International Journal of Research in Medical Sciences
Varma HS et al. Int J Res Med Sci. 2016 Jun;4(6):1897-1902
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20161443

Research Article

Randomized controlled analysis-autogenous bone peg graft improved offset hemiarthroplasty in high risk patients: a novel cost effective technique

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Received: 02 April 2016
Revised: 09 April 2016
Accepted: 02 May 2016

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ABSTRACT

Background: Femoral neck fractures in elderly with comorbidities are a serious and increasing challenge. Surgery remains the mainstay of treatment for early rehabilitation. In present Indian scenario, the two major factors that drive our strategy for treatment are affordability and use of cemented prosthesis in high risk patients. The primary objective is to develop a technique that not only maintains the hip biomechanics after arthroplasty but also cost-effective.
Methods: Fifty high risk elderly patients of either sex with fracture neck femur after randomization were divided into two groups. Hemiarthroplasty through postero-lateral approach was done .Unipolar prosthesis were used in both the groups. A new measurement "X" was defined. Radiologically correlation between the value of 'X' and the variation in femoral offset is measured with novel technique and compared the parameters with conventional technique. P<0.05 was considered significant.
Results: In patients with novel technique value of X was 1 mm±0.8 SD, whereas value of X in conventional technique the value of X was significantly higher of about 7.2 mm±1.6 SD and this was associated with increased femoral off set 47.2±2.0 SD and the correlation was found to be statistically significant (p<0.05). Furthermore, in group B where graft was not used subsidence was found in 6 patients (24%). None was revised during the period of follow up.
Conclusions: Our preliminary results indicate that the approach proposed is feasible and effective in the management of intracapsular fracture neck femur in high risk patients with unipolar prosthesis.

Keywords: Fracture neck femur, Hemiarthroplasty, Unipolar prosthesis

INTRODUCTION

Fracture neck femur especially in high risk elderly pose a serious health care problem. Therefore, these fractures demands appropriate treatment. Surgery is the main stay of treatment that allows early mobilization and rehabilitation. The optimal management for patients with comorbidities is the subject of considerable debate.[1] While treating these high risks patients surgeons mind is laden with lots of dilemma, whether to go for total hip arthroplasty or hemiarthroplasty; cemented or uncemented; unipolar or bipolar. There were no evidence based recommendations or consensus on management of fracture neck femur in high risk elderly patients. Recent study considered unipolar implants to be sufficient in elderly patients with more comorbidities and hemiarthroplasty is a satisfactory procedure in physiological older patients.[2,3] Restoration of femoral offset is imperative for reproducing the biomechanics of hip joint after hip arthroplasty. Furthermore, use of

cement is associated with British cardiovascular intervention society (BCIS).[4] Also hydroxyapatite coated stem are expensive. These are two major factors that decide our management for fracture neck femur in elderly patients with comorbidities in Indian scenario. We adopted a novel technique to address these concerns encountered during arthroplasty hip. We presumed it would be possible to lateralize the prosthesis by placing a compact autogenous bone graft harvested from the femoral head on a calcar with a peg. This novel surgical technique provides adequate lateralization and prevents varus placement of the prosthesis intra-operatively. Once the graft has healed, it maintains the femoral offset, is called graft improved offset hip arthroplasty (GIO-HA). This technique would take care of both critical concerns.

The primary objective of the present research was to verify whether this novel surgical technique would provide the benefits of lateralization and maintains femoral offset with prosthesis like Austin Moore (unipolar) in present Indian scenario. We tested the hypothesis that a cancellous bone graft, harvested from the femoral head during hip arthroplasty, would heal to the native calcar and thus maintain the femoral offset and abductor muscle lever arm and strength. Furthermore, adequate lateralization of the prosthesis would be associated with lower rates of thigh pain and prevents placement of the prosthesis in varus and retroversion.

METHODS

The present research was a single centre, prospective, controlled, randomized study. Our cohort comprised of 50 patients (mean age 66±5 SD years) with intra-capsular fracture neck of femur with cardiovascular disease and/or high risk profile. Patients were defined as having cardiovascular disease if they had a history of ischemic heart disease, congestive heart failure or of any of the following cardiovascular events: myocardial infarction, angina or coronary artery bypass grafting or stroke. Patients who were non ambulatory before the fracture, patients with pathological fractures, patients with previous hip fractures with distorted anatomy, patients unfit for anesthesia were excluded from the study. The enrolled cohorts were treated with hemi-arthroplasty using uncemented unipolar Austin Moore's prosthesis (AMP). The cohort was randomized based on odd/even number. Each group had equal number (n=25) of patients. They were divided into two groups with odd numbers (Group A) assigned to novel surgical technique and even number (Group B; controlled group) with conventional technique. All the procedures were performed under spinal anesthesia. All operations were performed by the senior author or under his direction. The procedure was carried out under spinal anesthesia in the lateral decubitus position. Posterolateral approach was used. 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 (Figure 1), and the head size was measured using templates.

Figure 1: Extracted femoral head.

The neck osteotomy was achieved using an osteotomy template. Oscillating saw was used to make the cuts through the strong calcar bone to avoid splintering. Femoral canal was accessed using a box chisel to resect the lateral femoral cortex and medial trochanteric wall. With a canal finding reamer opened the medullary canal. The reamer was directed from supero-lateral to infero-medial so as to avoid the varus placement of the prosthesis. Beginning with smallest broach, progressively larger broach was used till the final one seated to the desired depth of the medullary canal. Graft with a length of 2-2.5 cm and width of 1.5 cm was harvested from the extracted head (Figure 2).

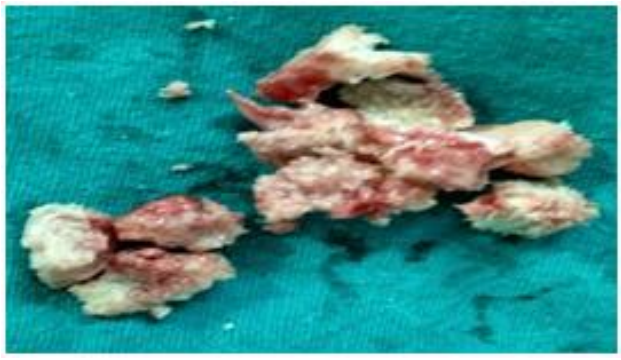

Figure 2: Extracted head cut into pieces (peg like).

Proximally the graft was seated at the junction of the calcar portion of neck with femoral head. The graft was then trimmed in a peg like form and was inserted into the void in such a way that half of its length was in the medullary canal and the other half lying outside. The remaining graft was inserted into the proximal fenestrations of the prosthesis. This will give mechanical stability once it gets healed and thus making it a self-locking device (Figure 4). The broach was then inserted to assess the fit of the graft. The required prosthesis was inserted using an artery forcep to control the rotation. The impacting force packed the graft tightly between the

medial edge of the prosthesis and medial cortex and thus was auto-stabilized (Figure 5).

Figure 3: Peg graft harvested from femoral head inserted in calcar area (as pointed by artery forcep; 50% of its length was in the medullary canal, and 50% was outside).

Figure 4: Graft inserted into proximal fenestration of the prosthesis.

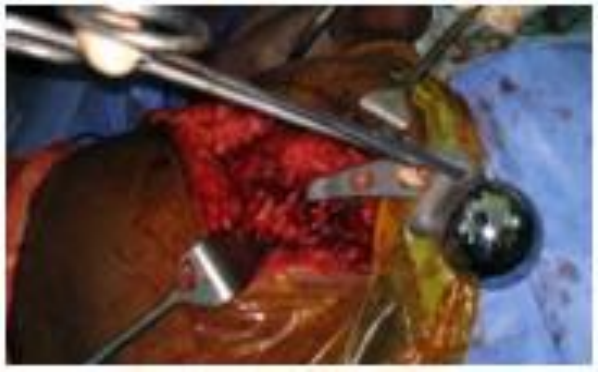

Figure 5: The prosthesis inserted using an artery forcep to control rotation (Graft: in the calcar region and in fenestration of prosthesis).

The varus bending forces of prosthesis pushes the proximal half of graft toward the medial cortex as a result the distal half was pushed against the medial edge of prosthesis; these counter forces further stabilized the graft. The prosthesis was finally hammered to its optimal position keeping 15 degree of ante-version. The prosthesis was reduced. The stability was checked in full extension with external rotation to 45 degrees, flexion to 100 degrees, adduction to 20 degrees and internal rotation to 60 degrees. The abductors were repaired. The wound closed in layers over negative suction drain. The other group treated with conventional technique. All patients were given low molecular weight heparin preoperatively and for eight days postoperatively. Cloxacillin 2 gram was given preoperatively, followed by two additional doses during the first 24 hours. Patient began full weight bearing with walker/crutches the next day of surgery and advanced to cane (on the side opposite the arthroplasty) as rapidly as tolerated. The immediate post operation and follow up X-ray showed perfect sitting of collar over the calcar and maintenance of femoral offset (Figure 6) (Figure 7).

Figure 6: Pre-op and Immediate post op x-ray: perfect resting of collar over calcar region using novel technique (GIO-HA); Graft visualized in calcar region and into fenestrations.

Figure 7: 1 year follow up X-ray: graft acceptance/consolidation on medial side and in the fenestrations; maintenance of femoral offset.

Patients were discharged 2 days after surgery. The rehabilitation protocol used for the GIO-HA was same as that for conventional HA. All patients were prospectively evaluated at 3, 6, and 12 months. All measurements were taken on anteroposterior (AP) pelvic radiographs (standing position), the lower limb kept in internal

rotation so as to keep the patella in frontal plane. The distance between calcar and medial end of collar of prosthesis is measured 'X' (Figure 8) and correlation is done in terms of radiological and clinical assessment.

Figure 8: X-ray showing "X" (marked in red): the distance between calcar and medial end of collar of prosthesis.

Radiologically correlation between the value of 'X' and the variation in femoral offset is measured with and without the graft used. And also the incidence of subsidence was measured in follow up. Subsidence was calculated by measuring the reduction in the distance between the tip of lesser trochanter and a fixed point on the prosthesis. Clinically correlation is done in terms of incidence of thigh pain, limp. The data was analyzed with the Software (SPSS, version 20.0). Data were compared by using a paired t-test for quantitative data. $P < 0.05$ was considered significant.

RESULTS

No significant differences between the treatment groups were found with respect to demographic variables (Table 1; $p>0.05$). Lateralization was independent from endomedullary features (width of proximal femoral canal, femoral enlargement). In the present study it was found that using a peg graft at calcar region is an effective tool in lateralization. The distance between calcar and the medial most aspect of collar of prosthesis 'X' is correlated with the femoral offset. For an ideal procedure done, 'X' must be 0 mm (Figure 6), (Figure 7) as value of 'X' increases the value of femoral offset also increases and chances of varus also increases (Table 2).

Table 2: Showing mean values of "X" and Femoral Offset using conventional and novel technique (GIO-HA).

Technique	Mean value of X	Femoral off set
Novel technique: (GIO-HA) (n=25 patients)	1 mm	41 mm
Conventional technique (n=25patients)	6 mm	46 mm

In patients where graft in calcar region was used value of X was 1 mm±0.8 SD, whereas value of X in which graft was not used the value of X was significantly higher of about 7.2 mm±1.6 SD and this was associated with increased femoral off set 47.2±2.0 SD (Figure 9) and the correlation was found to be statistically significant ($p<0.05$) (Table 3).

Figure 9: With convention technique: showing poor lateralization, medialization and varus placement of prosthesis (pre-op and follow up x-rays: as shown by marker).

Table 1: Demographic variables (P>0.05).

Age group	Graft not used (conventional technique)					Graft used (novel technique: GIO-HA)					Total
60-65 years	12					9					21
	(57.14%)					(42.86%)					100
66-70 years	8					9					17
	(47.06%)					(52.94%)					100
70+years	5					7					12
	(41.67%)					(58.33%)					100
Statistical significance											
Characteristics	**Graft not used (conventional technique)**					**Graft used (novel technique: GIO-HA)**					
	N	**Mean**	**SD**	**Min**	**Max**	**N**	**Mean**	**SD**	**Min**	**Max**	**T-test**	**P-value**
Age	25	66.6	5.3	60	78	25	67.8	5.5	60	78	0.81	0.42

Table 3: Showing Statistical comparison of parameters using conventional and novel technique (GIO-HA).

	Graft not used (Conventional technique)				Graft used (Novel technique: GIO-HA)				t-test	P-value
Characteristics	n	Mean	SD	Min	Max	Mean	SD	Min	Max		
Age	25	66.6	5.3	60	78	67.8	5.5	60	78	0.81	0.42
X	25	7.2	1.6	4	10	1.0	0.8	0	3	17.25	<0.0001(p<0.05)
Femoral offset	25	47.2	2.0	44	51	40.0	2.0	36	44	12.70	<0.0001(p<0.05)

Furthermore, in group B where graft was not used subsidence was found in 6 patients (24%). No patient had a dislocation. None was revised during the period of follow up.

DISCUSSION

Selection of correct femoral component is critical in restoration of abductor muscle lever arm besides femoral offset. Failure to achieve sufficient lateralization will lead to abductor weakness, increased wear/tear and loosening of prosthesis.[5] Therefore; adequate lateralization in arthroplasty significantly contributes to the stability of prosthesis.[6] The treatment of choice for a displaced femoral neck fracture in the most elderly patients is a cemented hemiarthroplasty (HA). There were two critical factors while treating the present cohort. The first and foremost is affordability and second one was the high risk patients. Donaldson AJ et al suggested that a cemented prosthesis should be avoided in patients who are at high risk of bone cement implantation syndrome (BCIS) unless there are overriding orthopaedic considerations.[4] Furthermore, cementless hydroxyapatite coated stem is expensive. In view of these critical concerns we have to use uncemented unipolar prosthesis. Cemented hemiarthroplasty (HA) led to less pain in the hip and improved return of mobility compared to an uncemented HA.[7] To address these problems we report our experience with novel technique GIO-HA. The principle of GIO-HA is, once the autologous graft has healed to the native calcar (Figure 7), the femoral offset is maintained and restoration of abductor lever arm achieved. This in turn leads to less hip pain and provide stability. In most hemiarthroplasty done, extracted head is disposed off but this actually is good source of cancellous graft. It is found that using cancellous bone graft from extracted head is helpful in proper lateralization and to maintain femoral offset. Another important feature is of subsidence of prosthesis into medullary cavity which is reason for thigh and hip pain. In the present study authors have found that the incidence of subsidence significantly decreases if the graft is used. This is probably as the strength of calcar region is enforced by cancellous bone graft once it gets healed. Arthroplasty allows early mobilization, weight bearing and and rapid rehabilitation; avoids fixation failures and need for subsequent revision procedure.[8] Literature advocated the use of long stem prosthesis and calcar replacing stem in cases of postero-medial void or defects.[9] Authors speculated that these prosthesis are expensive and are not readily available. Also, use of these prosthesis is associated with significantly increased cost, longer operative time and more blood loss when compared to normal prosthesis. Advantages such as Restoration of normal length to the extremity, achieving the desirable degree of offset, prevention of varus tilt and subsidence, preservation or reconstruction of normal bone stock which may be of value during revision surgery making the present approach (GIO-HA) well suited for patients and/or in conditions where the use of cement is associated with BCIS. Since the GIO-HA allows the use of standard prosthesis, it is cost-effective. The authors reasserted that implant subsidence was not a problem owing to presence of an intra-medullary or peg calcar graft. There has been concern regarding resorption of a non-vascularized graft with time. Long experiences of author shows that the graft consolidates well in majority of patients as it was autologous and was placed under compressive forces. Haentjens et al. showed that callus formation occur mainly in the posteromedial aspect of the proximal femur following prosthetic replacement.[10] Also, native calcar peg grafting as described in present series is useful in minimizing the subsidence of the implant and in maintaining the limb length. Small sample size, short term results and no attempts made to measure or assess the healing of graft through CT scan, were the limitation of the present series.

CONCLUSION

GIO-HA offers the advantage of maintaining the femoral offset and restoration of abductor lever arm. This in turn leads to decreased hip pain and provide stability. Preliminary results are encouraging; enable us to conclude that the technique (GIO-HA) has a promising future. The procedure can also be performed in case of calcar loss to restore the bone stock.

ACKNOWLEDGEMENTS

Authors would like to thank to the doctors and senior colleagues for providing fruitful and critical comments on the draft of this paper.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Varma HS, Upadhyay S, Jagadeesh N. Randomized controlled analysis-autogenous bone peg graft improved offset hemiarthroplasty in high risk patients: a novel cost effective technique. Int J Res Med Sci 2016;4: 1897-902.