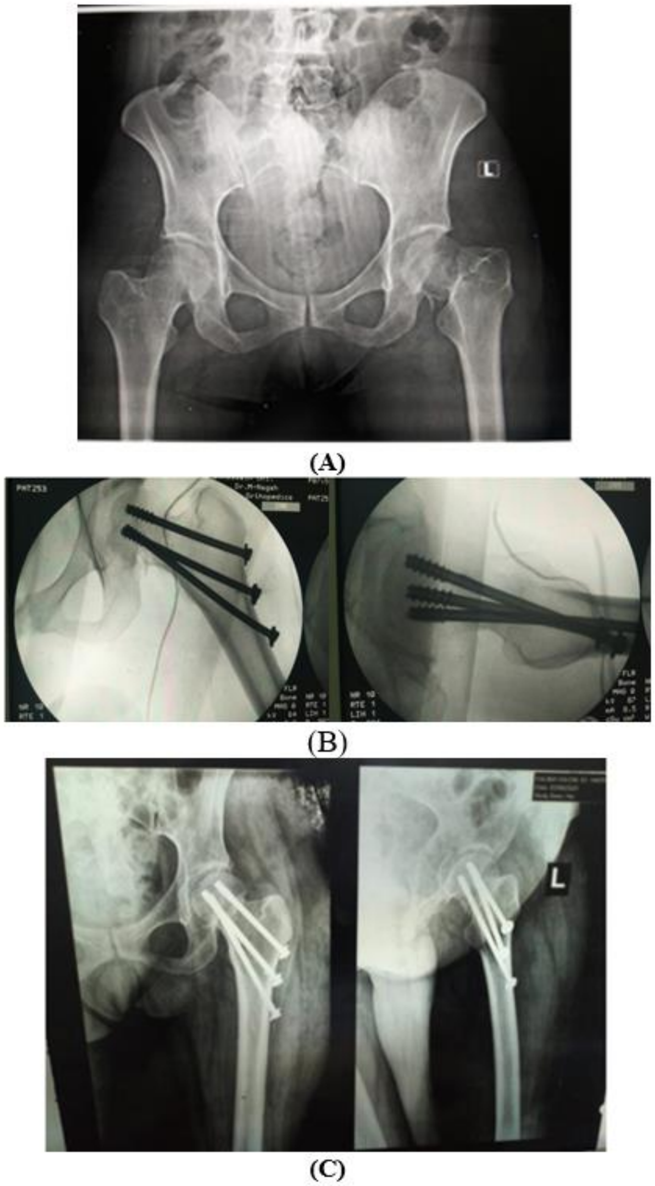

Figure 1: (A) Preoperative plain x ray of the pelvis showing fracture left neck of femur Garden type III. (B) Immediate postoperative x ray. (C) Three months later after complete union

Discussion

Screws positioning in treatment of femoral neck fractures in adults is controversial. Placement of the distal screw touching the distal cortex of the femoral neck (the calcar) is recommended by some authors: (7, 8) Other authors recommend central placement of the screws in lateral view (9, 10). Others recommend peripheral placement of the screws (11) and ensuring of a posterior cortical support (12).

Many authors recommend parallel screws in both AP and Lateral views (13, 14). However, this is not proven biomechanically.

On the other hand, spreading of the screws in lateral view is advised by some authors (15).

In the last decade, fixation with three cannulated partially threated screws is the standard method in treatment of fracture neck of femur in adults. Many configurations can be used such, inverted triangle configuration, upright triangle, diamond pattern, linear vertical, and linear horizontal configuration. The inverted triangle configuration is most widely used, as it was supposed to provide greater strength (16, 17). The screws placed under increased angle demonstrate better fixation strength (18).

The basic idea of this technique depends on the fact that BDSF provides two calcar-buttressed screws that are oriented at different inclinations. The obtuse distal BDSF screw comes in optimal orientation for axial weight bearing.

Its bearing capacity is added to the middle BDSF screw and helps maintain constant stability across a wide range of inclinations during gait activities. With double support at the inferior and posterior femoral neck cortices, the distal BDSF screw could be especially effective when axially loaded along the diaphyseal axis and when AP bending and torsion are applied. This is an essential advantage of the BDSF method because during diverse patient activities the resultant dynamic forces and moments change their directions, loading the femoral neck in axial compression (e.g., standing on one leg, standing with the feet apart), AP bending and torsion (e.g., rising up from a chair, climbing, running), This technique is better than the three parallel screws technique because in the three parallel screws technique, screws all placed at an angle of 120-130 to the diaphyseal axis, which canbe less functional.

Secondary axial stiffness after cyclic testing was significantly higher compared with initial axial stiffness regardless of inclination or fixation during the cyclic test. technique. The reason for this increase could be fracture impact occurring.

BDSF proved higher construct failure loads than the three parallel screws technique. However multi-center studies & long-term follow-up is needed to fully evaluate this method. With the BDSF-method through the concept of biplane positioning of the three screws, 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 for arthroplasty, as well as for a conventional screw fixation. patients. BDSF is mainly addressed to patients, who have contraindications for arthroplasty, as well as for a conventional screw fixation .

In general, compared with three parallel screws technique, the fixation strength of BDSF is considerably higher because of the following factors.

Two calcar-buttressed screws are used during BDSF, as opposed to only one screw in the three parallel screws technique. The two calcar screws are in contact with the distal neck cortex in two different regions, located 1-2 cm apart from each other (depending on the CCD angle), and distribute the applied axial load over a larger surface area. Consequently, in contrast to three parallel screws technique, the applied load is spread over approximately 50%of the femoral neck cortex length without concentrating stress in a single spot, thereby resulting in increased bearing capacity. The steeper screw orientation angle to the diaphyseal axis contributes to increased varus resistance, reduced beam sagging, and allows for easier sliding when osteoporotic fracture impaction and shortening occurs during weight bearing, thus avoiding cut-out and maintaining stronger fixation strength. Expected reduced risk of sub-trochanteric fracture. The distance between the lateral and medial supporting points of the distal BDSF screw is increased because of its steeper angle to the diaphyseal axis. As a result, the load acting on the lateral and medial cortical-supporting points is reduced (13).

Furthermore, the distance between the distal and medial screw entry points is increased to 20-40 mm, allowing for the tensile forces to spread over a larger area on the lateral cortex. In addition to the posterior cortical neck support, the calcar supporting point of the distal BDSF screw is located at the lateral part of the inferior neck cortex. Therefore, BDSF can be used for the fixation of more unstable fractures with posterior comminution and/or more vertical fracture lines, whereas parallel screws would be inappropriate in these situations.

Biologically, BDSF screws are positioned in the ventral and dorsal oblique planes, away from the weight. bearing upper pole of the femoral head, and can thereby avoid the danger of damaging the intraosseous vascularization (13).

Conclusion

This new method of fixation of femoral neck fractures using Biplane double-supported screw fixation [filipov method} enhance femoral neck fracture fixation strength, reveals excellent clinical outcome and is a vaild alternative to other fixation methods . Provides satisfactory results in 85% of cases and unsatisfactory results in 15% of cases. Early intervention within 24h, anatomical reduction, cortical screw support and intraoperative impaction are the most important steps. This method provides union rate of 95% without incidence of femoral neck shortening or failure of fixation.

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