

BICENTRIC BIPOLAR PROSTHESIS IN NON-TRAUMATIC HIP PATHOLOGIES: MAXIMUM 10 YEARS FOLLOW UP

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ABSTRACT

Introduction

Introduction of bipolar prosthesis was basically made for the treatment of fresh fracture neck of femur in elderly, but with advancement in design and techniques its use has been increased to various non-traumatic hip pathologies.

Objective

To assess clinical and radiological outcome of BHU bicentric bipolar hip prosthesis in treatment of non-traumatic hip pathology.

Methodology

This longitudinal study was done in 30 cases of various hip conditions, during the period of March 2002 to March 2012. All patients had secondary osteoarthritis of hip with abnormal acetabulum following advanced tubercular arthritis, rheumatoid arthritis, ankylosing spondylitis and avascular necrosis of femoral head. Primary bipolar hemi-replacement arthroplasty was done in all the cases using Banaras Hindu University (BHU) bicentric bipolar hip prosthesis. Each patient was assessed radiologically for movement and fraction of it occurring at various components of prosthesis and clinically for functional outcome using modified Harris hip score for the maximum of 10 years.

Results

There were 17 males and 13 females (n=30), aged between 31-60 years. Three and half years following surgery, (n=12) 100% patients were able to squat and sit crossed legged. At four and half years follow-up, (n=7) 100% patient had excellent result when assessed by modified Harris hip score. Radiologically, by the end of 10 years (n=1) all the movements of hip occurred at inner bearing while the outer bearing was fixed to acetabulum.

Conclusion

This intermediate term follow-up study suggests that the use of BHU bicentric bipolar hip prosthesis for bipolar hemi-replacement is associated with better clinical outcomes, in non-traumatic hip pathologies.

KEYWORDS

BHU bicentric bipolar hip prosthesis, follow up, secondary osteoarthritis



INTRODUCTION

Bateman and Giliberty introduced bipolar implant for hip reconstruction, principally in fracture neck of femur, avascular necrosis of femoral head and non-union of femoral neck in an attempt to alleviate the problems of conventional metallic proximal femoral endoprosthesis.^{1,2} The bipolar hip prosthesis has a ball and joint socket, and the majority of motion is supposed to occur between the small inner metallic head and the ultra-high molecular-weight polyethylene (UHMWPE) socket. The UHMWPE socket is bonded to an outer stainless steel shell, and this outer shell articulates with the acetabulum. Various other authors have advocated use of bipolar prosthesis in post-traumatic conditions and avascular necrosis of femoral head.³⁻⁵ With success of bipolar prosthesis in fracture neck of femur, its indication was extended to various other hip pathologies like advanced osteoarthritis of hip, rheumatoid arthritis, avascular necrosis of femoral head or even cases with acetabular dysplasia, which were previously being treated by total hip arthroplasty.³ The unique design of bipolar prosthesis helped to reduce the shear stresses and decrease the incidence of protrusio acetabuli and stem loosening.^{4,5} The impact loads are better absorbed by the bipolar prosthesis, thus providing further protection for the acetabulum.² Added advantage of greater stability and reduced likelihood of dislocation was attained with the bipolar hip prosthesis.^{2,6}

Several authors have reported good to excellent short-term and intermediate-term results with the use of bipolar prosthesis for osteoarthritis (OA) of the hip, avascular necrosis (AVN) of the femoral head, rheumatoid arthritis (RA), ankylosing arthritis, tuberculosis (TB) of hip.⁷⁻⁹ However, mid to long-term follow-up demonstrated unacceptably high rates of complications like pain, migration of prosthesis, osteolysis, and the need for revision to total hip arthroplasty.¹⁰⁻¹³ The objective of this study was to analyze the long-term outcomes of Banaras Hindu University (BHU) bicentric bipolar hemiarthroplasty applied to these indications including the inner and outer bearing movements of the prosthesis.

METHODOLOGY

It was a longitudinal study conducted between March 2002 to March 2012, where 35 bipolar hemi-replacement arthroplasties were performed for the treatment of various non-traumatic hip pathologies causing hip OA secondary to healed TB hip, RA, AVN and Ankylosing arthritis of hip. Five patients lost to follow up during the period of time, hence remaining 30 were included in the study. All the operated patients had preoperative modified Harris hip score of less than 50. Patients with age less than 30 and more than 60 or have had previous hip surgery were excluded from the study.

A patented bipolar prosthesis by name "BHU bicentric bipolar prosthesis" designed by the second author was used for the study. First and second author were involved in the

surgery and case management. Second author was involved from the beginning of the study hence had maintained all the records of the patients whereas first author was involved in the last three years of study.

It is a bipolar hip prosthesis with some design modification, compared to the conventional bipolar hip prosthesis. BHU bicentric bipolar prosthesis has passed through various stages of stem design and modifications, which were tried on cadaver bones. The final design was approved and national patent was obtained and has been used in this study after ethical approval from the institutional review committee (Figure 1).



Figure 1 : BHU bicentric bipolar hip prosthesis

All the surgeries were performed by senior surgeons with patients under general anesthesia or spinal anesthesia, after taking written informed consent. Patients were positioned in lateral decubitus and Harding lateral approach was used. In all the cases uncemented type of hip hemi-replacement arthroplasty was performed. The postoperative protocol was to encourage the patients to perform quadriceps strengthening exercise from postoperative day 1 and partial weight bearing walking was allowed from 3rd day after the operation and full weight bearing was allowed at 6 week from the date of operation. The patients were followed at 6 weeks, 3 months, 9 months, 12 months than 6 monthly for 4 years and then yearly till last follow up. At each follow up, radiological assessment of movement at the inner and outer bearing of prosthesis was done by plain anteroposterior radiograph of bilateral hip in neutral position and then in maximum abduction. Additionally, clinical assessment was done by self-administered modified Harris hip score based on pain, function, entry in public transportation, absence of deformity, range of motion, sitting crossed legged (Table 1). Grading of modified Harris hip score was as follows: 1. Poor: 0-69 2. Fair: 70-79 3. Good: 80-89 4. Excellent: 90-105.

Table 1: Modified Harris hip Scoring System

1. Pain	
None or ignores it	44
Slight, occasional, no compromise in activities	40
Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin	30
Moderate pain, tolerable but makes concessions to pain; some limitation of ordinary activity or work; may require occasional pain medicine stronger than aspirin	20
Marked pain, serious limitation of activities	10
Totally disabled, crippled, pain in bed, bedrid den	0
2. FUNCTION	
LIMP	11
None	8
Slight	4
Moderate	0
Severe	
SUPPORT	11
None	7
Cane for long walks	5
Cane most of the time	3
One crutch	2
Two canes	0
Two crutches	0
Not able to walk	
ABILITY TO WALK	
Indoors only	2
Bed and chair	0
Unlimited	11
Six blocks	8
Two or three blocks	5
STAIRS	
Normally without using a railing	4
Normally using a railing	2
In any manner	1
Unable to do stairs	0
PUT ON SHOES AND SOCKS	
With ease	4
With difficulty	2
Unable	0
SITTING	
Comfortably in ordinary chair one hour	5
On a high chair for one-half hour	3
Unable to sit comfortably in any chair	0
3. Enter public transportation: Yes / No	1
5. ABSENCE OF DEFORMITY (All Yes = 4; Less Than 4 = 0)	
Less than 30° fixed flexion contracture: Yes No	
Less than 10° fixed adduction: Yes No	
Less than 10° fixed internal rotation: Yes No	
Limb length discrepancy less than 3.2 cm: Yes No	
6. RANGE OF MOTION (*Normal)	
Total degree measurements, then check range to obtain score	
Flexion (*140°): _____ External rotation (*40°): _____	
Abduction (*40°): _____ Internal rotation (*40°): _____	
Adduction (*40°): _____	
RANGE-OF-MOTION SCALE:	
211°-300°	5
161°-210°	4
101°-160°	3
60-100°	2
31°-60°	1
0°-30°	0
7. Sitting Cross legged	
With ease	5
With difficulty	2
Can't	0
Total	105

On the x-ray in the neutral position (Figure 2), a line drawn tangential to the most inferior aspect of the ischium was used as a reference line and angle A was defined by the intersection with this line of a line drawn along the inferior margin of the acetabular component. Angle B was formed by the intersection of the ischial reference line with a line drawn along the center of the long axis of the femoral stem. The exercise was repeated on the AP radiograph taken with the operated limb in maximum abducted position and angle A1 and B1 was plotted. The difference B2 between angle B and B1 represented the change in the amount of abduction of the hip and the change A2 between angle A and A1 represented the amount of motion taking place between the acetabular component and the acetabulum. The difference between B2 and A2 represented the amount of abduction taking place at the inner bearing.¹⁴ During this method, the limbs were maintained in the neutral rotation. Total amount of abduction movement occurring at outer and inner component were calculated and tabulated for each patients at each follow up.

Statistical analyses were performed using STATA 12 software. Descriptive statistics were conducted based on the collected data from 30 patients.



Figure 2 : Method of assessing component movement by Drinker and Murrays method

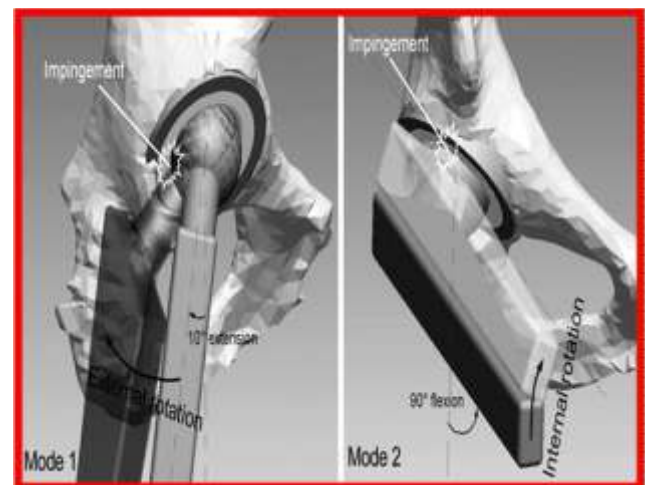


Figure 3 : Wear debris from Bipolar Femoral neck cup Impingement

RESULTS

Out of 30 patients, 17 were males and 13 were females. Their age ranged from 30 to 60 years. Osteoarthritis of hip secondary to TB hip was present in 15 patients, 7 had RA, 2 had ankylosing spondylitis and 6 had AVN of hip. Radiological assessment of movement and fraction of it occurring at various components at each follow up are tabulated in table 2. At first follow up at 6 weeks, 75.82% of total prosthetic movement was occurring at inner bearing while only 24.18% of motion was occurring between the acetabulum and prosthesis. At 1 year follow-up (n=21) the movement at the inter-prosthetic joint has steadily been above 70% of total motion while for next 7 years (n=2) the movement at inter-prosthetic joint was around 70% of the total movement. While after 8 years follow-up, (n=2) percentage of movement at inner bearing gradually increased and by 10 years (n=1) all the movement was occurring between inter-prosthetic joint (Graph 1).

Patients based self-assessment was done by modified Harris hip score questionnaire at each follow up (Table 3), At 6 months follow up (n=30) 14.28 % patients had good outcome, 61.91% had fair outcome and 28.57% had poor outcome. While by 1 years (n=21) 14.28 % had excellent outcome, 7.14 % had good outcome, 42.86% had fair outcome and 35.72% had poor outcome. By the end of 4.5 years (n=7) all the patients had excellent outcome on modified Harris hip score (Graph 2).

Table 2: Abduction movement and fraction of it occurring at various components

Duration	Total [mean value in degrees]	Outer [mean value in degrees]	Percentage	Inner [mean value in degrees]	Percentage
6 weeks (n=30)	20.43	4.94	24.18	15.49	75.82
3 months (n=30)	23.21	6.21	26.76	17.00	73.24
6 months (n=30)	23.16	6.42	27.72	16.74	72.28
9 months (n=25)	20.32	5.67	27.90	14.65	72.10
1 years (n=21)	22.14	6.14	27.73	16	72.27
1½ years (n=19)	21.32	6.82	31.99	14.5	68.01
2 years (n=16)	22.4	7.84	35.00	14.56	65.00
2½ years (n=14)	19.82	6.1	30.78	13.72	69.22
3 years (n=13)	22.42	7.43	33.14	14.99	66.86
3½ years (n=12)	24.6	7.65	31.10	16.95	68.90
4 years (n=10)	25.5	7.54	29.57	17.96	70.43
4½ year (n=7)	24.86	8.2	32.98	16.66	67.02
5 years (n=5)	25.45	7.45	29.27	18	70.73
6 years (n=3)	25.86	7.24	27.99	18.62	72.01
7 years (n=2)	25.54	7.20	28.19	18.34	71.80

8 years (n=2)	30	4	13.33	26	86.66
9 years (n=1)	30	2	6.66	28	93.33
10 years (n=1)	30	0	0	30	100

Table 3: Analysis of Modified Harris Hip Score

	Excellent	Good	Fair	Poor
6 week (n=30)	0	9.52	28.57	61.91
3 months (n=30)	0	9.52	57.14	33.34
6 months (n=30)	0	14.28	61.91	28.57
9 months (n=25)	11.76	17.64	35.3	35.3
1 year (n=21)	14.28	7.14	42.86	35.72
1½ years (n=19)	14.28	7.14	42.86	35.72
2 years (n=16)	33.33	25	16.67	25
2½ years (n=14)	50	0	25	25
3 years (n=13)	50.0	12.5	12.5	25
3½ years (n=12)	75	0	25	0
4 years (n=10)	75	0	25	0
4½ years (n=7)	100	0	0	0
5 years (n=5)	100	0	0	0
6 years (n=3)	100	0	0	0
7 years (n=2)	100	0	0	0
8 years (n=2)	100	0	0	0
9 years (n=1)	100	0	0	0
10 years (n=1)	100	0	0	0

DISCUSSION

Total hip arthroplasty is already an established and standard modality of treatment for severe OA of hip secondary to rheumatoid arthritis, avascular necrosis of femoral head and is being performed all over the world. Although the early and intermediate outcomes were very successful and promising with longer follow up surgeons are tackling complications like acetabular component loosening, instability, dislocation and difficulty in revision. Relatively simple and gratifying procedure of bipolar hip arthroplasty could be a good and cheaper alternative in both aged and younger patients with hip OA. Almost 80% of patients showed good to excellent results after bipolar hip arthroplasty in study conducted by Dudani et al. Bateman in his series of 760 degenerative hip has shown good results with improvement of Harris hip score from 51 to 87 after bipolar hip arthroplasty.^{15,7} McConville et al. found bipolar hip arthroplasty as viable option against THA, in their series of 100 consecutive patients of degenerative arthritis of hip.⁸ At an average follow-up of 65.7 months Pandit et al. noticed 93-96 % hips had good to excellent results after bipolar hip arthroplasty, which was comparable to our study where at end of 4.5 years all 7 patients had excellent results.¹⁶

We propose changes in the design of BHU bicentric bipolar prosthesis as mentioned by Rai et al. for the prolonged preservation of movement at inter-prosthetic joint, and good to excellent modified Harris hip score in majority of patients in this series.^{17, 18} Modification of seating angle between the stem and the collar has allowed preservation of the calcar by quarter to 1 cm after implantation of the prosthesis. Due to low seating angle in conventional bipolar (Bateman type), the calcar has to be sacrificed during the surgery and hence on weight bearing the prosthesis tends to sink if cement is not used.^{17, 18} The ultra-high molecular weight polyethylene (UHMWPE) lining has a beveled margin (Figure 3). Thus, reduces wear and debris formation at extremes of the movement.^{17, 18} The neck of the prosthesis has been made trapezoidal like the Charnley type neck and the cup has been modified in a staggering fashion to decrease neck cup impingement. This modification in design has grossly improved movement at the inner articulation and avoided the neck cup impingement, thereby increasing the life of the bipolar prosthesis. UHMWPE wear in a bipolar prosthesis is 0.7 mm/year. A 22 mm Charnley head diameter has been used in the BHU bicentric bipolar prosthesis, so that thicker UHMWPE can be provided in outer bearing, thereby increasing the survivorship of the prosthesis.^{17, 18} Moreover, smaller sized head further provides increased movement at the inner bearing for a longer time, adding longevity to the prosthesis. BHU bicentric bipolar prosthesis is available in 37-55 mm head sizes in 1 mm increments, which provides appropriate head size for replacement and subsequently prevents early failure of the prosthesis, by avoiding Hertzian contact stress.^{17, 18} The BHU bicentric bipolar prosthesis allows crossed legged sitting and squatting without limiting patient range of movement at the hip (Figure 4).



Figure 4 : Eight year follow up : Patient squatting and sitting crossed legged

Bipolar hip arthroplasty has been used as a treatment for AVN of femoral head.^{13, 19, 20, 21} Chan et al. found no statistical difference in clinical results, thigh pain, groin pain, osteolysis, dislocation, and revision rate while comparing bipolar hip arthroplasty with THA for hip osteonecrosis in the same patient.²² In contrast to our results, Hiroshi et al. showed inferior results of bipolar hip arthroplasty in osteonecrosis of femoral head.²³ They had 42% of radiographic failure, 42% patients had groin pain and 25% hip required revision surgery. Hence, they no longer used bipolar hip arthroplasty for AVN of hip. Similarly, Ito et al.²⁴ demonstrated that the average Harris hip score improved

from 46 to 86 in patients treated with bipolar hemiarthroplasty for AVN hip, but at final follow-up of average 11.4 years, 20 (42%) hips had radiographic failures, 12 (25%) hips were revised and groin symptoms were present in 20 (42%) hips. Hence they no longer recommend bipolar prosthesis for the treatment of osteonecrosis of femoral head.

Vazquez-vela et al. noticed in all patients with protusio and thin medial wall there was no increase in protusio, rather in majority of patients there was significant thickening of the medial acetabular wall.⁹ In none of the patients, bone graft was used. Incidence of ectopic para-articular bone formation following total hip arthroplasty is variable in literature. However, functional impairment due to this occurs in 3-10% cases of THA.^{25, 26} Incidence of this complication is remarkably less in cases of bipolar hip arthroplasty since this is a relatively simple procedure where minimal capsular exposure is required and acetabular preparation is either not required or is minimal. Bhan et al. in their study of bipolar hip arthroplasty in ankylosing spondylitis concluded that bipolar arthroplasty gives excellent results in OA hip secondary to AS, since it is technically easy, has lower risk of initiating heterotopic ossification and provides excellent functional recovery.²⁷

In a study by Rai et al. where they used BHU bipolar prosthesis in treatment of intra-capsular fracture neck of femur they noticed gradual increase in movement at outer bearing, which was 80.51% at last follow-up.¹⁷ Similarly, the movement at the inner bearing gradually decreased from a mean of 7.53 (31.4%) to 4.5 (19.49%). They concluded that there was a slight loss of movement at the inner bearing over the months on subsequent follow up as compared to the first follow up, whereas this difference was not statistically significant.

CONCLUSION

The BHU bicentric bipolar prosthesis has been shown to be a good option for non-traumatic hip disorders, as it is associated with better clinical outcomes.

RECOMMENDATION

It may be a viable alternative to the costly total hip replacement arthroplasty for the poor Indian subcontinent patients.

LIMITATION OF THE STUDY

The findings of this study should be interpreted in line with the following limitations. First our sample size was small with only one of the patient having 10 years follow-up. Second, 5 patients were lost to follow-up.

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CONFLICT OF INTEREST

The authors have read the manuscript and declare that there are no conflicts of interest in relation to the article.

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