International Journal of Research in Orthopaedics
Manoj KKA et al. Int J Res Orthop. 2019 Jan;5(1):145-151
http://www.ijoro.org

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20185337

Calcar buttressed screw fixation for femoral neck fracture

K. K. Arvind Manoj[1], R. Karthik[2]*, A. Vishnu Sankar[3]

Department of Orthopaedic Surgery, [1]Government Sivagangai Medical College, Sivagangai, [2]PSG IMSR, Coimbatore, [3]Government Thiruvannamalai Medical College, Thiruvannamalai, Tamil Nadu, India

Received: 02 October 2018
Revised: 17 November 2018
Accepted: 19 November 2018

***Correspondence:**
Dr. R. Karthik,
E-mail: karthik.dr.r@gmail.com

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

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, life style 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]

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".[7,8] 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.[9] However, the concept of parallel screw placement has not been proven and some authors prefer divergent placement of screws on the lateral view.[10,11]

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.[12-14] 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.[15] 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.

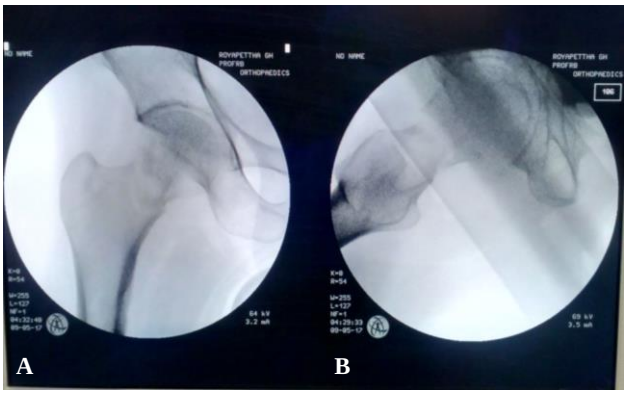

Figure 1: Intraoperative image intensifier picture showing anatomical reduction (A) AP view, (B) lateral view.

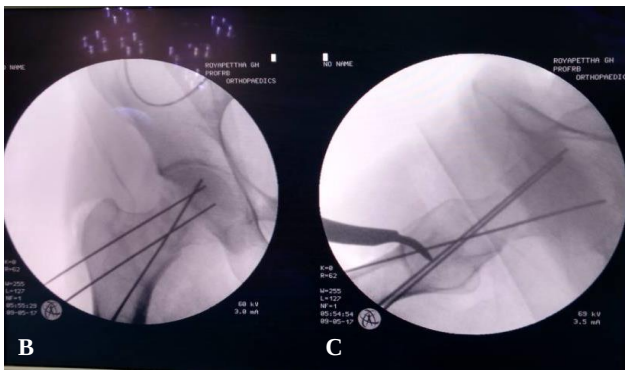

Figure 2: (A) Intraoperative position of guide wires, (B) image intensifier picture of guide wires in AP, (C) lateral view.

A straight lateral incision, starting at the level of lower border of greater trochanter, with distal length of 6 to 10 cm was made. First, the guide wire for the distal cannulated screw was inserted. Its entry point is about 5-7 cm distally from the lower border of the greater trochanter, directed at an angle of 150–165°, with inclination to posterior-proximal. Thus the wire also comes naturally in contact with the posterior neck cortex. The middle guiding wire was placed second with entry point 2 to 4 cm proximally from the distal wire at an

angle of 135-140^0 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.

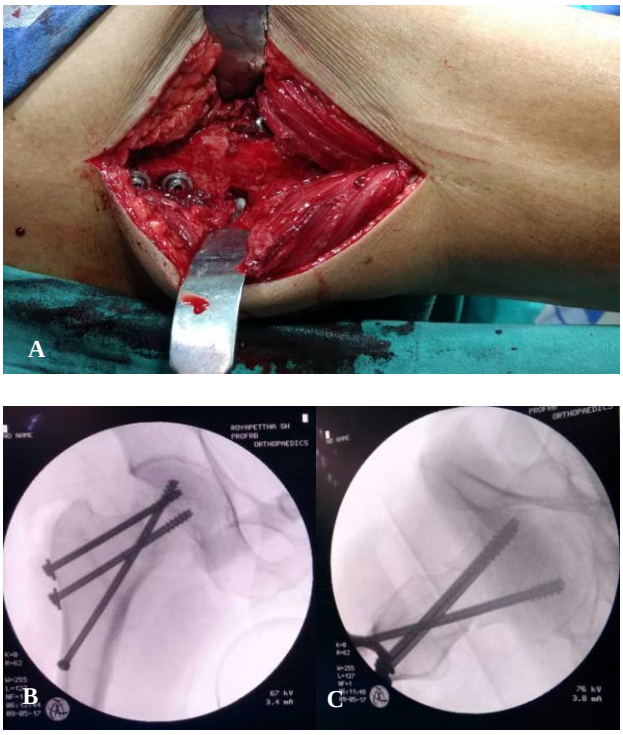

Figure 3: (A) Intraoperative position of screws, (B) image intensifier picture of screws placement in AP view, (C) lateral view.

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).

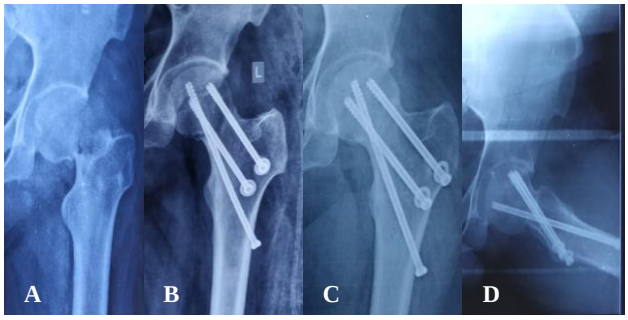

Figure 4: A case of 51 year old male with Garden type 4 and Pauwel type 3 femoral neck fracture. Fracture united by end of 3rd month with excellent HHS at final follow up. (A) Preoperative AP view, (B) immediate postoperative AP view, (C) final follow up AP view, (D) final follow up lateral view.

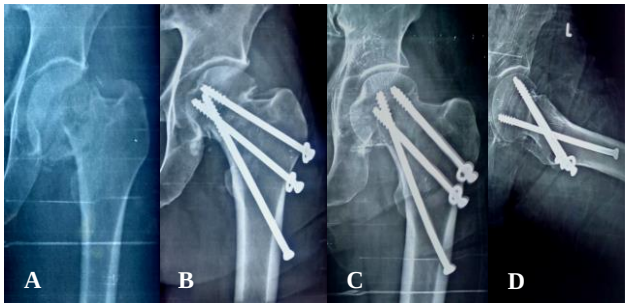

Figure 5: A case of 65 year old male with Garden type 3 and Pauwel type 2 femoral neck fracture. Fracture united by end of 4th month with excellent HHS at final follow up. (A) Preoperative AP view, (B) immediate postoperative AP view, (C) final follow up AP view, (D) final follow up lateral view.

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%)	
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 10 patients (23.3%)	>72 hrs 5 patients (11.6%)	
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		
	N (%)	N (%)		
Age (years)				
<50	9 (81.8)	2 (18.2)	11	<0.001
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				
Type 1	2 (100)	0 (0)	2	<0.001
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				
Type 1	10 (100)	0 (0)	10	<0.001
Type 2	19 (86.4)	3 (13.6)	22	
Type 3	3 (27.3)	8 (72.7)	11	
Time of presentation (hrs)				
< 24	25 (89.3)	3 (10.7)	28	0.002
24-72	6 (60)	4 (40)	10	
>72	1 (20)	4 (80)	5	
Time of surgery (days)				
<3	13 (86.7)	2 (13.3)	15	0.007
3 -7	19 (76)	6 (24)	25	
>7	0 (0)	3 (100)	3	

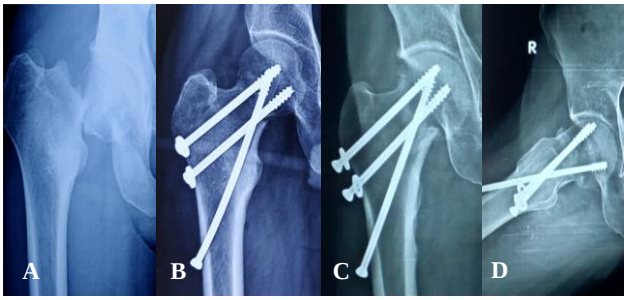

Figure 6: A case of 53 year old female with Garden type 4 and Pauwel type 3 femoral neck fracture. Fracture united by end of 3rd month with good HHS at final follow up. (A) Preoperative AP view, (B) immediate postoperative AP view, (C) final follow up AP view, (D) final follow up lateral view.

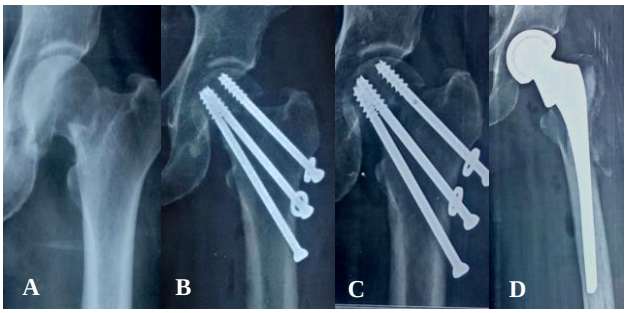

Figure 7: A case of 54 year old female with Garden type 4 and Pauwel type 3 femoral neck fracture, ended in non union at 6 months follow up. Later implant exit followed by cemented hemiarthroplasty was done. (A) Preoperative AP view, (B) immediate postoperative AP view, (C) 6 months follow up with non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

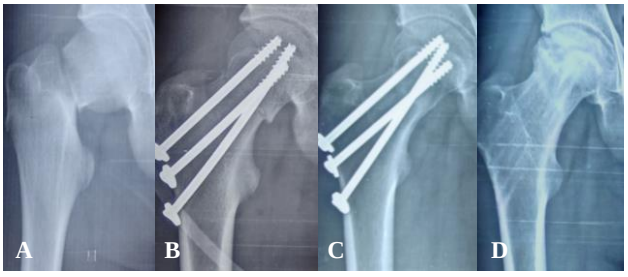

Figure 8: A case of 18 year old male with Garden type 4 and Pauwel type 3 femoral neck fracture. Fracture united by end of 3rd month but the patient ended in AVN by 14 months follow up. (A) preoperative AP view, (B) immediate postoperative AP view, (C) 3 months follow up showing fracture union, (D) AVN 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.[16]

The period defined in the literature for occurrence of bone union after osteosynthesis of femoral neck fractures is usually within 3 months following surgery.[17,18] 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.[19]

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.[19]

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.[19] 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%). [15] 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.[20-22] 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.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Cooper C, Campion G, Melton LJ. Hip fractures in the elderly: a world-wide projection. Osteoporos Int. 1992;2:285-9.
2. Tidermark J, Ponzer S, Svensson O, Soderqvist A, Tornkvist H. Internal fixation compared with total hip replacement for displaced femoral neck fractures in the elderly. A randomised, controlled trial. J Bone Joint Surg Br. 2003;85:380-8
3. Walker E, Mukherjee DP, Ogden AL, Sadasivan KK, Albright JA. A biomechanical study of simulated femoral neck fracture fixation by cannulated screws: Effects of placement angle and numbers of screws. Am J Orthop. 2007;36:680-4.
4. Tan V, Wong KL, Born CT, Harten R, DeLong WG Jr. Two-screw femoral neck fracture fixation: A biomechanical analysis of 2 different configurations. Am J Orthop. 2007;36:481-5.
5. Zdero R, Keast-Butler O, Schemitsch EH. A biomechanical comparison of two triple-screw methods for femoral neck fracture fixation in a synthetic bone model. J Trauma. 2010; 69:1537-44.
6. Booth KC, Donaldson TK, Dai QG. Femoral neck fracture fixation: A biomechanical study of two cannulated screw placement techniques. Orthopedics. 1999;22:477.
7. Lindequist S, Tornkvist H. Quality of reduction and cortical screw support in femoral neck fractures. An analysis of 72 fractures with a new computerized measuring method. J Orthop Trauma. 1995;9:215–21.
8. Bout CA, Cannegieter DM, Juttmann JW. Percutaneous cannulated screw fixation of femoral neck fractures: the three point principle. Injury. 1997;28:135–9.
9. Selvan VT, Oakley MJ, Rangan A, Al-Lami MK. Optimum configuration of cannulated hip screws for the fixation of intracapsular hip fractures: a biomechanical study. Injury. 2004;35:136–41.
10. Garden R. Low angle fixation in fractures of the femoral neck. J Bone Joint Surg Br. 1961;43:647–63.
11. Christie J, Howie CR, Armour PC. Fixation of displaced subcapital femoral fractures. Compression screw fixation versus double divergent pins. J Bone Joint Surg Br. 1988;70:199–201.
12. Asnis SE, Wanek-Sgaglione L. Intracapsular fractures of the femoral neck. Results of cannulated screw fixation. J Bone Joint Surg Am. 1994;76(12):1793-803.
13. Lu-Yao GL, Keller RB, Littenberg B, Wennberg JE. Outcomes after displaced fractures of the femoral neck. A meta-analysis of one hundred and six published reports. J Bone Joint Surg Am. 1994;76(1):15-25.
14. Tidermark J, Ponzer S, Svensson O, Söderqvist A, Törnkvist H. Internal fixation compared with total hip replacement for displaced femoral neck fractures in the elderly. J Bone Joint Surg Br. 2003;85-B(3):380-8.
15. Filipov O. Biplane double supported screw fixation (F-technique): a method of screw fixation at osteoporotic fractures of the femoral neck. Eur J Orthop Surg Traumatol. 2011;21(7):539-43.

16. Filipov O, Gueorguiev B. Unique stability of femoral neck fractures treated with the novel biplane double-supported screw fixation method: a biomechanical cadaver study. Injury. 2015;46(2):218–26.
17. Husby T, Alho A, Nordsletten L, Bugge W. Early loss of fixation of femoral neck fractures. Comparison of three devices in 244 cases. Acta Orthop Scand. 1989;60(1):69–72.
18. Rehnberg L, Olerud C. Fixation of femoral neck fractures. Comparison of the Uppsala and von Bahr screws. Acta Orthop Scand. 1989;60(5):579–84.
19. Filipov O, Stoffel K, Gueorguiev B, Sommer C. Femoral neck fracture osteosynthesis by the biplane double-supported screw fixation method (BDSF) reduces the risk of fixation failure: clinical outcomes in 207 patients. Arch Orthop Trauma Surg. 2017;137(6):779-88.
20. Damany DS, Parker MJ, Chojnowski A. Complications after intracapsular hip fractures in young adults. A metaanalysis of 18 published studies involving 564 fractures. Injury. 2005;36(1):131–41.
21. Loizou CL, Parker MJ. Avascular necrosis after internal fixation of intracapsular hip fractures; a study of the outcome for 1023 patients. Injury. 2009;40(11):1143–6.
22. Nikolopoulos KE, Papadakis SA, Kateros KT, Themistocleous GS, Vlamis JA, Papagelopoulos PJ, et al. Long-term outcome of patients with avascular necrosis, after internal fixation of femoral neck fractures. Injury. 2003;34(7):525–8.

Cite this article as: Manoj KKA, Karthik R, Sankar AV. Calcar buttressed screw fixation for femoral neck fracture. Int J Res Orthop 2019;5:145-51.