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Research Article

Evaluation of Biplane Double Supported Screw Fixation of Femoral Neck Fracture: A Longitudinal Study at a Tertiary Health Care Center in Manipur

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ABSTRACT

Background: Various treatment modalities for treating fracture neck of femur have been described. But complications like insufficient reduction, unstable fixation and avascular necrosis of head have been reported with almost all the fixation techniques. **Objective:** To evaluate and assess the clinical and functional outcomes of biplane double supported screw fixation for managing femoral neck fracture using Harris Hip Score. **Materials and Methods:** A hospital-based longitudinal study was taken up in the Department of Orthopaedics RIMS, Imphal, Manipur during the period August, 2018 to July, 2020. All the patients admitted in RIMS Hospital with fracture neck of femur medically fit for surgery during the study period were included except those who are not medically fit for surgery and not willing to participate. Under standard surgical precautions, biplane double supported screw fixation was performed with 3 cannulated screws. Patients were followed for a minimum of 6 months to assess the outcome using Harris Hip Score. **Results:** Forty seven patients could be followed up-to 6 months. There was no significant blood loss during the surgery. After 6 months of the surgery radiological union was seen in 39 (83%) patients. At the end of 3 months the Harris Hip Score was not that encouraging but at the end of 6 months 40% had excellent score, 36% good score, 13% fair score and the remaining 11% had bad score. The difference in the scores at 3 and 6 months was found to be statistically significant. **Conclusion:** Management of femoral neck fracture with Biplane Double-Supported Screw Fixation provides good clinical and functional outcomes. BDSF is a surgical technique which should be offered to the patients with fracture neck femur before contemplating total or hemiarthroplasty of hip.

KEYWORDS

Double supported, fracture, Harris Hip Score, neck of femur, screw fixation

INTRODUCTION

Hip fractures are common and comprise 20% of the operative workload of an orthopedic trauma unit[1]. Intracapsular femoral neck fractures account for 50% of all hip fractures[2]. They commonly occur in the aged population.

Various treatment modalities have been tried. But complications like insufficient reduction, unstable fixation and avascular necrosis of head are reported. Cannulated screws are often used, however this osteosynthesis is associated with poor results in 21-46% of the clinical cases[3]. Screw configuration has been investigated in several comparative studies[4-11]. Placement of distal screw in a manner that it is supported by the distal femoral neck cortex is recommended. Placement of central screw on lateral view is either central or peripheral. Secured posterior cortical screw support is also recommended. The classical method has been placement of 3 screws parallel to

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each other. However, the dictum of parallel placement has been challenged and some authors prefer divergent placement on the lateral view.

The conventional method of 3 parallel screws for femoral neck fracture does not always provide appropriate fixation strength. Filipov's novel method for Biplane Double-Supported Screw Fixation (BDSF) also known as F-technique can increase the fixation stability, demonstrate a high degree of reproducibility during its standardized surgical procedure and has been clinically applied since 2011[12]. The innovative concept of biplane screw positioning makes it feasible to place 3 cannulated screws at steeper angles to the diaphyseal axis in order to improve their beam function and cortical support. Here, 3 screws are laid in 2 vertical oblique planes that medially diverge toward the femoral head on lateral view. The distal screw is placed in the dorsal oblique plane with additional support by the posterior femoral neck cortex. The middle and proximal screws are oriented in the ventral oblique plane. What is innovative about this method is that the 3 screws are laid in 2 planes, which makes it possible for the entry points of two of the implants to be placed much more distally, in the solid cortex of the proximal diaphysis and also to lean onto the femoral neck distal cortex. Thus, we establish 2 supporting points. Another advantage with the BDSF is also that the screw, placed at a highly increased angle, works in a direction close to the direction of the loading force, which guarantees better results for the screw in its role of a beam because of the influence of its sagging decreases.

As it is rather a newer method and also as any published literature from the North-Eastern part of India is not available, it was felt important to evaluate it.

MATERIALS AND METHODS

A hospital-based longitudinal study was taken up in the Department of Orthopaedics RIMS, Imphal, Manipur during the period August, 2018-July, 2020. All the patients admitted in RIMS Hospital with fracture neck of femur medically fit for surgery during the study period and who informed consent for the study and fulfilling the inclusion criteria of adults aged 40-90 years, having Garden's type I-II fracture neck of femur[13], fresh fracture (fracture up-to 3 weeks) were included in the study.

Patients having associated comorbidities such as any type of coagulopathy, uncontrolled diabetes mellitus, pelvic injury, abdominal injury etc., were excluded.

Based on the standard deviation of Harris Hip Score from a study conducted by Filipov[4] and an allowable margin of error as 2 at 95% confidence level a sample size of 58 was scientifically calculated[12].

The independent variables used were socio-demographic variables, pre-operative and post-operative haemoglobin, operative time, immediate postoperative rehabilitation progress 24 hrs post operatively, length of hospital stay, limb length discrepancy and complications. The outcome variable used was Harris Hip Score (modified) which is an objective outcome measure frequently used for the evaluation of patients following a hip surgery. The max possible score is 100. It takes into account of parameters like pain, function, gait and absence of deformity[14]. A score of 90-100 was considered as excellent while scores of 70-90 and <70 were considered as fair and poor, respectively.

A semi-open semi-structured profoma was used to collect data on socio-demography and for evaluation of clinical history. A Goniometer was used to measure the flexion angle postoperatively. A non-elastic measuring tape was used to measure limb length discrepancy. Plain x-ray of hip (antero-posterior and lateral view) was taken preoperatively to assess the degree of displacement of femoral head, if any.

During surgery the tools used were 6.5 mm self-tapping cannulated cancellous screws, cannulated reamer for screws, cannulated drill bit for 6.5 mm screw of varying length and a screw driver for 6.5 mm screws. Under spinal or epidural anaesthesia fracture was manipulated. Injection cefuroxime was given before 1 hr of operation. With the patient lying supine on fracture table, a mild traction, internal rotation and a light abduction of the limb was applied. Criteria for acceptable reduction was taken as no varus and vagus alignment of 0°-15° on AP view, maximum displacement of 2 mm, up-to 20° ventral and 10° angular displacements on lateral view (Figure 1). Reduction was checked under C-arm guidance (Figure 2). The affected area was painted with 10% povidone iodine and draped.

Then a straight lateral incision, starting at the level of the lower end of the greater trochanter, with a distal length of 6-10 cm was made and stripping of the periosteum of the lateral diaphysis at 6-7 cm was done. The 3 cannulated screws were placed in the frontal plane at a highly increased angle. Both the distal and the middle screws touched 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

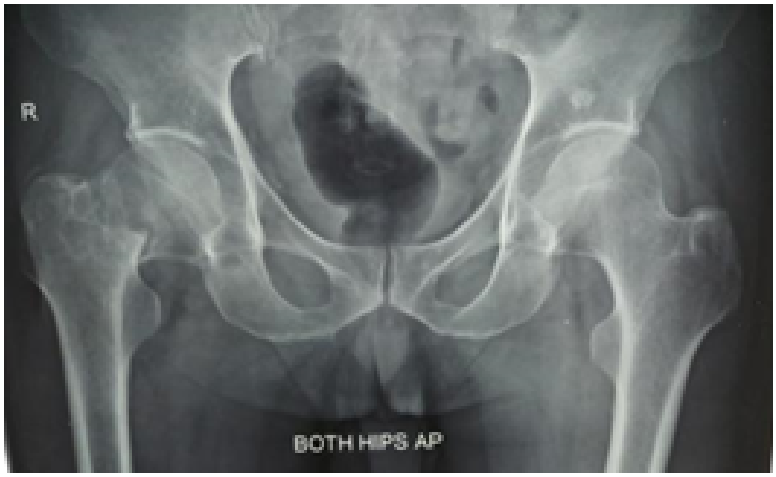

Figure 1: Preoperative AP radiograph of a patient with type IV fracture neck of right femur

Figure 2: Patient positioned in supine on fracture table and fracture reduced

Figure 3(a-b): Radiography, (a) A-P view and (b) Lateral view

other 2 screws, thus forming the letter F (F-technique). Via the concept of biplane positioning, developed by the BDSF, the 3 screws are placed in 2 vertical oblique planes (in lateral view). The 2 planes were made to diverge towards each other in the direction of the femoral head and were oblique towards the frontal plane. The distal screw was laid in the dorsal oblique plane. The middle and the proximal screws were placed in the ventral oblique plane (Figure 3). Firstly, we laid the guide wire for the distal cannulated screw. Its tip was placed 5-7 cm distally from the base of the trochanter in the anterior one-third of the surface of the diaphysis. It was 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 guide wire was placed second. The entry point was 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 was 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.

Afterwards, the proximal guide wire was laid, 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 anterior one-third and into the proximal one-third of the femoral head.

Next, we drilled and placed the screws one by one. Before placing the middle and distal screws, we over drilled their holes in the lateral cortex by using a 6.5 mm cannulated reamer. Then, the middle and the proximal screws are placed first because they are perpendicular to the fracture surface. Next, we released the foot traction and a several-time impaction of the fracture with an additional tightening up of the screws followed. Finally, the distal screw was placed.

As post-operative care and management opioid medications were administered twice a day for the first 48 hrs of surgery and injection cefuroxime were administered twice a day for 5 days. The operated limb was kept elevated and active toe movement exercises were encouraged once the patient recovers from anaesthesia. Check x-ray was taken on the 2nd or 3rd post-operative days. Physical therapy and patient mobilization as tolerated were initiated within 1 weeks after surgery and weight bearing were started after 4 weeks as tolerated. All patients were instructed to use a walker or 2 crutches and advance weight bearing and exercises as tolerated until 1 month after surgery. The skin sutures were removed on postoperative 10 days. No specific protocol was used to encourage early discharge from the hospital and each patient's response to the surgery determines the discharge planning.

The patients were followed up monthly at outpatient department of RIMS orthopaedics department for a minimum period of 6 months. Clinical and functional assessments were done during the follow-up studies using the Harris Hip Score. A good outcome was defined radiologically as a fracture union with no evidence of avascular necrosis/non-union and with good functional and clinical outcomes.

Data collected were checked for completeness and consistency. They were entered and analyzed using Statistical Package for Social Sciences (SPSS) V.23 for Windows (IBM Corp., Armonk, Ny, USA). Descriptive data were presented in terms of mean, standard deviation and proportions. Chi-square test was used for categorical variables. Paired t-test and ANOVA test were used wherever appropriate. A $p<0.05$ was considered significant. Ethical approval was taken from Institutional Research Ethics Board, RIMS Imphal before starting the study (vide No. A/206/REB-Comm (SP)/RIMS/2015/509/127/2018 dt. 30th July, 2019) and informed consent was taken from all the participants. Confidentiality of records was maintained.

RESULTS

A total 51 patients underwent BDSF during the study-period, out of which 4 were lost to follow up. So a total of 47 cases were analyzed and studied. Geriatric population (aged 60 or more) constituted majority of the cases (30; 64%). It ranged from 45-85 years with a mean age of 65 years. Females outnumbered males (1.6:1). Type IV fracture by Garden's classification was the most commonly found fracture (28; 60%). Fall trauma from the standing height was the main cause of inflicting fractures (30; 64%) (Table 1).

Based on the radiological signs almost half (23; 48.9%) of them had osteoporotic changes. It was more frequently seen among the female cases (Table 2).

The mean interval (SD) between injury and surgery was found to be 7.3 (3.01) days with a range of minimum 1 day and a maximum of 10 days. The mean (SD) operative time was 92 min with a variation of approximately 30 (15.62) min.

The mean pre-operative Hb level was 13.23 mg dL^{-1} and the mean post-operative Hb level was 12.58 mg dL^{-1}. The difference was insignificant ($p>0.05$) which indicates that with BDSF blood loss is minimal (Table 3).

The mean duration of hospital stay was found to be 10 days with a variation of ±2 days.

After 6 months of the surgery radiological union was seen in 39 patients (83%) whereas the remaining 8 cases showed non-union.

Table 1: Baseline data of study participants (n = 47)

Variables	Numbers	Percentage
Gender		
• Male	18	39
• Female	29	61
Age group (years)		
• 40 up-to 50	08	17
• 50 up-to 60	09	19
• 60 up-to 70	12	26
• 70 up-to 80	16	34
• ≥80	02	4
Type of fracture		
• I	02	4
• II	13	28
• III	04	8
• IV	28	60
Etiology of fracture		
• Road traffic accident	17	36
• Fall from height	30	64

Table 2: Correlation of osteoporosis with gender

	Osteoporosis based on x-ray		
Gender	No (%)	Yes (5)	p-value
Male	17 (68)	8 (32)	<0.05
Female	7 (31.8)	15 (68.2)	

Table 3: Distribution of Hb level in the pre-operative and post-operative period

Hemoglobin level	Mean±SD	p-value
Pre-operative	13.23±1.38	0.2
Post-operative	12.58±1.41	

Table 4: Comparison of Harris Hip Score at 3 months and Harris Hip Score at 6 months

			95% CI		
Variables	Mean±SD	Mean difference	Lower	Upper	p-value
HHS at 3 months	55.85±20.9	21.19	-26.1	-16.2	0.015
HHS at 6 months	77.04±18.7				

Regarding the main outcome variable, Harris Hip Score at 3 months post-operatively was found to be "good" in majority (21; 45%) of the patients followed by "fair" (14; 30%), "poor" (07; 15%) and excellent (05; 10%). The average Harris Hip Score was registered to be 55.85. A great improvement was seen at the end of 6 months. 19 (40%) patients had "excellent" score, 17 (36%) had "good" score, 6 (13%) had "fair" score and rest 5 (11%) had "bad" score. The average Harris Hip Score went up-to 77.04. Paired "t-test" of the values of Harris Hip Score at 3 months and 6 months showed significant difference indicating a significant improvement over time and with rehabilitation process proven by $p<0.05$ (Table 4).

Deep vein thrombosis was observed in 1 case on post-operative 1 day. Superficial wound infection was noticed in 2 cases, 1 limb-length discrepancy and 3 cases of avascular necrosis of femoral head were recorded at the end of 6 months.

DISCUSSION

In our study, the mean age of the patients were found to be 65.2±11.4 years (range 45-85 years). Filipov[4] reported the average age to be 76.9 years with the youngest aged 45 and oldest 85. The relatively higher but acceptable mean age and the wider range can be due to higher Human Development index in the country Filipov studied owing to higher standard of living and the higher life span compared to the developing country like India.

Fracture union based on radiological findings was seen in 83% and non-union in 17% whereas, in the study done by Filipov[5] the fracture union was achieved in 88 and 12% went into avascular necrosis[12]. The findings are almost comparable.

In our study, majority of the patients (64%) sustained the injury due to trivial trauma like tripping or slipping.

Kalantri *et al.*[16] in his study made similar observation where 63.3% of the study population sustained injury due to trivial trauma.

The present study showed that the correlation between the osteoporosis and the fracture union was insignificant indicating that osteoporosis has little or no role in the determining the clinical and functional outcomes. Similarly in the study conducted by Koaban *et al.*[17] on elderly population, it was found that there were no significant correlation between the fracture union and the osteoporosis.

Harris Hip Score registered at 3 months were excellent in 5 (10%), good in 21 (45%), fair in 14 (30%), poor in 7 (15%). Mean Harris Hip Score was 55.85. At 6 months the scores were excellent in19 (40%), good in 21 (45%), fair in 6 (13%) and poor in 5 (11%). Mean Harris Hip Score was 77.04. The Harris Hip Score values recorded were close to the value found by Kalia *et al.*[15], which gave the following results: Excellent 51%, good 28.5%, fair 11.42% and poor 8.57%. Students paired "t-test" between the 2 Harris Hip Scores, 1 at 3 months and other at 6 months, showed statistically significant difference. In the study conducted by Filipov and Gueorguiev[6] Harris Hip Scores were excellent in 37 (42.04%), good in 21 (24.86%), fair in 20 (22.72%), poor in 10 (11.36%)[4]. The average score recorded was 84.26% which is slightly higher from the values recorded from our study which may be due to the lesser surgical experience we have.

The present study had certain limitations. Firstly, the desired sample size was narrowly missed because of time constraint. In addition, due to long period of follow up time, 4 patients were lost follow up. At times, there was difficulty in attaining the exact required angles of screws with the C-arm due the minimally invasive technique which doesn't requires opening of hip joint of the fractured area. Another precaution is that the surgery required experienced surgeons. Lastly but not the least, there was no comparison group as it was not a clinical trial.

CONCLUSION

From the present prospective study, we came to the conclusion that management of femoral neck fracture with BDSF provides good clinical and functional outcomes. This technique has a better mechanical construct than the conventional parallel screw fixation technique. Patients with fracture neck of femur should be offered with this treatment modality before contemplating arthroplasty.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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DISCLAIMERS

The opinions expressed in this article are the authors' personal views and do not represent that of their affiliated organizations, employers, or associations.

DATA AVAILABILITY STATEMENT

Not applicable

HIGHLIGHTS OF THE STUDY

- Various modalities for treatment of fracture of femoral neck exist but they have their modal-specific complications and failures
- Need to explore safer and effective modal of treatment
- Result of biplane double supported screw fixation is encouraging
- This technique is easier to perform and can be offered to the patients with fracture neck femur before contemplating total or hemiarthroplasty of hip

AUTHOR CONTRIBUTIONS

CIS conceived the review idea. LG conducted the literature search. CBS prepared the first draft of the manuscript. SBS reviewed, edited and revised the manuscript substantially on the key intellectual content. CIS finalized and approved the current version agreed to be accountable for accuracy and integrity and decided to submit the manuscript to Trends in Medical Research.

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