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A Retrospective Study of Role of Calcar Femorale In Unstable Intertrochanteric Fractures

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Original Research Article

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Abstract: The sliding screw-plate devices and cephalo-medullary nail devices have performed sound in stable inter-trochanteric fractures in patients with sensibly good quality of bone. However, their suboptimal performance in comminuted fractures in the presence of osteoporotic bone has prompted many surgeons to consider bipolar hemiarthroplasty as the primary modality of management of comminuted inter-trochanteric fractures in elderly patients. However, long term stability of the hemiarthroplasty implant also may be compromised due to the presence of postero-medial bone loss at the area of the calcar. Materials and Methods: We have presented a straightforward and effectual technique of calcar grafting by harvesting cortical bone strut from the neck of the fractured femur. A total of 35 patients with inter-trochanteric fractures of the femur were treated with calcar grafting. The mean age was 79.2 years. The graft was harvested from the calcar region of the head and neck fragment of the femur and wedged between the medial femoral cortex and medial edge of the prosthesis. The mean followup period was 12 months. In 32out of 35 patients in our series, the calcar graft healed well without dislodgement. There was graft resorption in two patients associated with subsidence of the implant and loosening. Calcar grafting using this technique provides stability to the implant in the presence of comminution and incorporates well in the majority of patients. Donor site morbidity of graft harvesting is also avoided.
Keywords: Unstable I/T fracture, Calcar femorale, Bony Calcar Graft, Hemiarthroplasty, Transtrochanteric approach, Harris hip score

INTRODUCTION

In elderly patients, although spine fracture is the most common fracture associated with osteoporosis, but hip fracture are the most universal cause of morbidity and mortality in elderly patients [1]. Almost ninety percent intertrochanteric fractures are due to a simple fall in elderly patients [2]. The incidence of all hip fractures is almost 80 in 1,00,000 persons of which intertrochanteric fractures are 45% of overall hip fractures[3]. The tendency to fall increases with patient age and is exacerbated by quite a few factors including poor vision, decreased muscle power, blood pressure variation, delayed reflexes, muscle incoordination and other musculoskeletal problems [4]. Most intertrochanteric fractures in elderly patients of age more than 65 years have reported mortality rates ranging from 15 to 30% [5]. Evans made a classification of intertrochanteric fractures on the foundation of the posteromedial cortex continuity and divides these fractures into stable and unstable types and determining the course of treatment[6]. Stability of intertrochanteric fractures depends on the preservation of the posteromedial cortical buttress[7]. Studies have exposed that bipolar hemiarthroplasty with early mobilisation in unstable intertrochanteric fractures in elderly have given good results[8-11]. They are also associated with sooner rehabilitation and former weight bearing[12]. Before 1930, handling of intertrochanteric fracture was mainly conventional, i.e. Russell's traction, skeletal traction, counterpoised suspension and well leg traction. The introduction of triflanged Smith-Petersen nail in year 1931 for fracture neck femur resulted in great enhancement in union process and decreased mortality.

Johanssen in 1932 and West Cott in 1934 introduced a cannulated nail for hip. This had more accurate placement in the femoral head than the older nails. Austin T. Moore in 1934 treated intertrochanteric fractures with open reduction and internal fixation. Lawson Thornton in 1937 developed a plate that could be attached to the Smith-Petersen nail, which was

known as the Thornton plate. This plate was a advance invention in operative management of intertrochanteric fracture. Merwyn Evans in 1949 devised a method for classification of intertrochanteric fractures based on the permanence of posteromedial cortex into stable and unstable type. Evans had also suggested that internal fixation of intertrochanteric fracture has better chances of early mobilisation and causes reduced morbidity[4].

The management options ranges from conservative managements to osteosynthesis by intramedullary and extramedullary implants. Replacement arthroplasty is also a good management option for treatment of intertrochanteric fracture. Despite of so many treatment options, the GOLD STANDARD or the most apt treatment for these fractures is controversial and there is no clear-cut best treatment method, specially for unstable intertrochanteric fractures[3].

The main goal of treatment is stable fixation with early rehabilitation. Stable intertrochanteric fractures can be treated by osteosynthetic methods and these give reasonable results. But the same result cannot be achieved in unstable intertrochanteric fractures when treated with osteosynthetic methods. Cut during of the screw, collapse and loss of fixation are common complications with conventional osteosynthesis.

An important issue while doing arthroplasty of hip in cases of intertrochanteric fractures is the verdict to reconstruct the area of the calcarfemorale, which is mostly broken in cases of unstable intertrochanteric fractures[13]. This reconstruction is important for stability of the implant and helps in maintaining the length of the operated limb[14].

This study will assess the functional outcome of cemented bipolar prosthesis with calcar reconstruction using the same femur head in unstable intertrochanteric fractures in elderly patients. The literature regarding this is sparse, especially with stress on the trochanteric and calcar reform

The incidence of inter-trochanteric fractures of the femur is very high in the elderly population[1]. The world-wide evaluation of hip fractures was around 1.66 million in 1990, and the number is anticipated to rise to 6.26 million in 2050[2]. There are no established figures for incidence of hip fractures in India but the number is sure to rise with increasing life-expectancy and wide-spread osteoporosis. In the Indian subcontinent, one out of eight males and one out of three females are at hazard of osteoporosis and osteoporotic hip fractures be likely tooccur 10-20 years past than in the westerncountries[3].

For stable fracture with good quality of bone, both sliding screw plate devices and cephalomedullary devices have been shown to be associated with good results[4-8]. However, in unstable, comminuted fractures in osteoporotic bones, shortening, external rotation deformity, implant cut-out, and re-operation are common occurrences with sliding nail plate devices[9-14]. Intramedullary nailing is currently desired for these fractures, but the current versions of intramedullary devices are also associated with technical and mechanical complications like cut-out of screws from the head and fracture of the shaft of the femur at the site of distal screw[15-17]. These devices seem to be still under evolution with a series of modifications [18,19]. Prosthetic replacement using cemented implant is another possible alternative in the management of unstable, osteoporotic fractures, and it allows early mobilization[14,20-25].

The medial calcar support is scarce in inter trochanteric fractures. This necessitates the use of a prosthesis with long neck and shaft length or calcar bearing prosthesis (which may not be readily available off the shelf and are expensive). The other option is to fill the void around the area of the calcar with bone cement. The latter is an inferior option, as cement has poor tolerance to bending and shear forces. Further problems of prosthetic replacement include achieving limb length equalization and upholding adequate soft tissue tension in abductors to prevent dislocation. Loss of bone stock in the proximal femur due to the use of metallic prosthesis or bone cement is a disadvantage at the time of revision procedure (if required later).

To overcome these problems, the senior author has devised a simple method of using bone from the head and neck portion of the femur as a graft. This graft fills the commonly occurring postero-medial void; prevents placement of the prosthesis in varus and retroversion and serves as a guide to limb length equalization. The aim of this study is to analyze the outcome of this novel technique in the management of comminuted, unstable inter-trochanteric fractures in elderly.

MATERIAL AND METHODS

This was a retrospective study of 35 patients with inter-trochanteric fractures treated with this technique between 2014and 2016. Out of a total of 48 patients who weresucceeded with this technique, 10 patients had expired, and 3 patients were lost to followup. Thus, 35 patients were available for followup. We used Singh's index[26]. The inclusion criteria were AO fracture types 2.2 and A2.3 and severe osteoporosis (Singh's index <3) [Figure 1]. Exclusion criteria included patients who were non ambulatory before the fracture, patients with pathological fractures, patients with previous contralateral hip fractures, patients unfit

for anesthesia, patients with stable fractures and integral lesser trochanter. There were 29 females and 5 males. The age group ranged from 63 years to 95 years with a mean age of 79.2 years. The medical co-morbidities were diabetes mellitus, hypertension, ischemic heart disease and degenerative brain disorders. At least one of these was existent in 31 out of 35 patients.

All patients were operated within 24 hours of presentation to the hospital. Bipolar prosthesis was used in 33 patients and cemented Austin–Moore prosthesis was used in two patient. Out of 33 patients in whom a bipolar prosthesis was used, modular bipolar prosthesis (Exeter Stem and Bipolar Cup, Stryker ®, Michigan, USA) was used in 16 patients while a fixed bipolar prosthesis (INOR ®, Mumbai, India) was used in the enduring 17 patients. All the femoral stems were cemented. All the stems were of standard length and were non calcar replacement type of implant. None of the patients required blood transfusion. Cefoperazone/sulbactam amalgamation was used for antibiotic prophylaxis in the dose of 1 g 8 hourly for a total of 3 doses, the first dose overseen at the time of induction of anesthesia.

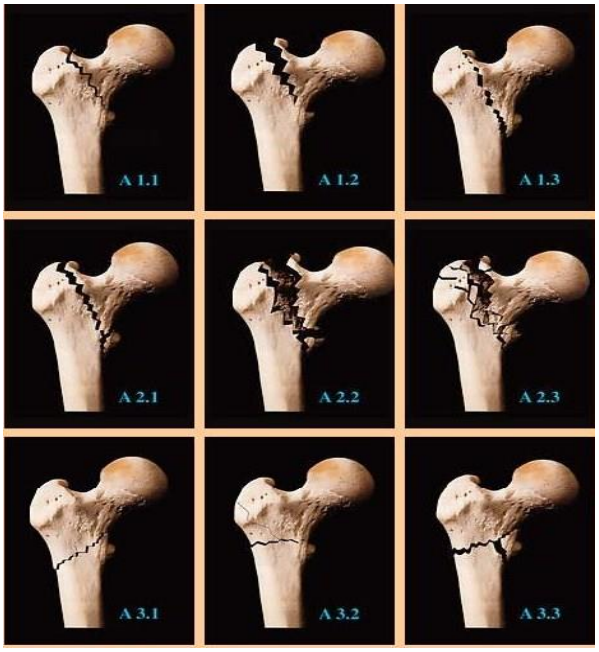


Fig-1: AO Classification

OPERATING TECHNIQUE

All the procedures were achieved under spinal anesthesia.Transtrochanteric approach was used with the patient in the lateral decubitus position. The greater trochanteric break was identified, and the trochanteric pieces were detached to reach the head neck fragment. Going through the trochanter is useful in retaining the attachment of abductors and short rotators. All the capsular attachments to the proximal head and neck section were meticulously released. The ligamentumteres was resected with sharp scissors. The femoral head was extracted, and the head size was stately using templates.

Graft with a length of 2-2.5 cm and width of 1.5 cm was harvested from the calcar region of the proximal fragment [Figure 3]. The proximal limit of the graft was the junction of calcar portion of the neck with the head [Figure 4]. Oscillating saw was used to make the cuts through the strong calcar bone to avoid splintering.

The femoral canal was prepared in the standard fashion. Since the greater and lesser trochanters were no longer attached to the femoral shaft, the correct anteversion was judged in relation to inter-epicondylar line of the distal femur (with knee flexed to 90°). If the lesser trochanter was separated from the proximal femur, it was brought back into its anatomical position and held with a cerclage wire around the femoral shaft. The graft was then trimmed if necessary and was inserted in the void, so that 50% of its length was in the medullary canal, and 50% was outside [Figure 5]. The broach or the trial prosthesis was now inserted to judge the fit of the graft. The graft was firmly wedged between the medial femoral cortex and medial edge of the prosthesis and thus was auto-stabilized [Figure 6]. The varus bending movement of the prosthesis pushes the upper edge of the graft towards the medial femoral cortex; this causes the lower edge of the graft to push against the medial edge of the prosthesis [Figure 7]. In this way, opposing forces stabilize the graft obviating the need for any further fixation In 31 out of 34 patients, the trochanteric pieces were sutured together

by 18 g stainless steel wire (wiring of trochanter was planned in such a way that the trochanter was reattached to the shaft, hence appropriate holes were made in the shaft and wires passed before cementing). In some cases, we used vertical loop of Charnley technique to reattach greater trochanter to the shaft. In 3 patients, No 5 Ethibond ® suture was used for reattaching the fragments.

The medullary canal was washed using pulsed lavage. Second-generation cementing technique was used in all our patients. Cement restrictor was inserted till the appropriate depth, and the canal was packed with dry roller gauze pack. The cement was inserted using a cement gun and the area that was to receive a bone graft was cleaned off cement with a curette. The prosthesis was inserted and any cement that came into the area of the graft insertion was cleared once again. Time was allowed for the cement to reach doughy consistency. The graft was inserted at this stage such that half of its length was inside the canal, and half was out. This would be akin to the calcar cut at the proposed level while doing a hip replacement. The prosthesis was finally impacted in to the femoral canal maintaining the necessary ante-version, till the mark on the prosthesis was at the level of the proximal edge of the graft, and if a collared prosthesis was being used, till the collar made contact with the superior edge of the graft. This automatically ensured correct leg length in majority of cases. The joint was reduced after the cement had hardened. Two horizontal wire loops were tied to close the gap in the greater trochanter, and vertical loop was tied to bring the trochanter back to the shaft. The wound was closed in layers.

Sequential calf compression device was used postoperatively for 48 hours, to reduce the incidence of deep vein thrombosis. The patients were mobilized on the next day, allowing weight bearing mobilization with the aid of a walker. The use of walker and hip abduction pillow was continued until the abductor power was at least grade IV. Suture removal was done on the tenth postoperative day. Patients were re-examined at 1-month, 3 months, 6 months and 1-year intervals. Thereafter patients were examined on a yearly followup basis. At each followup visit, patients were examined clinically; Harris hip score was calculated, and the patients were graded (< 70 - poor, 70-79 - fair, 80-89 - good and 90-100 - excellent)[27]. Antero-posterior and lateral radiographs were obtained. The Criteria described by Gingras *et al*. were used for assessment of radiographic loosening of the implants[28].

Fig-3: Bone graft taken from neck of femur for calcar replacement

Fig-4: Calcar graft

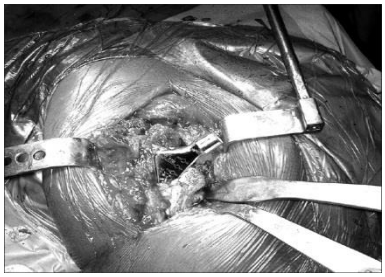


Fig-5: Peroperative photograph showing trial bipolar stem is being inserted with the calcar graft *in situ*

Fig-6: Model bone showing the extent of graft insertion

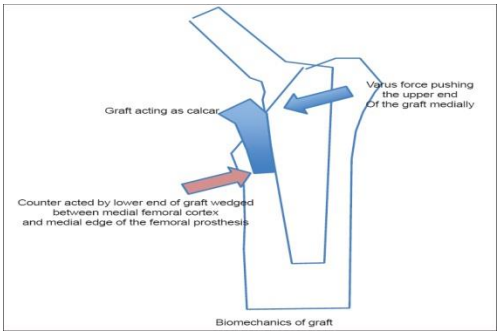


Fig-7: Schematic diagram showing graft is wedged between the medial femoral cortex and the medial edge of the prosthesis. Vaurs force (blue arroof the graft medially, this is counter acted by the lower end of the graft and medial edge of the prosthesis (pink arrow)

Postoperative Care

Postoperatively, all patients were given same antibiotics cover as prophylaxis. All patients were given anticoagulation therapy with low-molecular-weight heparin and support stockings. Intravenous third-generation cephalosporin antibiotics were started on the day of surgery and the first dose was given one hour prior to surgery. Intravenous antibiotics were given till the third postoperative day. Postoperatively, the limb was kept in abduction using an abduction bar. Blood transfusions were given wherever required. Drains were removed after 48 hours of surgery and postoperative check X-rays were done. Patients were encouraged to sit and stand out of their bed twice daily from the first postoperative day and range of motion exercises started from the next day of surgery. Partial weight bearing was allowed from 2nd post-operative day onwards and the patient was mobilised with a walker. Stitches were removed on the 14th day of the surgery. The time required for each patient to start full weight bearing and also to reach their preoperative condition were recorded in terms of number of days. The functional outcome of surgery was assessed with Harris Hip Score postoperatively.

RESULTS

Out of 35 patients, 28 patients were walking independently before trauma, and six patients were

walking with a cane. The mean followup time was 54.5 months (range 12-84 months). The mean operative time was 55 min (range 42-71 min). The mean intraoperative blood loss was 206 ml (range 100-400 ml). Complications included implant subsidence in two patients (one patient required revision with long stem uncemented total hip replacement [THR] 48 months following the index procedure), nonunion of the greater trochanter in one patient, limb shortening of 1 cm in one patient and superficial decubitus ulcer in one patient that healed with non operative care.

The mean Harris hip score at 6 months was 84.96. Out of 35 patients, the outcome of 13 patients was graded as excellent, 13 as good, 7 as fair and 2 as poor as per Harris hip score. Twenty six patients were walking independently, and the remaining 6 had to use a cane. There were no dislocations, heterotopic ossifications, peri-prosthetic fractures orprotrusioacetabuli.

It was seen that in 32 patients, the bone consolidated over a period without dislodgement . In two patients in whom there was subsidence of the implant, the graft was found to have been resorbed.

Fig-8: Case-1: Pre-operative Xray showing unstable I/T fracture left

Fig-9: Case-2:Pre-operative Xray showing unstable intertrochantreric fracture on left side

Fig-10: Post-operative Xray showing cemented monopolar hemiarthroplasty with TBW of greater trochanter

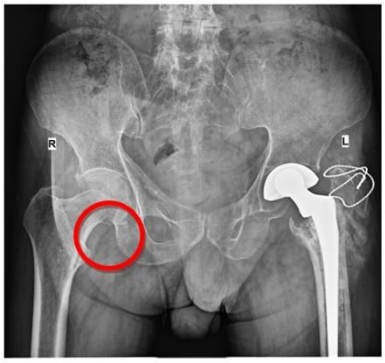
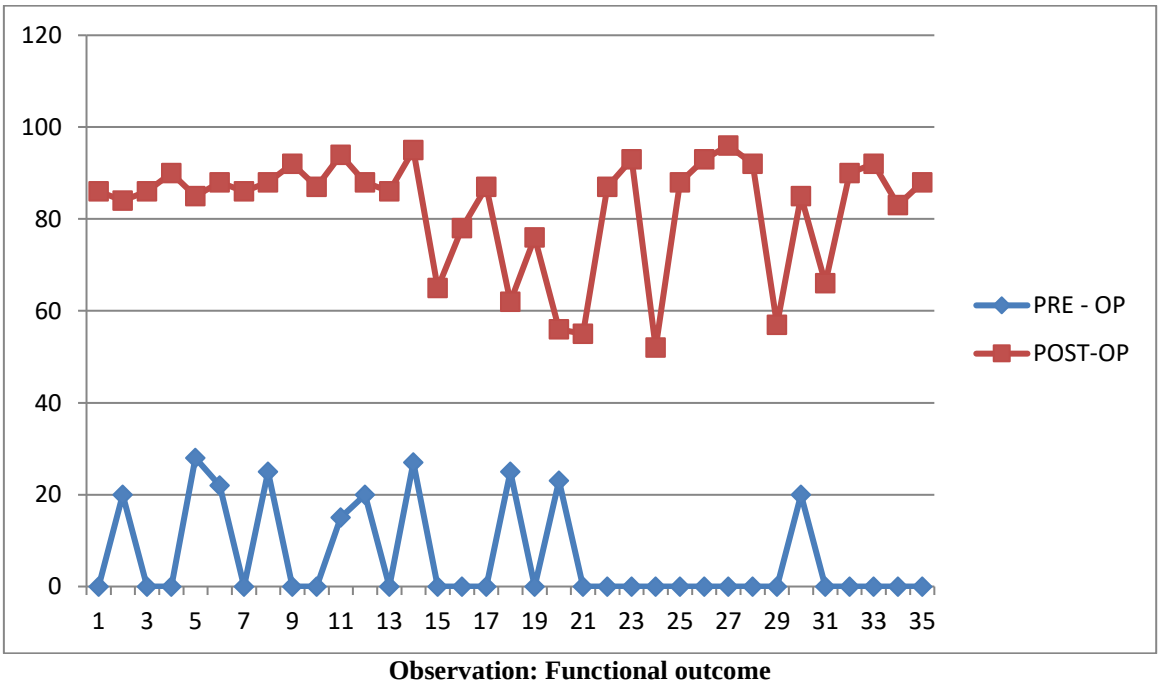
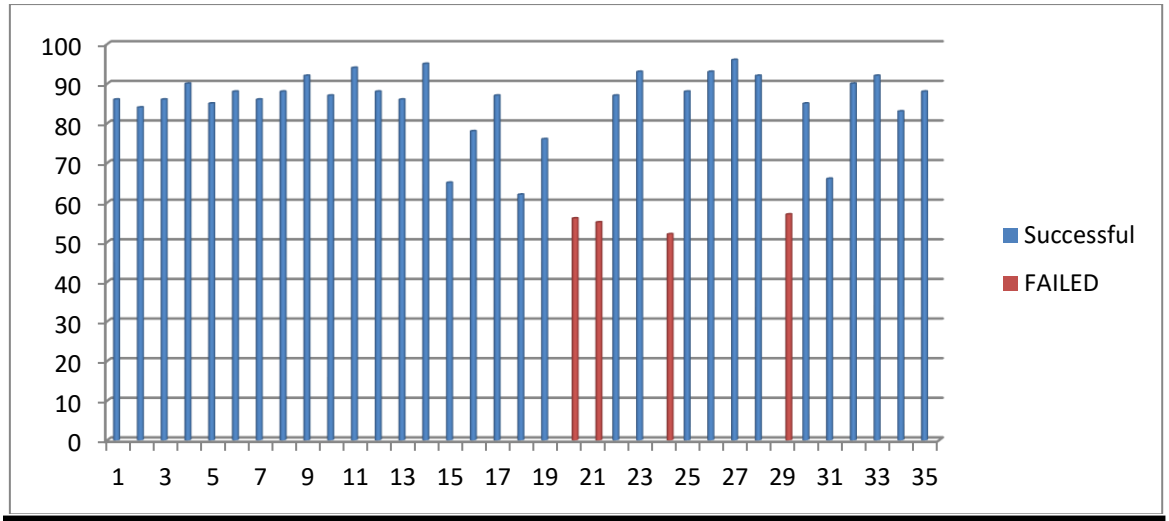


Fig-11: Post-operative Xray showing Cemented bipolar prosthesis done with TBW of greater trochanter,encircled area shows calcar graft placement



Observation: Functional outcome



STUDY BY	NUMBER OF CASES	EXCELLENT	GOOD	FAIR	POOR	FAILED
Green et al.,	20	3	7	2	4	4
Haentjens et al.,	37	7	11	7	5	3
Chan et al.	54	9	8	-	-	12
Our study	35	8	18	2	3	4

Successful and failed cases

DISCUSSION

Unlike in fracture of the neck of femur, prosthetic replacement is still not considered as the gold standard of treatment for unstable inter-trochanteric fractures. Inter-trochanteric fractures have traditionally been treated with internal fixation using dynamic hip screw (DHS) or cephalo-medullary nailing devices. Union rates of close to 100% have been achieved in stable, well-fixed fractures in patients with good quality of bone. However, problems arise in unstable osteoporotic fractures, where a high incidence of complications has been observed. Sinno *et al*. reported 26% unsatisfactory results with DHS due to bio-mechanical failure[14]. Shortening of limb is another common problem with DHS fixation in unstable inter-trochanteric fractures[10,11]. Wolfgang *et al*. reported a complication rate of 38.6% during fixation of the inter-trochanteric fractures with sliding hip screws[9]. Studies with proximal femoral nail (PFN) in unstable inter-trochanteric fractures have shown a high incidence of complications. According to a study by Tyllianakis *et al*., technical and mechanical complications were noted in 41.3% during operation and 30.4% during followup[16]. Overall re-operation rate was 28.8%. Only 30% of the patients recovered to the previous level of functional scores. After analyzing the cases of lateral and intra articular protrusion of screws, they suggested a possible explanation that screws were jammed or their sliding through PFN did not proportionately follow the fracture subsidence or impaction and PFN implant acted as a fixed device. Studies of the recent trochanteric femoral nail also show a high rate of complications and require a precise surgical technique. The study by Crawford *et al*. reported 11% re-operation rate because of screw cut-out or fracture at the distal tip of the nail[15].

Earlier authors have reported that prosthetic replacement for inter-trochanteric fractures is a technically difficult procedure associated with considerable blood loss[21,25]. However, in our experience the morbidity as well as transfusion requirements were low. Hemiarthroplasty with a standard bipolar implant is a reasonable alternative to open reduction and internal fixation. Arthroplasty has the advantage of early weight bearing and avoids potential fixation failure and need for subsequent revisions[22]. Since there is posterior-medial defect, the use of long stem prosthesis and calcar replacement stem has been reported in the literature[16]. These implants are not readily available everywhere and are expensive. Calcar replacement or head and neck replacement prostheses require removal of a large amount of bone from the proximal femur[22]. Use of long stem calcar replacement prosthesis has been shown to be associated with higher cost, longer surgical time, higher blood loss and increased mortality rate in comparison with internal fixation using PFN[23]. The advantages of building posteromedial defect with strut graft include - near normal limb length; prevention of varus tilt/collapse of stem; preservation of the normal host bone, which may be useful in revision surgery. Since it permits the use of standard endoprosthesis, it is less expensive than calcar replacement long stem prosthesis and entails less bone resection from the proximal femur. We used standard endoprosthesis in all our patients and implant

subsidence was not a major problem in our series due to the presence of the intramedullary calcar graft.

There is a concern that the non vascularizedcalcar graft may undergo resorption with time. But our experience shows that the graft consolidates well without resorption in the majority of patients. Haentjens *et al*. showed that callus formation occurs following prosthetic replacement of the proximal femur and the callus occurs mainly in the posteromedial aspect of the proximal femur. Comminuted bone fragments united with the femoral shaft even in the absence of fixation due to this callus formation[24]. The same callus can be expected to stabilize the calcar graft also when it binds to the extra medullary portion of the graft.

Calcar grafting may be useful in these situations. Complications in our series of patients included implant subsidence in two patients (one patient required revision with long stem uncemented THR), nonunion of the greater trochanter in one patient, limb shortening of 1 cm in one patient and superficial decubitus ulcer in one patient that healed with non operative care. The rate of complications in our series compares favorably with those of other authors. In conclusion, it can be said that that prosthetic replacement is a suitable alternative to fixation in elderly individuals because it provides early full weight bearing and rapid rehabilitation[21,22]. Considering our experience and review of the literature, replacement arthroplasty may be considered as a primary option in selected patients for comminuted unstable inter-trochanteric fractures. Calcar grafting as described here is useful in minimizing the subsidence of the implant and in maintaining the limb length.

REFERENCES

1. 1.Koval KJ, Zuckerman JD. Hip fractures are an increasingly important public health problem. Clin Orthop Relat Res 1998;348:2.
2. 2.Marsh JL, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA. Fracture and dislocation classification compendium – 2007: Orthopaedic Trauma Association classification, database and outcomes committee. J Orthop Trauma 2007;21:S1-133.
3. Blomfeldt R, To¨rnkvist H, Ponzer S, So¨derqvist A, Tidermark J. Comparison of internal fixation with total hip replacement for displaced femoral neck fractures: randomized, controlled trial performed at four years. J Bone Joint Surg Am 2005; 87:1680–88.
4. Geiger F, Schreiner K, Schneider S, Pauschert R, Thomsen M. Proximal fracture of the femur in elderly patients. The influence of surgical care and patient characteristics on post-operative mortality. Orthopade 2006; 35:651–58.
5. Larsson S. Treatment of osteoporotic fractures. Scand J Surg 2002;91:140-6.
6. Kenzora JE, McCarthy RE, Lowell JD, Sledge CB. Hip fracture mortality. Relation to age, treatment, preoperative illness, time of surgery, and complications. Clin Orthop Relat Res. 1984;186:45-56.
7. Baumgaertner MR, Curtin SL, Lindskog DM. Intramedullary versus extramedullary fixation for the treatment of intertrochanteric hip fractures. Clin Orthop Relat Res 1998;348:87-94.
8. Jensen JS, Tondevold E, Mossing N. Unstable trochanteric fractures treated with the sliding screw-plate system: A biomechanical study of unstable trochanteric fractures. III, Acta Orthop Scand. 1978;49:392.
9. Suriyajakyuthana W. Intertrochanteric fractures of the femur: results of treatment with 95 degrees Condylar Blade Plate. J Med Assoc Thai. 2004;87:1431–8.
10. Bridle SH, Patel AD, Bircher M, Calvert PT. Fixation of intertrochanteric fractures of the femur. A randomised prospective comparision of the gamma nail and the dynamic hip screw. J Bone Joint Surg Br 1991;73:330–4.
11. Guyton JL. Intertrochanteric femoral fractures. In: Canale ST, editor. Campbell's Operative Orthopaedics. Vol III, 9th ed. Missouri: Mosby; 1998:2182–99.
12. Esser MP, Kassab JY, Jones DH. Trochanteric fractures of the femur. A randomised prospective trial comparing the Jewett nail-plate with the dynamic hip screw. J Bone Joint Surg Br 1986;68:557–60.
13. Andress HJ, Kahl S, Kranz C, Gierer P, Schurmann M, Lob G. Clinical and finite element analysis of a modular femoral prosthesis consisting of a head and stem component in the treatment of pertrochanteric fractures. J Orthop Trauma 2000;14:546–53.
14. Leung KS, So WS, Shen WY, Hui PW. Gamma nails and dynamic hip screws for peritrochanteric fractures. A randomised prospective study in elderly patients. J Bone Joint Surg Br 1992;74:345–51.
15. Kosygan KP, Mohan R, Newman RJ. The Gotfried percutaneous compression plate compared with the conventional classic hip screw for the fixation of intertrochanteric fractures of the hip. J Bone Joint Surg Br 2002;84:19–22.
16. Green S, Moore T, Proano F. Bipolar prosthetic replacement for the management of unstable intertrochanteric hip fractures in the

elderly. Clin Orthop Relat Res 1987;224:169–77.
17. Haentjens P, Casteleyn PP, De Boeck H, Handelberg F, Opdecam P. Treatment of unstable intertrochanteric and subtrochanteric fractures in elderly patients. Primary bipolar arthroplasty compared with internal fixation. J Bone Joint Surg Am 1989;71:1214–25.
18. Stern MB, Angerman A. Comminuted intertrochanteric fractures treated with a Leinbach prosthesis. Clin Orthop Relat Res 1987;218:75–80.
19. Ganz R. Fractures of the trochanteric region. In: Muller ME, Allgower M, Schneider R, Willeneger H, editors. Manual of internal fixation. Berlin: Springer Verlag; 1991:528.
20. Bohm P, Bischel O. Femoral revision with the Wagner SL revision stem: evaluation of one hundred and twenty-nine revisions followed for a mean of 4.8 years. J Bone Joint Surg Am 2001;83:1023–31.
21. Ko PS, Lam JJ, Tio MK, Lee OB, Ip FK. Distal fixation with Wagner revision stem in treating Vancouver type B2 periprosthetic femur fractures in geriatric patients. J Arthroplasty 2003;18:446–52.
22. Wagner H, Wagner M. Cone prosthesis for the hip joint. Arch Orthop Trauma Surg 2000;120:88–95.
23. d'Aubigne RM, Postel M. Functional results of hip arthroplasty with acrylic prosthesis. J Bone Joint Surg Am 1954;36:451– 75.
24. Chang WS, Zuckerman JD, Kummer FJ, Frankel VH. Biomechanical evaluation of anatomic reduction versus medial displacement osteotomy in unstable intertrochanteric fractures. Clin Orthop Relat Res 1987;225:141–6.
25. Desjardins AL, Roy A, Paiement G, Newman N, Pedlow F, Desloges D. Unstable intertrochanteric fracture of the femur. A prospective randomised study comparing anatomical reduction and medial displacement osteotomy. J Bone Joint Surg Br 1993;75:445–7.
26. Davis TR, Sher JL, Horsman A, Simpson M, Porter BB, Checketts RG. Intertrochanteric femoral fractures. Mechanical failure after internal fixation. J Bone Joint Surg Br 1990;72:26–31.
27. Gundle R, Gargan MF, Simpson AH. How to minimize failures of fixation of unstable intertrochanteric fractures. Injury 1995;26:611–4.
28. Rosenfeld RT, Schwartz DR, Alter AH. Prosthetic replacement for trochanteric fractures of the femur. J Bone Joint Surg Am 1973;55:420.
29. Weber M, Hempfing A, Orler R, Ganz R. Femoral revision using the Wagner stem: results at 2-9 years. Int Orthop 2002;26:36–9.
30. Stappaerts KH, Deldycke J, Broos PL, Staes FF, Rommens PM, Claes P. Treatment of unstable peritrochanteric fractures in elderly patients with a compression hip screw or with the Vandeputte (VDP) endoprosthesis: a prospective randomized study. J Orthop Trauma 1995;9:292–7.
31. Koval KJ, Zuckerman JD. Hip fractures are an increasingly important public health problem. Clin Orthop Relat Res 1998;348:2.
32. Lewinnek GE, Kelsey J, White AA 3rd, Kreiger NJ. The significance and a comparative analysis of the epidemiology of hip fractures. Clin Orthop Relat Res 1980;(152):35-43.
33. Sernbo I, Johnell O, Gentz CF, Nilsson JA. Unstable intertrochanteric fractures of the hip. Treatment with ender pins compared with a compression hip-screw. J Bone Joint Surg Am 1988;70:1297-303.