

Calcar femorale grafting in the hemiarthroplasty of the hip for unstable inter trochanteric fractures

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ABSTRACT

Background: The sliding screw-plate devices and cephalo-medullary nail devices have performed well in stable inter-trochanteric fractures in patients with reasonably 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 simple and effective technique of calcar grafting by harvesting cortical bone strut from the neck of the fractured femur. A total of 34 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 54.5 months.

Results: In 32 of 34 (94%) 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.

Conclusion: 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.

Key words: Bipolar hemiarthroplasty, calcar grafting, inter trochanteric fractures, sliding screw and plate, proximal femoral nailing

MeSH terms: Grafts, hip fractures, intertrochanteric fractures, arthroplasty

INTRODUCTION

The incidence of inter-trochanteric fractures of the femur is very high in the elderly population.¹ The world-wide estimate of hip fractures was around 1.66 million in 1990, and the number is projected 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 risk of osteoporosis and osteoporotic hip fractures tend to occur 10-20 years earlier than in the western countries.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 preferred 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 appear to be still under evolution with a series of modifications.¹⁸⁻¹⁹ Prosthetic replacement using cemented implant is another viable alternative in the management of unstable, osteoporotic fractures, and it allows early mobilization.^{14,20-25}

The medial calcar support is deficient in inter trochanteric fractures. This necessitates the use of a prosthesis with long

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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. Additional problems of prosthetic replacement include achieving limb length equalization and maintaining 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.

MATERIALS AND METHODS

This was a retrospective study of 34 patients with inter-trochanteric fractures treated with this technique between 2005 and 2011. Out of a total of 48 patients who were managed with this technique, 11 patients had expired, and 3 patients were lost to followup. Thus, 34 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 intact 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 present in 31 out of 34 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 one 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 remaining 17 patients. All the femoral stems were cemented. All the stems were of standard

length and were non calcar replacement type of implants [Figure 2]. None of the patients required blood transfusion. Cefoperazone/sulbactam combination was used for antibiotic prophylaxis in the dose of 1 g 8 hourly for a total of 3 doses, the first dose administered at the time of induction of anesthesia.

All the procedures were performed under spinal anesthesia. Posterolateral approach was used with the patient in the lateral decubitus position. The greater trochanteric break was identified, and the trochanteric pieces were separated 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 fragment were meticulously released. The ligamentum teres was resected with sharp scissors. The femoral head was extracted, and the head size was measured 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



Figure 1: Preoperative radiograph of hip joint anteroposterior view showing comminuted intertrochanteric fracture of the left femur



Figure 2: Immediate postoperative anteroposterior radiograph showing the graft and the implant

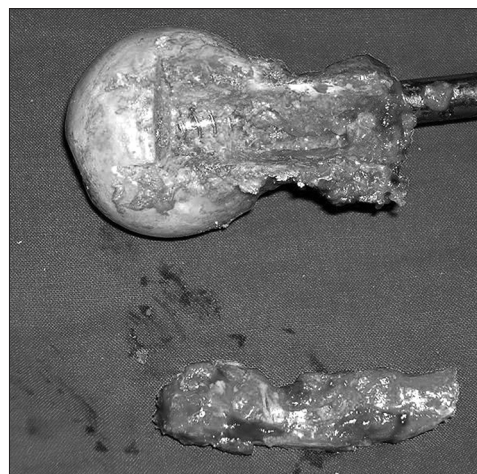


Figure 3: Intraoperative photograph showing calcar femorale graft harvested from the head and neck fragment of the femur using a power saw



Figure 4: Model bone showing the proximal extent of the graft



Figure 5: Intraoperative photograph showing trial bipolar stem being inserted with the calcar graft *in situ*

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



Figure 6: Model bone showing the extent of graft insertion

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

RESULTS

Out of 34 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 34 patients, the outcome of 13 patients was graded as

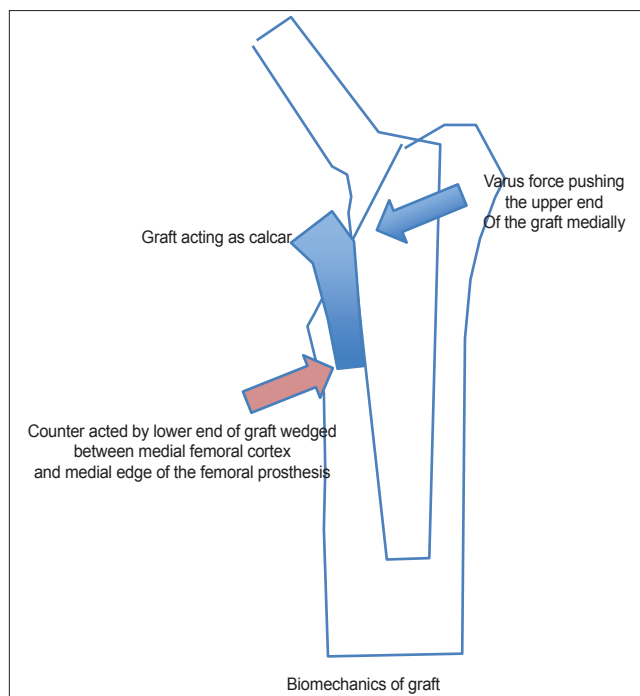


Figure 7: Schematic diagram showing graft is wedged between the medial femoral cortex and the medial edge of the prosthesis. Vaurs force (blue arrow) pushes the upper end of the graft medially, this is counter acted by the lower end of the graft and medial edge of the prosthesis (pink arrow)

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 or protrusio acetabuli.

It was seen that in 32 patients, the bone consolidated over a period without dislodgement [Figures 8, 9a and b]. In two patients in whom there was subsidence of the implant, the graft was found to have been resorbed.

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



Figure 8: Followup anteroposterior and lateral radiographs at the end of 1-year showing graft incorporation

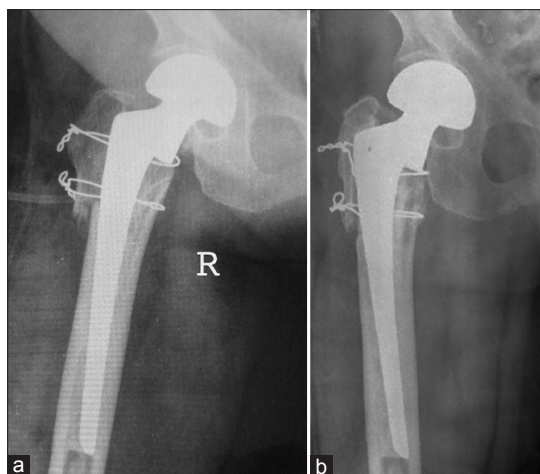


Figure 9: (a) 6 months followup radiograph anteroposterior view after cemented bipolar hemiarthroplasty with calcar grafting showing graft is seen on the medial side of the stem just below the collar. (b) 4 years followup anteroposterior radiograph showing graft is maintained and there is no subsidence of the stem

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 vascularized calcar 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 [Table 1]. 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.

Table 1: Comparison of studies on prosthetic replacement for inter-trochanteric fractures

Author	Number of patients	Mean age (years)	Followup (months)	Type of implant	Results	Complications
Stern and Angerman ³⁰	105	80.4	88.1 (1-84)	Hemiarthroplasty (Leinbach prosthesis-calcar replacement)	94% of patients returned to prefracture level of mobility; mortality-15 patients died within 8 months postoperatively	Thigh pain-1, erosion of acetabulum-1, infections-4 (1 superficial and 3 deep), GI bleed-1, pulmonary embolism-1
Green <i>et al.</i> ²¹	20 (17 primary procedures, 3 salvage following failed internal fixation)	82.2	13.2 (6-23)	Hemiarthroplasty (bipolar head-neck replacement prosthesis (Osteonics))	12 patients remained ambulant, 4 were nonambulant and 4 patients died postoperatively	Nonunion of greater trochanter-2, postoperative peri prosthetic fracture-1, painful hip-4
Haentjens <i>et al.</i> ²⁴	37	82	20 (6-48)	Muller femoral component (Protek) and DePuy cup	75% had good and excellent Merle D'Aubigne scores, 13 patients died within 6 months of operation	Deep infection-1, dislocations-2, postoperative periprosthetic fracture-1, trochanteric nonunion-1
Stappaerts <i>et al.</i> ³¹	133	70+	3 months	Compression hip screw in 90 patients, Vandeputte cemented endoprosthesis in 43 patients	No difference between the two groups in terms of hospital stay, duration of operation and postoperative ambulation. Slightly higher blood loss in the endoprosthesis group	11 patients with compression screw required re-operation due to complications whereas only 1 patient in the endoprosthesis group required re-intervention
Stern and Goldstein ³²	29	79	29.3 (1-44)	Hemiarthroplasty (Leinbach prosthesis)	86% were ambulatory within 1-week of operation	Infection-3 (1 superficial and 2 deep), subsidence of implant-1, painful implant-1, GI bleed-1, pulmonary embolism-1
Chan and Gill ²²	55	84.2	13.6 (6-24.6)	Bipolar hemiarthroplasty-noncalcar replacement stems (biomet hip fracture system stem in 53 patients and standard stem in 2 patients)	19 patients maintained prefracture mobility status, 12 patients died within 6 months	Nonunion of trochanter-1, pain due to over sized implant-1, painful prosthesis-1
Rodop <i>et al.</i> ³³	54	75.6	22.3 (5-48)	Hemiarthroplasty (Leinbach prosthesis-calcar replacement)	98% were ambulating at discharge from hospital; 5 patients died postoperatively	Acetabular erosion-1, trochanteric nonunions-2, deep infection-1, leg length discrepancy-5
Haidukewych and Berry ²⁹	60 (salvage of failed internal fixation)	78	120 (minimum) and more	32 total hip arthroplasty, 27 bipolar hemiarthroplasty, 1 unipolar hemiarthroplasty	87.5% survivorship of implants at 10 years; 10 patients died within 2 years of operation	Intra-operative periprosthetic fractures-2, thigh haematoma-1, dislocations-2 (in one patient)
Zhang <i>et al.</i> ²⁵	19 (salvage of failed internal fixation)	64.1	40.3 (2-288)	16 total hip arthroplasty, 3 bipolar hemiarthroplasty-standard length, noncalcar replacement stem		Intra-operative fracture of greater trochanter-7, dislocations-3, nonunion of greater trochanter-1

Contd..

Table 1: *Contd...*

Author	Number of patients	Mean age (years)	Followup (months)	Type of implant	Results	Complications
Kim <i>et al.</i> ²³ (prospective, randomized controlled trial of proximal femoral nailing vs. calcar replacement, long stem hemiarthroplasty)	48	82±3.4	35 (24-58)	29 proximal femoral nailing, 29 long stem uncemented bipolar hemiarthroplasty (calcar replacement, long stem)	Significant improvement in Harris hip scores in both groups, no significant difference between nailing and hemiarthroplasty in terms of functional scores, hospital stay, postoperative mobility	Nonunion of greater trochanter-2, dislocation-1
Present study, 2014	48	79.2	54.5 (12-84)	Standard length, noncalcar replacement bipolar prosthesis in 33 patients and unipolar (Austin-Moore implant in one patient. Of the bipolar implants, 17 were modular bipolar stems (Stryker) and 16 were fixed bipolar stems (INOR)	11 patients died within 3 years of operation. Excellent and good Harris hip scores in 26 patients, fair scores in 7 patients and poor scores in 2 patients. 26 patients mobilized independently and 6 patients needed cane	Subsidence of implant-2 (1 required revision with THR), nonunion of greater trochanter-1, superficial decubitus ulcer-1

GI=Gastrointestinal, THR=Total hip replacement

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