

Bipolar hip arthroplasty for avascular necrosis of femoral head in young adults

Baldev Dudani, Ashok K Shyam^{1,2}, Pankush Arora^{1,2}, Arjun Veigus³

ABSTRACT

Background: Bipolar hip arthroplasty (BHA) is one of the options for treatment of avascular necrosis (AVN) of the femoral head. Acetabular erosion and groin pain are the most allowing for gross motion between the common complications. We propose that these complications are secondary to improper acetabular preparation allowing for motion between the BHA head and the acetabulum.

Materials and Methods: The current study retrospectively evaluated patients' records from case files and also called them for clinical and radiological followup. 96 hips with AVN of the femoral head treated with BHA were included in the study. All patients were males with a mean age of 42 years (range 30-59 years). In all cases, the acetabulum was gently reamed till it became uniformly concentric to achieve tight fitting trial cup. Clinical followup using Harris hip score (HHS) and radiological study for cup migration were done at followup.

Results: The mean followup was 7.52 years (range 4-16 years). The HHS significantly improved from a preoperative value of 39.3 (range, 54-30) to a postoperative value of 89.12 (range 74-96). According to HHS grades, the final outcome was excellent in 52 hips, good in 28 and fair in 16 hips. Hip and groin pain was reported in four hips (5%), but did not limit activity. Subsidence (less than 5 mm) of the femoral component was seen in 8 cases. Subgroup analysis showed patients with Ficat Stage 3 having better range of motion, but similar HHS as compared to Ficat Stage 4 patients.

Conclusion: Bipolar hip arthroplasty (BHA) using tight fitting cup and acetabular reaming in AVN hip has a low incidence of groin pain, acetabular erosion and revision in midterm followup. Good outcome and mid term survival can be achieved irrespective of the Ficat Stage.

Key words: Femoral head, avascular necrosis, bipolar hip arthroplasty, acetabular reaming

MeSH terms: Femur head, femoral head prosthesis, avascular necrosis of bone, hip, arthroplasty

INTRODUCTION

Surgical treatment of avascular necrosis (AVN) of head of femur include core decompression, osteotomies, nonvascularized bone grafting, free vascularized fibular grafts, hip resurfacing, bipolar hip arthroplasty (BHA) and total hip arthroplasty (THA).¹⁻³ THA is indicated in the young individual in AVN with acetabular involvement;

however, its role is unclear in cases without acetabular involvement.⁴ BHA was initially limited to be used in hip osteoarthritis, nonunions and acute neck femur fractures.^{5,6} Bateman⁷ and Giliberty⁸ were first to use BHA in Ficat Stage 3 AVN based on the hypothesis that “acetabular floor retains a regenerative property, which regenerates bone in the subchondral region, if stimulation in the form of weight bearing is given through an accurately fitted cup” and theorized that preferential motion at inner bearing will decrease the cartilage erosion. Papers have been published with both satisfactory⁹⁻¹⁴ and unsatisfactory results using BHA.^{5,15-17} The main limitations sighted are migration of the outer cup (secondary to the acetabular erosion) and unpredictable pain relief.^{3,5,14} Incidence of groin pain varied from 11.5% to 42%¹⁸⁻²⁰ and incidence of acetabular erosion and protrusion is reported to range from 0% to 45%.^{18,19} The activity of the patient and the duration of followup determine the erosion of acetabulum and appearance of symptoms.²¹ However, the main issue seems to be motion between the outer cup and the acetabulum, a nonconcentric acetabulum and particulate wear.^{16,22-24} To decrease this motion between the outer cup and the acetabulum a gentle reaming of the acetabulum with insertion of tight fitting

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acetabular cup can be done as suggested above by Bateman and Giliberty.^{7,8} This is thought to decrease the incidence of groin pain and the acetabular erosion and also revision secondary to these issues.^{25,26} In this retrospective series, we have assessed the midterm outcome of BHA in young adults (age <60) with Ficat Stages 3 and 4 AVN.

MATERIALS AND METHODS

A retrospective study with a prospective followup was planned. 80 consecutive patients below 60 years of age (96 hips) were operated by the senior author between 1995 and 2010 using BHA with tight fitting cup technique. Preoperative details were taken from the records. All patients were alive and available for final followup. All patients were males with a mean age of 42 ± 6.44 years (range 30-59 years). Out of a total of 96 hips, 76 were diagnosed as idiopathic AVN, 8 were posttraumatic AVN while 12 were post alcohol consumption AVN. Ficat's classification system was used based on anteroposterior (AP) and lateral hip radiograph.²⁶ Clinically, the indication for surgery was pain with progressive inability to carry out daily activities. Patients with radiographs showing no or minimal acetabular involvement were included to undergo the procedure, while cases with advanced osteoarthritis with osteophytosis or protrusio were excluded. Surgeries were done in the lateral decubitus position using the posterolateral approach under epidural anesthesia. The hip joint capsule was excised if diseased. In our study, intraoperatively on gross examination, all the 96 hips (Ficat stage 3 and 4) were found to have mild to moderate acetabular involvement as per Steinberg *et al.*² The cartilage was graded grossly as Grade 0 (normal) if no abnormalities were observed; Grade I (mild degeneration) if there was superficial fibrillation and slight irregularity of the surface; Grade II (moderate degeneration) if there was moderate fibrillation, alteration in color and consistency and thinning of cartilage without complete erosion to bone. Gentle superficial reaming of the acetabulum was done making the acetabulum concentric for a tight fitting bipolar

cup [Figure 1a]. Concentricity and tight fit were confirmed by trial cups. The trial cups should fit snugly enough so that when the hip is taken through a range of motion, no gross movement should be appreciated between the outer cup and the acetabulum. This assures that the prosthesis is tight fitting and movement between the outer cup and the acetabulum is avoided. During the process of making acetabulum concentric, sometimes subchondral bone was exposed. In these cases, visualization of acetabulum showed thinned out cartilage with interspersed exposed subchondral bone. Subchondral reaming of the acetabulum was not done in any patient. Pulse lavage of the prepared acetabulum was done to remove all debris before putting the bipolar cup. The size of the cup was equal to the size of the tight trial cup chosen. We did keep instrumentation for total hip replacement (THR) ready intraoperatively; however, we did not have to do THR in any of our selected cases.

Self-centering cup with 28 mm inner head and uncemented stems were used in 60 hips (Zimmer, Warsaw, USA, Biomet, Warsaw, USA). In the remaining 36 hips, normocentric hemispherical cups with 26 mm inner head and cemented stems were used (Inor, Mumbai, India and Rch, Mumbai, India).

Rehabilitation protocol

The patients were allowed ambulation with support of a walker or crutches on the 5th postoperative day and were advised to use the same for a period of 4-6 weeks. All patients were called for a final followup for clinical and radiological assessment. The clinical evaluation consisted of recording the details of thigh or groin pain, range of movements at the hip (patient was asked to sit cross legged on the bed), limb length discrepancy and Harris hip score (HHS).

Radiological evaluation

The radiological evaluation comprised of looking for subsidence of the stem, recording of any evidence of stem loosening in the form of a radiolucent line surrounding

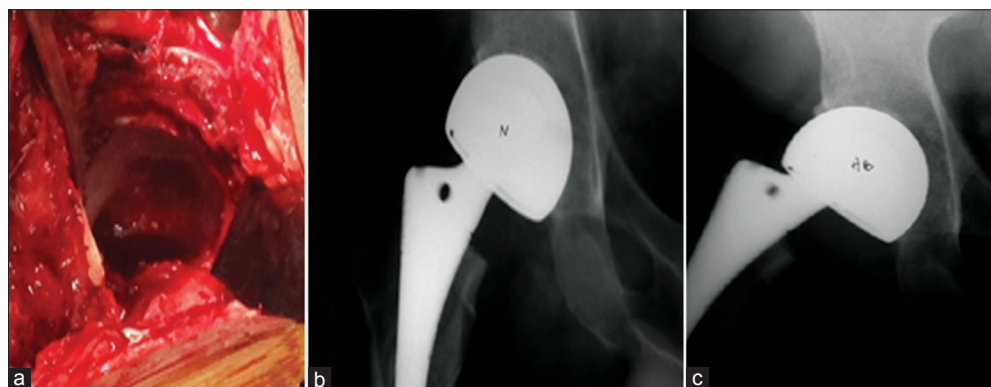


Figure 1: (a) Intraoperative photograph showing concentric acetabulum after superficial gentle reaming with the large hand reamer. (b and c) X-ray taken in neutral and abduction showing movement taking place mostly at inner bearing

the stem and superior or medial migration of the cup. AP X-rays were taken with the patient lying supine with the hip in neutral and abduction position to check for movement in inner and outer bearing as shown [Figure 1b and c]. The femoral component subsidence was evaluated by measuring the distance between the superior margin of the greater trochanter and the shoulder of the stem.³ Medial migration of the bipolar cup was determined from the distance between a line perpendicular to Kohler's line and center of the outer head, whereas superior migration was indicated by a change in distance between the inter teardrop line and the centre of outer head means centre of the circle that is calculated from the circumference of outer cup of bipolar prosthesis that is easily outlined on the radiograph.³ All radiographic measurements were done by either of two authors on AP radiograph of the hip and were compared to the immediate postoperative radiographs. A subgroup analysis was also done, by dividing the cohort according to Ficat's class, to evaluate the effect of acetabular involvement on the outcome of the procedure.

RESULTS

The mean followup was 7.52 ± 1.80 years (range, 4-16). The HHS improved from a preoperative value of 39.33 ± 6.11 (30-54) to 89.12 ± 6.68 (74-96) ($P = 0.0001$, paired *t*-test) in the postoperative period. According to HHS grades, the final outcome was excellent in 52, good in 28 and fair in 16 hips. Hip and groin pain was reported in four hips (5%) but this did not limit activity in any of the patient [Table 1]. 22 hips had flexion deformity of approximately $3-5^\circ$ with a final range of flexion of $100.2^\circ \pm 8.82^\circ$ (85-116°). Subsidence of the femoral component was seen in 8 hips (<5 mm); however, these hips were asymptomatic. Shortening of 1 cm was noted in 10 limbs, and 1.5 cm shortening was noted in 1 limb. There was no incidence of hip dislocation or dissociation of the

bipolar cup and no case required revision. On AP neutral and abduction X-rays there was no appreciable movements noted between the outer cup and the acetabulum in any of the case. There was medial migration in 5 hips and proximal migration in 12 hips, but none more than 2 mm and all were asymptomatic.

On subgroup analysis between the Ficat Stages 3 and 4 [Table 2] it was noted that hips with Ficat Stage 3 were younger at the time of surgery and also had better final outcome in terms of range of motion. The final HHS score was however not statistically different in both groups indicating good results even in cases with acetabular involvement. None of the Ficat Stage 3 patients had any groin pain or femoral subsidence at the final followup while 4 cases of groin pain and 8 cases of femoral subsidence were seen in Ficat Stage 4 group. Figures 2 to 5 show case series with final result of four patients in our series.

Table 1: Comparison of results with various studies

Author	Number of hips	Average followup in year	Groin pain %
Lachiewicz <i>et al.</i> ¹⁷ (1988)	31	4.6	20
Cabanela <i>et al.</i> ¹⁴ (1990)	23	9.2	12
Ito <i>et al.</i> ¹⁵ (1999)	48	11.4	42
Lee <i>et al.</i> ³ (2004)	40	8.0	20
Takaoka <i>et al.</i> ²⁰ (1992)	83	5.6	34
Dudani <i>et al.</i> ²⁵ (2005)	38	6.84	-
Our study	96	7.52	5

BHA=Bipolar hip arthroplasty

Table 2: comparison between the Ficats 3 and 4 subgroups

Variables	Ficat 3	Ficat 4	P value
<i>n</i>	24	72	
Age	37.83±6.45	43.38±5.89	0.008
Preoperative HHS	47.66±5.03	36.55±3.22	0.001
Postoperative HHS	92.16±3.09	88.11±7.26	0.07
ROM	105±9.4	98.16±8.14	0.02
Groin pain	None	4	

P value for unpaired *t*-test. HHS=Harris hip score, ROM=Range of movements



Figure 2: X-ray right hip joint anteroposterior view in a 35 year old male showing (a) Preoperative radiograph with avascular necrosis right hip secondary to fracture neck femur. Also showing implant *in situ* (b) 4 years postoperative radiograph of the same patient treated with bipolar hip arthroplasty. (c) 16 years followup radiograph of the same patient without any loosening or migration and with subchondral sclerosis

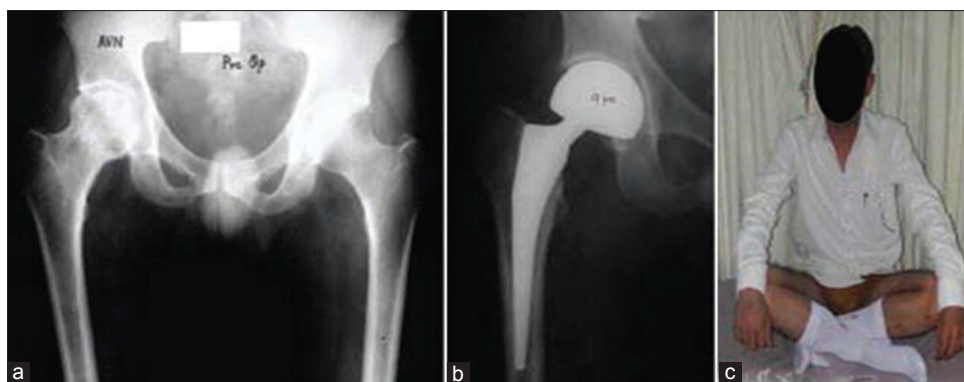


Figure 3: (a) X-ray pelvis with both hip joints anteroposterior view in a 40 year old male showing avascular necrosis Ficat stage III in right hip (post alcoholic) (b) X-ray of right hip joint anteroposterior view of same patient showing Implant in position at 9 years followup without any sign of erosion or migration. (c) Clinical photograph of same patient showing cross legged sitting



Figure 4: (a) X-ray pelvis with both hip joints anteroposterior view in a 65 year old male showing posttraumatic avascular necrosis Ficat stage IV (see non concentric acetabulum) and implant *in situ*. (b) X-ray pelvis with both hip joints anteroposterior view of same patient at 9.5 years followup showing well fitting large cup. (c and d) Clinical photographs showing range of motion

DISCUSSION

Surface replacement is an option in younger people with AVN, but has limited indications and is a demanding procedure with high cost.²⁷ The results published by for surface replacement are not uniform and a longterm followup is lacking.²⁷⁻²⁹ THA is the method of choice for the treatment of advanced AVN of the femoral head,^{5,30,31} however, its overuse may lead to increased wear and need for early revision in young adults.¹⁴ Various studies have shown that functional utility of THA reduces to 80% at 10 years, 33% at 16 years, subsequently requiring a revision surgery. Alternate bearing surfaces like metal on metal or

ceramic on ceramic decrease the wear rate but have their own set of complications (metallosis, squeaking)³²⁻³⁹ and long term results are still awaited.⁴⁰ When compared with BHA, conflicting results have been reported. Chan and Shih³⁰ have reported that there was no difference in the incidence of osteolysis, thigh or groin pain, dislocation rates and revision rates between BHA and THA. They concluded that in young patients with Ficat Stage 3 AVN, BHA may be a useful alternative to THA. Furthermore, BHA is less demanding, blood loss is comparatively less⁵ and revision is easier as compared with the revision of THA as the acetabulum is still intact.⁴¹ Lee *et al.*³ have reported 23% outer cup migration rate, 15% gluteal pain and 20% groin

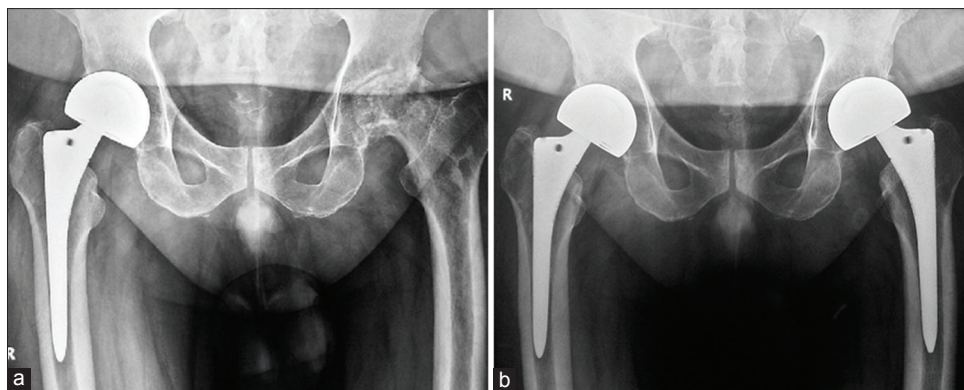


Figure 5: X-ray pelvis with both hip joints anteroposterior view in a 45 year old man with bilateral avascular necrosis of femoral head (a) 6 months followup showing right side bipolar arthroplasty left side Ficat stage IV avascular necrosis. (b) At 5 years followup showing well fixed implant with large cup well placed in acetabulum

pain in BHA. Ito *et al.*¹⁵ have reported 42% radiological failures, 42% incidence of groin pain requiring a revision surgery in 25% hip undergoing BHA. Similar results were shown by Cabanela¹⁴ and Lachiewicz and Desman¹⁷ with groin pain and acetabular erosion as the two most important reasons for poor results in BHA. Groin pain has been variably attributed to the preservation of diseased joint capsule, to irritation of the subchondral nerve endings of the acetabulum and to the acetabular erosion.^{14,42} In our study, the diseased capsule was always excised to avoid capsular impingement. Furthermore, as nerve endings in the posterior capsule supply the acetabulum, excising it blocks the nerve supply to the acetabulum and thus helps in relieving pain. Poor fitting bipolar prostheses can lead to cartilage necrosis giving rise to groin pain and degeneration.^{30,41} Acetabular erosion has also been attributed to a fair amount of movement at the outer bearing due to a wide surface of the cup, which was greater than two third of a sphere.^{42,43} Reaming in BHA technique creates a better fit that reduces movements between the outer cup and the acetabulum⁴¹ and ensures that on weight bearing, movements are transmitted to the inner bearing. In effect, this works like a low friction arthroplasty and results in reduced pain and damage to the acetabular bone stock.⁴¹ This also explains the low incidence of acetabular migration and low revision rate in our series. Dudani *et al.*²⁵ too used the same technique and reported 80% good result at average follow of 7.2 years. However, some reports have stated that reaming may not necessarily work. Pellegrini *et al.*¹⁹ have reported a higher risk of revision with acetabular reaming while Muraki *et al.*⁵ concluded that acetabular reaming increases the tendency of superomedial migration. We did not find these in our series. The uniformly good results at the mid term seen in our series may be attributed to the technique and amount (depth) of reaming. Pellegrini *et al.*¹⁹ reamed the acetabulum till a depth when the osseous floor showed punctuate bleeding. We have used a more conservative reaming without breaching the integrity of

the subchondral bone, and this is probably why we have low incidence and magnitude of medial migration. On the contrary [Figure 2c] the subchondral bone shows sclerosis, asserting the Bateman hypothesis regarding the regenerate potential of acetabulum.⁴⁴ In our series, ten patients showed this sclerosis. Nagai *et al.*⁴³ in 12-18 years old followup study of nonself centering Bateman bipolar endoprosthesis for nontraumatic osteonecrosis of the femoral head concluded that the original Bateman endoprosthesis was effective in delaying the need for THA for more than 10 years in Ficat Stage 3 AVN of the femoral head. However, the sample size was very small, with 4 out of 12 patients having some groin pain and study limited to Ficat stage III AVN only. In another study Tsumura *et al.*⁴⁵ found no difference in clinical results however incidence of migration in Ficat 2 and 3 stage was less when compared with stage 4. Based on this they recommended BHA only for Ficat Stages 2 and 3. In our study, we have used BHA for both stages 3 and 4 stages. Although the final range of motion was better in Ficat Stage 3 group, the final HHS was similar in both the groups showing effectiveness of BHA with tight fitting cup in both Ficat 3 and 4 stages. Thus, even in cases with acetabular involvement this technique can be used with good clinical results and can defer the need for THA.

Bipolar hip arthroplasty using tight fitting cup for AVN hip has a low incidence of groin pain, acetabular erosion, and revision in midterm followup. This procedure can be used for treatment in young adults with Ficat Stages 3 and 4 AVN of the femoral head to defer a definitive THA. Further large series with long term followups, multicentric randomized studies and reproducibility of results will be needed to establish this method.

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