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Comparison of the Short-Term Outcomes of Cementless Bipolar Hemiarthroplasty and Cementless Total Hip Arthroplasty for Displaced Femoral Neck Fractures in the Elderly

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Purpose: Displaced femoral neck fracture (DFNF) in elderly patients are frequently managed by hip replacement. However there is no consensus on bipolar hemiarthroplasty (BHA), which has a lower dislocation rate, less blood loss and shorter operative time, while total hip arthroplasty (THA) provides better functional and long term outcomes. This study aimed to evaluate patient function and complications following both BHA and THA in an elderly population who presented with DFNF.
Methods: A prospective, randomized controlled trial comparing BHA and THA for DFNF treatment was performed. Patients over 60 years of age with DFNF (Garden's classification types 3 and 4) participated in this study, while patients with preexisting hip conditions and impaired cognitive function were excluded from the study. All operations were performed by a single surgeon using the same techniques the posterior approach. Demographic data, intraoperative blood loss, operative time, and morbidity and mortality statistics were collected. Patients were followed up at 1, 3, 6 and 12 months and their functional scores were calculated according to the Harris hip score. Statistical analyses were performed to the intention-to-treat principle.
Results: The cohort comprised 75 patients, with 38 patients in the BHA group (mean age 76.7 years) and 37 patients in the THA group (mean age75.7 years). The mean operative times for the BHA and THA groups were 40.76 and 51.08 minutes respectively. The average intraoperative blood loss was 200 cc and 279.7 cc, respectively. The mean hospital stay was 5.07 days for the BHA group and 4.92 days for the THA group. The mean Harris hip scores at 1, 3, 6 and 12 months in the BHA group were 71.5, 78, 85 and 86, respectively, while in those in the THA group were 71, 79, 85.5 and 88 respectively. Statistically, there were no significant difference between the two groups. Morbidities including fractures and dislocations, and mortality rates, also showed no statistically significant difference.
Conclusions: Harris hip score, dislocation, length of hospital stay and mortality rate at one year is not statistically different between group. Blood loss and operative time were significantly lower in the BHA group than in the THA group.

Keywords: fracture neck of femur, femoral neck fracture, bipolar hemiarthroplasty, total hip arthroplasty, Harris Hip Score

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Femoral neck fractures (FNF) are a major cause of morbidity and mortality, especially in elderly age patients. These require immediate and appropriate management[1,2]. As these fractures are associated with impaired mobility, loss of function, and personal independence as well as with global economic health costs[2,3]. Displaced femoral neck fracture (DFNF) can result in non-union or avascular necrosis. They are rarely managed nonoperatively. Surgical management options for FNF include internal fixation and hip arthroplasty. Internal fixation is the method of choice for young patients with displaced fractures or patients in any age group with non displaced fractures[4]. Bipolar hemiarthroplasty (BHA) or total hip arthroplasty (THA) are the preferred treatment modalities in the elderly population (>60 years). Both BHA and THA are widely accepted hip replacement methods for DFNF[5,6]. Some evidence has suggested that THA leads to a better functional outcome than BHA; However, there are some advantages of BHA over THA such as reduced dislocation rate, less complex surgery, shorter operation time, less blood loss, and lower initial costs[7-9].

Therefore, through this randomized controlled trial (RCT). We aimed to evaluate the clinical outcomes and complications FNFs in the elderly population after BHA and THA. These results will improve our understanding of the treatment options for DFNF in elderly Thai patients.

PATIENTS AND METHODS

The patients were enrolled in the study after providing informed consent. The inclusion criteria were age ≥60years with an acute DFNF (Garden's classification type 3,4) and an absence of preexisting hip conditions and Randomization was performed using a random number table. The exclusion criteria included patients who refused to follow the protocol, had cognitive impairment or were unavailable for follow-up.

The trial was conducted over 2 years (2018-2019) and was approved by the hospital's ethics committee. Spinal anesthesia was administered to all patients. All surgeries were performed by a single surgeon using the same posterior approach (Moore's approach).

In the THA group, the CORAIL/ PINNACLE combination was chosen, based on the 2018 Annual Report of the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man where revision rates at 10 years were 2.84%.[10,11] A PE liner and a 32 mm diameter CoCr head were used in every case (Figure 1). In the BHA group, CORAIL hip system femoral stem (DePuy Synthes, Johnson and Johnson) which has been reported to survive beyond 25 years[12], was used in every cases (Figure 2). Post operatively patients were allowed early weight bearing with a walker as soon as their pain threshold permitted. After discharge, the patients were followed up at 1, 3, 6 and 12 months.

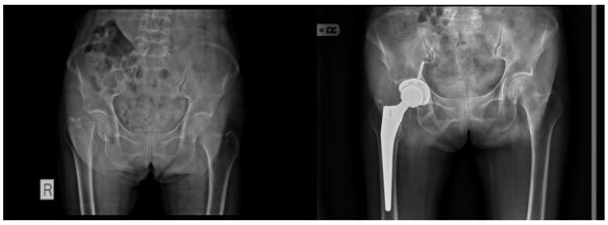

Fig. 1 Radiographs at time of injury and 1-year follow-up after total hip arthroplasty.

Fig. 2 Radiographs at time of injury and 1-year follow-up after bipolar hemiarthroplasty.

Data were recorded on operative time, intraoperative blood loss, duration of hospital stay and complications. Functional outcome were assessed using the Harris hip score at 1, 3, 6 and 12 months after surgery. General complications were recorded and specific complications such as periprosthetic dislocation, periprosthetic fracture, and any new fracture of the lower limb during the follow up, were recorded. All patients included in the outcome analysis remained in their primary randomization group regardless of the secondary procedures according to the intention-to-treat principle.

The sample size was calculated using the formula for testing two independent means of sampling (two-tailed test).

$$n_1 = \frac{\left(z_{1-\frac{\alpha}{2}} + z_{1-\beta}\right)^2 \left[\sigma_1^2 + \frac{\sigma_2^2}{r}\right]}{\Delta^2}$$

$$r = \frac{n_2}{n_1}, \Delta = \mu_1 - \mu_2$$

A power analysis based on a previous study with the same inclusion criteria[13], with an alpha level of 0.05 and a power of 90%, indicated that 31 patients would be needed in each group. The drop out rate was expected to be approximately 20%. The final sample size was 37 patients per group with the actual number being 37 patients in one group and 38 in the second group.

Statistical Methods

Statistical analysis were performed using the R statistical package (version 3.6.3). Non-parametric data were tested using an independent t-test. The chi-squared test or Fisher's exact test was used for nominal variables. Wilcoxon's signed rank test was used to comparing data at follow up meetings. Results were considered significant at $p < 0.05$.

RESULTS

A total of 75 patients with DFNF were enrolled and randomly allocated by a random number table to receive treatment using either BHA or THA. There were 38 patients in the BHA group and 37 in the THA group, with no significant differences in demographic data between the two groups (Table 1). The mean age of the patients was 76.7 years (62-92 years) in the BHA group and 75.7 years (60-88) in the THA group, with 79% of the patients with DFNF being females. Patient histories showed that fall were the mode of injury in most patients (97.4%), and 55% of the patients underwent surgery within 72 hours of the injury.

The mean operative times were 40.76 (30-55 min) in the BHA group and 51.08 (35-65 min) in the THA group, which was significant (p= 0.0002). The mean intraoperative blood loss was 200 ml in the BHA and 279.7 ml in the THA group, which was significant (p= 0.0002). The mean hospital stay was 5.07 (3-10) days for the BHA group and 4.92 (3-9) days for the THA group (p= 0.97). Operative details are presented in Table 2.

In the BHA group, the mean HHS were 71.5, 78, 85 and 86 at 1, 3, 6 and 12 months respectively. In the THA group, the mean HHS were 71, 79, 85.5 and 88 at 1, 3, 6 and 12 months respectively. There were no statistical differences between the two groups at 1, 3, 6 or 12 months (Fisher's exact test), as shown in Table 3.

Table 1 Baseline Demographics.

	BHA group	THA group	P-value
Case (n)	38	37	
Average age (year, range)	76.7 (62-92)	75.7 (60-88)	0.608
Female (n)	27	32	0.270
Body weight (kg)	53.66	52.14	0.540
Right side (n)	21	14	0.564
Mean time to surgery (<72 hrs)	24 (63%)	17 (47%)	0.250

THA, total hip arthroplasty; BHA, bipolar hemiarthroplasty

Table 2 Operative details.

	BHA group	THA group	P-value
Duration of operation (min)	40.76 (30-55)	51.08 (35-65)	0.0002
Intraoperative blood loss (ml)	200 (50-500)	279.7 (100-800)	0.0002
Hospital stay (day)	5.07 (3-10)	4.92 (3-9)	0.970

THA, total hip arthroplasty; BHA, bipolar hemiarthroplasty

Table 3 Comparison of Harris Hip Score of post-operative functional outcomes between BHA and THA.

Median follow-up time	BHA group	THA group	P-value
1 month	71.5 (39-91)	71.0 (40-100)	0.700
3 months	78.0 (49-93)	79.0 (65-100)	0.163
6months	85.0 (49-95)	85.5 (72-100)	0.103
1 year	86.0 (49-100)	88.0 (75-100)	0.095

THA, total hip arthroplasty; BHA, bipolar hemiarthroplasty

Table 4 Complications within 12 months.

	BHA group (n=38)	THA group (n=37)	P-value
Dislocation	2	3	0.675
New event of fracture	2	2	1.000
Periprosthetic fracture	1	1	1.000
Revision operation	-	-	N/A
Infections	-	-	N/A
Mortality	3	4	0.711

THA, total hip arthroplasty; BHA, bipolar hemiarthroplasty

During the 1-year follow up, seven patients died: three patients (7.9%) in the BHA group and four patients (10.8%) in the THA group. This difference was not statistically significant (p = 0.711). The cause of death was not related to hip joint fracture. In the THA group, the four patients died from meningitis with sepsis, myocardial ischemia, pneumonia and hemorrhagic stroke (at 2, 3, 5 and 9 months). In the BHA group, one patient died from urinary tract infection with sepsis and the other two died from pneumonia with respiratory failure (at 5, 7 and 10 months)

Two patients sustained a post operative periprosthetic fracture due to a fall. One patient in the THA group sustained a peri-prosthetic fracture (Vancouver B1 fractures) 4 months after the THA procedure which was successfully treated with plate fixation. One patient in the BHA group sustained a periprosthetic fracture (Vancouver B1 fractures) 3 months after the operation by falling, which was treated with wiring and bone grafting.

Contralateral hip fracture, however, occurred in three patients in each of the two groups. After specific treatment, all patients returned to their normal activity of daily living. There was no loosening or prosthetic infection in our patients.

Four patients sustained additional hip fractures involving the opposite side before the 1-year follow up period. One patient in the BHA group had an intertrochanteric fracture that was treated with a short cephalomedullary nail, and the other patient sustained a DFNF that was treated with BHA. Two patients in the THA group had a DFNF that was treated with a BHA.

In the THA group, three patients sustained a posterior hip dislocation after a simple fall. These were stable after closed reduction under general anesthesia and the patients were able to return to active daily life. In the BHA group, two patients developed posterior hip dislocation after falling; both were stable after closed reduction and did not subsequently experience dislocation again. The differences between the two groups were not statistically significant (p = 0.6745, Fisher's exact test). No loosening, infection or revision case. All the complications are presented in Table 4.

DISCUSSION

Globally, DFNF is common among elderly patients and leads to a substantial risk of health complications, reduced quality of life and death. Despite this high DFNF frequency of among the elderly, the best surgical method by which DFNF should be managed remains uncertain. To date, there is a paucity of data relevant to the Thai population whose lifestyle might be different from

that of foreigners as Thailand has a predominantly agricultural and rural population. This study was conducted in the Buddhachinaraj Hospital, where BHA is the primary treatment in approximately 80% of cases. However, the results and subsequent complications were not recorded.

Two RCTs[13,20], indicated that THA has better functional outcomes for elderly patients with femoral neck fracture than BHA. One meta-analysis[15] provided data that indicated THA gave a better functional score and a lower revision rate despite THA having a higher rate of dislocation. Given these outcomes, THA is a widely accepted method of hip replacement after DFNF.

However, a recent RCT[16] showed that THA provided a clinically unimportant improvement over BHA in terms of function and quality of life over 24 months. Additionally, the incidence of secondary procedures after 2-years did not differ significantly between the two groups. Another recent meta-analysis[17] concluded that THA is the intervention of choice for individuals with DFNF who are younger than 80 years or have a life expectancy of 4-years or more. In contrast, for patients with a shorter life expectancy and those over 80 years, BHA is a reasonable intervention to manage DFNF and is superior to unipolar HA due to the lower risk of reoperation.

Therefore, this issue remains inconclusive. Our study showed that the functional scores, as shown by the Harris hip scores, consistently improved in both the BHA and THA in each follow up period. In accordance with previous studies[16,17], our data showed no statistically significant differences between the BHA and THA groups at 1, 3, 6 and 12 months.

From previous reports, the average operative time for THA was expected to be 10–15 min longer than BHA[15,18]. In our study, the average operative time was in agreement, with a significantly longer operative time of 51.08 min for the THA group as compared to 40.76 min for the BHA group (p=0.0002). Similarly, intraoperative blood loss was significantly lower in the BHA group (200 ml vs 279.7 ml, p=0.0002). However, while a longer operating time and higher blood loss were experienced in the THA group, there was no increase in the number of general complications or the mortality rate, and the length of hospital stay was not significantly different between the two groups (5.07 days vs 4.92 days, p=0.97). Wound infections were not reported in this study.

In femoral neck fractures, several surgeons have prefer the use of BHA to THA because of the lower risk of prosthetic hip dislocation. In addition, several meta-analyses found significantly higher dislocation rates after THA than after BHA[15,19]. In a study by Burgers et al[8], dislocation was found in 9% of THA cases and 3% of BHA cases. Bhandarai et al.[16] reported the relative risk of dislocation after THA was 2.53 times that after BHA (95% CI, 1.05 to 6.10). In our study, there were five dislocations: three cases (8.1%) in the THA group and two cases (5.3%) in the BHA group, which were not significantly different (p= 0.6745). In all 5 cases, the cause of dislocation was a simple fall and all patients were stable after closed reduction.

In general, pain after BHA due to acetabular erosion, is a common problem that decrease effectiveness and requires a second operation. Zhao et al.[15] reported that erosion was the reason for revision surgery in 78.1% of patients in the BHA group. Blomfeldt et al.[13] preferred to perform THA to avoid long-term acetabular cartilage erosion and the need for conversion of BHA to THA. Given the short-term follow-up in our study, there were no revised operations due to acetabular erosion in that timeframe.

While FNF's have a high mortality rate and natural morbidity of approximately 25%, independent of fracture type or surgical procedure[21], in the 1 year of our study, we found only 7 deaths in 75 patients (9.3%) but none of these deaths were related to hip joint fracture. Three of these deaths occurred in the BHA group, where as four deaths occurred in the THA group (7.9% vs 10.8%, p= 0.711). In previous RCTs and two meta-analyses, the THA and BHA mortality rates ranged from 5.8% to 27.5% [6,8,13,17,20].

Our study showed a refracture rate of 10.7%, which is substantial. Hence, precautions against osteoporotic fractures due to falling, and the treatment of osteoporosis, should be promoted. Further RCTs with larger sample sizes and longer

follow-up periods are required to confirm these findings and to investigate the influence of revised operative procedures, as well as mortality likelyhood following dislocation.

The advantages of this RCT were that all surgeries were performed by the same surgeon and the clinical results and imaging were observed by the same group of researchers. However, our study has some limitations. First, there was no record of pre-fracture hip scores and functional levels that could confound the postoperative functional outcomes. Second, additional risk factors and underlying diseases associated with postoperative functional outcomes were not included in our study. Finally, this trial was not blinded and the sample size was relatively small.

CONCLUSIONS

In conclusion, our study has shown that the short-term outcome of BHA yields a satisfactory hip function that is not different from that of THA. Similarly, the length of hospital stay, prosthetic hip dislocations, fractures, 1-year mortality rate, and reoperation risk were also not different, while blood loss and operative time were significantly lower in BHA. It may be concluded that BHA is suitable for elderly patients with lower functional demands and shorter life expectancy.

REFERENCES

1. Riggs BL, Melton 3rd LJ. The worldwide problem of osteoporosis: insights afforded by epidemiology. Bone 1995;17(5 Suppl):505S-511S.
2. Bhandari M, Swiontkowski M. Management of acute hip fracture. N Engl J Med 2017;377:2053-62.
3. Johnell O, Kanis JA. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. Osteoporos Int 2006;17:1726-33.
4. Bhandari M, Devereaux PJ, Swiontkowski MF, et al. Internal fixation compared with arthroplasty for displaced fractures of the femoral neck: a meta-analysis. J Bone Joint Surg Am 2003;85:1673-81.
5. Goh S-K, Samuel M, Ching Su DH, et al. Meta-analysis comparing total hip arthroplasty with hemiarthroplasty in the treatment of displaced neck of femur fracture. J Arthroplasty 2009;24: 400-6.
6. Liao L, Zhao J, Su W, et al. A meta-analysis of total hip arthroplasty and hemiarthroplasty outcomes for displaced femoral neck fractures. Arch Orthop Trauma Surg 2012;132:1021-9.
7. Hopley C, Stengel D, Ekkernkamp A, et al. Primary total hip arthroplasty versus hemiarthroplasty for displaced intracapsular hip fractures in older patients: systematic review. BMJ 2010;340:c2332.
8. Burgers PTPW, Van Geene AR, Van den Bekerom MPJ, et al. Total hip arthroplasty versus hemiarthroplasty for displaced femoral neck fractures in the healthy elderly: a meta-analysis and systematic review of randomized trials. Int Orthop 2012;36:1549-60.
9. Lewis DP, Waever D, Thorninger R, et al. Hemiarthroplasty vs total hip arthroplasty for the management of displaced neck of femur fractures: a systematic review and meta-analysis. J Arthroplasty 2019;34:1837-43.
10. National Joint Registry for England, Wales, Northern Ireland and the Isle of Man, 15th Annual Report. 2018:71-73. Available from: https://www.hqip.org.uk. Accessed December 31,2017.
11. National Joint Registry for England, Wales, Northern Ireland and the Isle of Man, 15th Annual Report. 2018:68-70. Available from: https://www.hqip.org.uk. Accessed December 31,2017.
12. Jacquot L, Bonnin MP, Machenaud A, et al. Clinical and radiographic outcomes at 25- 30 years of a hip stem fully coated with hydroxyapatite. J Arthroplasty 2018;33:482-90
13. Blomfeldt R, Törnkvist H, Eriksson K, et al. A randomised controlled trial comparing bipolar hemiarthroplasty with total hip replacement for displaced intracapsular fractures of the femoral

neck in elderly patients. J Bone Joint Surg Br 2007;89:160-5.

14. Miller BJ, Callaghan JJ, Cram P, et al. Changing trends in the treatment of femoral neck fractures: a review of the American Board of Orthopaedic surgery database. J Bone Joint Surg Am 2014;96:e149.
15. Zhao Y, Fu D, Chen K. Outcome of hemiarthroplasty and total hip replacement for active elderly patients with displaced femoral neck fractures: a meta-analysis of 8 randomized clinical trials. PLoS one 2014;9:e98071.
16. Bhandari M, Einhorn TA, Guyatt G. Total hip arthroplasty or hemiarthroplasty for hip fracture. N Engl J Med 2019;381:2199-208.
17. Lewis DP, Waver D, Thorninger R, et al. Hemiarthroplasty vs total hip arthroplasty for the management of displaced neck of femur fractures: A systematic review and meta-analysis. J Arthroplasty 2019;34:1837-43.
18. Sharma V, Awasthi B, Kumar K. Outcome analysis of hemiarthroplasty vs. total hip replacement in displaced femoral neck fractures in the elderly. J Clin Diagn Res 2016;10:RC11-3.
19. Wang F, Zhang H, Zhang Z, et al. Comparison of bipolar hemiarthroplasty and total hip arthroplasty for displaced femoral neck fractures in the healthy elderly: a meta-analysis. BMC Musculoskelet Disord 2015;16:229.
20. Macaulay W, Nellans KW, Garvin KL, et al. Prospective randomized clinical trial comparing hemiarthroplasty to, total hip arthroplasty in the treatment of displaced femoral neck fractures: winner of the Dorr Award. J Arthroplasty 2008; 23(6 Suppl 1):2-8.
21. Wolinsky FD, Fitzgerald JF, Stump TE. The effect of hip fracture on mortality, hospitalization, and functional status: a prospective study. Am J Public Health 1997;87:398-403.