Calcar buttressed screw fixation for femoral neck fracture

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INTRODUCTION

The femoral neck fracture is one of the common fractures in elderly population. It has always been a challenge to manage these fractures due to their higher failure rates. The prevalence of femoral neck fractures has been increasing with increased incidence of osteoporosis, poor vision in elderly, poor neuromuscular coordination, lifestyle changes, sedentary habits, improvement in life expectancy. The incidence is expected to double in next twenty years and triple by 2050.¹,² The treatment goals for these fractures are restoring of functions without morbidity, whereas controversies still exists in management of femoral neck fractures. Treatment complications originate from insufficient reduction, unstable fixation, and poor–quality osteoporotic bone.

Cannulated screws are often used for osteosynthesis of femoral neck fractures. Screw configuration has been investigated in several biomechanical studies.³-⁶

ABSTRACT

Background: The incidence of neck of femur fracture among elderly population is increasing day by day. Femoral neck fracture has always been an unsolved fracture as far as treatment and results are concerned. There are different views regarding the optimal method of internal fixation in femoral neck fractures. Biomechanical data from literature suggest that calcar fixation is superior to central screws placement. This study aims to analyse the functional and radiological outcome of femoral neck fractures treated by calcar buttressed screw fixation described by Filipov as biplane double supported screw fixation.

Methods: This is a prospective study conducted in our institution from May 2015 to May 2018. The study included 43 patients (31 male, 12 female) with femoral neck fracture. 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. Patients were followed up for average period of 2 years. Functional outcome was evaluated using Harris Hip score.

Results: Bone union occurred in 40 patients (93%) with average period of 3-4 months. 51.2% of cases had excellent outcome. 23.2% of cases had good and 16.3% of cases had fair outcome. 9.3% of cases ended with poor outcome. Non union was reported in 3 patients (7%) and AVN in one patient. Various factors like age, Garden and Pauwel fracture types, time of presentation and time of surgery were statistically significant to the final functional outcome in our study.

Conclusions: By providing additional calcar buttress compared to conventional method, this technique of screw fixation enhances femoral neck fracture fixation strength and reduces the fixation failure.

Keywords: Calcar buttressed screw fixation, Femoral neck fracture, Harris hip score, Biplane double supported screw fixation

INTRODUCTION

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Cannulated screws are often used for osteosynthesis of femoral neck fractures. Screw configuration has been investigated in several biomechanical studies.³-⁶
Currently, there is rather a divergence of views and concepts and majority of authors recommend placement of the distal screw supporting the distal femoral neck cortex, which is traditionally called the “calcar”. Central screw placement on the lateral view is advised in some papers, while other authors suggest peripheral placement of screws with secured posterior cortical screw support to withstand anteroposterior bending and torsional forces acting across the hip joint. It is widely accepted that the screws should be placed parallel to each other by many authors. However, the concept of parallel screw placement has not been proven and some authors prefer divergent placement of screws on the lateral view.

The conventional method for femoral neck fracture fixation uses three parallel cannulated screws in inverted triangle pattern, but this does not always provide adequate fixation strength. This is especially true in elderly patients with osteoporotic bone, and poor results might subsequently develop. Moreover the constructs could be occasionally unstable because the screws are inserted pretty close to each other, lacking lateral cortical support at the greater trochanter.

When cannulated screws are used to fix a femoral neck fracture in osteoporotic patients, intraoperative interfragmentary compression alone may not ensure adequate stability during fracture healing because it could soon be lost on fracture impaction. Construct stability can be considerably increased if cannulated screws with better cortical support in the distal fragment are used. Hence the objective of the study is to analyse the functional and radiological outcome of femoral neck fractures treated by calcar buttressed screw fixation which was originally described by Filipov as biplane double supported screw fixation.

METHODS

This prospective study was conducted in Government Royapettah Hospital, for a period of 3 years from May 2015 to May 2018. After institutional ethical committee clearance approval, totally of 43 patients with age more than 18 yrs with femoral neck fracture of all Garden types (1-4) and no other associated fractures were included in the study. Patients with non union changes in the femoral neck fracture, arthritic changes in the hip joint and pathological fractures were excluded from the study.

Operative procedure

Most of the patients were operated on mean period of 3 or 4 days depending on their co morbid condition. All patients were positioned on fracture table. In all patients anatomical or near anatomical reduction (Figure 1) was achieved by lead better technique except in 1 case where open reduction was done.
angle of $135-140^\circ$ and is inclined to anterior-proximal, so that after it touches onto the calcar tangentially, the wire goes into the anterior one-third of the femoral head. Then we placed the proximal guiding wire, with its entry point at 1.5-2 cm proximally from the middle wire and parallel to it (Figure 2). Following reaming, middle and proximal screws were placed first because they are perpendicular to the fracture surface. Finally, the distal screw was placed (Figure 3). Later wound closure was done in layers and followed by sterile dressing.

**Post operative protocol**

Passive knee mobilisation exercises and quadriceps strengthening exercises were advised immediately on first post op day. Non weight bearing was advised for 6 weeks from the day of surgery. Later after 6 weeks active hip mobilisation exercises and partial weight bearing was allowed after reviewing follow up x-rays of the patient. Later full weight bearing allowed after radiological union was confirmed. All patients were followed up regularly every month till 6 months and then every two months. The minimum follow up in our study was 18 months and the maximum follow up was 36 months. During the follow up period, functional outcome were assessed using Harris hip score after radiological union.

**Statistical analysis**

The statistical analysis in our study was performed using SPSS software version 20.0 and the various factors influencing the functional outcome like age of the patient, fracture classification based on Garden and Pauwel, time of presentation, time of surgery were analysed using Pearson Chi-Square analysis. All data were analyzed at a significance level of $p<0.05$.

**RESULTS**

Demographic characteristics, various observations including Pauwel and Garden types, mode of injury, timing of surgery, average surgery duration and blood loss, functional outcome based on Harris hip score are given in Table 1 and 2. On analysing the anteroposterior 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 reported in 40 patients (Figure 4-6). Non union was reported in 3 patients (Figure 7). The average time of union was less than 3 months in 14 patients (32.5%), 3 to 4 months in 20 patients (46.5%), 4 to 5 months in 8 patients (18.7%) and in 1 patient (2.3%) union achieved at 5½ months. Avascular necrosis was seen in one patient at the end of 14 months after fracture union (Figure 8).

**Figure 3:** (A) Intraoperative position of screws, (B) image intensifier picture of screws placement in AP view, (C) lateral view.

**Figure 4:** A case of 51 year old male with Garden type 4 and Pauwel type 3 femoral neck fracture. Fracture united by end of 3rd month with excellent HHS at final follow up. (A) Preoperative AP view, (B) immediate postoperative AP view, (C) final follow up AP view, (D) final follow up lateral view.

**Figure 5:** A case of 65 year old male with Garden type 3 and Pauwel type 2 femoral neck fracture. Fracture united by end of 4th month with excellent HHS at final follow up. (A) Preoperative AP view, (B) immediate postoperative AP view, (C) final follow up AP view, (D) final follow up lateral view.
Table 1: Demographic characteristics.

| Total no. of patients | n=43 (males-31, females-12) |
|-----------------------|-----------------------------|
| Age distribution      |                             |
| <50 years             | 11 patients (25.6%)         |
| 50-60 years           | 21 patients (48.8%)         |
| 61-70 years           | 8 patients (18.6%)          |
| >70 years             | 3 patients (7%)             |
| Garden type           |                             |
| Type 1                | 2 patients (4.6%)           |
| Type 2                | 9 patients (20.9%)          |
| Type 3                | 19 patients (44.3%)         |
| Type 4                | 13 patients (30.2%)         |
| Pauwel type           |                             |
| Type 1                | 10 patients (23.2%)         |
| Type 2                | 22 patients (51.2%)         |
| Type 3                | 11 patients (25.6%)         |
| Type 4                | 20 patients (45.4%)         |
| Anatomical type       |                             |
| Subcapital            | 18 patients (41.9%)         |
| Transcervical         | 23 patients (53.5%)         |
| Basicervical          | 2 patient (4.6%)            |
| Mode of injury        |                             |
| Slip & fall           | 10 patients (23.2%)         |
| RTA                   | 25 patients (58.2%)         |
| FFH                   | 8 patients (18.6%)          |
| Time of presentation  |                             |
| <24 hrs               | 28 patients (65.1%)         |
| 24-72 hrs             | 25 patients (58.2%)         |
| >72 hrs               | 8 patients (18.6%)          |
| Time of surgery       |                             |
| <3 days               | 15 patients (34.9%)         |
| 3-7 days              | 25 patients (58.1%)         |
| >7 days               | 3 patients (7.0%)           |
| Average surgery time  | 60 mins (range: 30-45 mins) |
| Follow up period      | 18 months- 36 months        |

RTA- road traffic accident, FFH- Fall from height

Table 2: Functional outcome in the patients.

| Results   | No. of patients | Percentage (%) |
|-----------|-----------------|----------------|
| Excellent | 22              | 51.2           |
| Good      | 10              | 23.2           |
| Fair      | 7               | 16.3           |
| Poor      | 4               | 9.3            |

Table 3: Comparison of significance of various factors on functional outcome.

| Factors                  | Functional outcome | Total | P value |
|--------------------------|--------------------|-------|---------|
|                          | Excellent + Good   | Fair + Poor |       |         |
| Age (years)              | N (%)              | N (%)              |       | <0.001  |
| <50                      | 9 (81.8)           | 2 (18.2)          | 11    |         |
| 50-60                    | 20 (95.2)          | 1 (4.8)           | 21    |         |
| 61-70                    | 3 (37.5)           | 5 (62.5)          | 8     |         |
| >70                      | 0 (0)              | 3 (100)           | 3     |         |
| Garden type              |                    |                  |       | <0.001  |
| Type 1                   | 2 (100)            | 0 (0)            | 2     |         |
| Type 2                   | 9 (100)            | 0 (0)            | 9     |         |
| Type 3                   | 17 (89.5)          | 2 (10.5)         | 19    |         |
| Type 4                   | 4 (30.8)           | 9 (69.2)         | 13    |         |
| Pauwel type              |                    |                  |       | <0.001  |
| Type 1                   | 10 (100)           | 0 (0)            | 10    |         |
| Type 2                   | 19 (86.4)          | 3 (13.6)         | 22    |         |
| Type 3                   | 3 (27.3)           | 8 (72.7)         | 11    |         |
| Time of presentation (hrs) |                  |                  |       | 0.002   |
| < 24                     | 25 (89.3)          | 3 (10.7)         | 28    |         |
| 24-72                    | 6 (60)             | 4 (40)           | 10    |         |
| >72                      | 1 (20)             | 4 (80)           | 5     |         |
| Time of surgery (days)   |                    |                  |       | 0.007   |
| <3                       | 13 (86.7)          | 2 (13.3)         | 15    |         |
| 3 -7                     | 19 (76)            | 6 (24)           | 25    |         |
| >7                       | 0 (0)              | 3 (100)          | 3     |         |
Figure 6: A case of 53 year old female with Garden type 4 and Pauwel type 3 femoral neck fracture. Fracture united by end of 3rd month with good HHS at final follow up. (A) Preoperative AP view, (B) immediate postoperative AP view, (C) final follow up AP view, (D) final follow up lateral view.

Figure 7: A case of 54 year old female with Garden type 4 and Pauwel type 3 femoral neck fracture, ended in non union at 6 months follow up. Later implant exit followed by cemented hemiarthroplasty was done. (A) Preoperative AP view, (B) immediate postoperative AP view, (C) 6 months follow up with non union, (D) revised with cemented hemiarthroplasty.

Figure 8: A case of 18 year old male with Garden type 4 and Pauwel type 3 femoral neck fracture. Fracture united by end of 3rd month but the patient ended in AVN by 14 months follow up. (A) preoperative AP view, (B) immediate postoperative AP view, (C) 3 months follow up showing fracture union, (D) AVN changes after implant exit.

Various factors like age of the patient, Garden and Pauwel classification of the fracture types, time of presentation, time of surgery significantly affected the final functional outcome in our study (Table 3). 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 such as more than 10 mm displacement, progression to varus angulation, more than 5% change between the axis of the screws, more than 20 mm of posterior translation and femoral head perforation. Based on these criteria, we had 3 cases of fixation failure which later on resulted in non union.

DISCUSSION

Our study is focused on the clinical and radiological outcomes in neck of femur fracture fixation using the calcar buttressed screw fixation method originally described by Orlin Filipov as biplane double supported screw fixation. Orlin Filipov and Boyko Gueorguiev did a biomechanical cadaveric study in 8 fresh frozen and 6 embalmed human femoral pairs in 2014 and proved that this method of fixation is biomechanically stable fixation than conventional method of fixation for femoral neck fractures.

The period defined in the literature for occurrence of bone union after osteosynthesis of femoral neck fractures is usually within 3 months following surgery. Going through the literature regarding the occurrence of complications, we assumed a minimal follow-up period of 12 months as sufficient to demonstrate occurrence of bone union and other associated complications. It is reported that the quality of reduction is the single most important factor within the surgeon’s control influencing the rate of healing. Besides the quality of reduction, a biomechanical stable fixation like BDSF method can prevent or reduce the failure rate.

We understood that the placement of guide wire for the distal screw at steeper angle of 150-160 degree was a tedious task, which can be mastered over time and experience.

In our study, we analysed the following parameters especially: age, fracture type according to Garden and Pauwel, time of presentation, timing of surgery and degree of posterior wall comminution with functional outcome of the patient.

In a study by Stoffel et al, he concluded that among all 207 patients, the Harris hip score was 86.2±18.9 (range 10–100). This score was significantly higher for patients with Garden type III when compared to Garden type IV fractures. In his study, Harris hip score for patients aged below 65 years was similar to the age group 66–70 years, but was significantly higher than all other age groups.

In our study we found that patient in younger age group preferably below 60 yrs had good functional outcome compared to patients above 60 years. With regarding to time of presentation and functional outcome, 28 patients who presented within 24 hrs of injury and operated...
earlier had good functional outcome with average Harris hip score of 89.

Our study shows that patients with Pauwel type 3 (25.6%), and Garden type 4 (30.2%) had low Harris hip score in comparison to other types. Moreover among 6 patients (13.9%) with posterior wall comminution, 4 patient had good functional outcome, while 2 patient had poor functional outcome.

Stoffel et al highlighted that 88.4% were pain free, 83.6% had good mobility, 80.7% of patient were able to put shoes and socks with ease. In our study out of 43 patients, 86% were pain free, 80% had good mobility, 85% of patients were able to trim nails with ease. Three cases of fixation failure were reported in our study, where we found malposition of the screws in one of them and a significant lack of posterior cortical support in two patients which later on resulted in non union and poor functional outcome.

Incidence of non-union in operated patients in Orlin Filipov study was 6 out of 83 patients (7.2%). In our study the incidence of non-union was 3 out of 43 cases (6.9%).

The rate of AVN seems to be similar worldwide and is slightly influenced by the applied fixation method and type of fracture pattern, rating about 9% (range 6–19%) for undisplaced and about 16% (range 9–32%) for displaced fractures. In our follow up period of 3 yrs, we had one patient (2.3%) with AVN after fracture union at 14 months follow up.

All the patients with the time of union of 3 months achieved excellent functional outcome. Other patients with longer union time achieved either good or fair functional outcome.

CONCLUSION

Calcar buttressed screw fixation 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, calcar buttressed screw fixation method ensures reliable stable fixation, early rehabilitation and good functional outcome especially in elderly.

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