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Functional outcome of non-cemented total hip arthroplasty for avascular necrosis in adults of below 50 years age group

Pathik Biswas[1]*, Jahangir Alam[1], Jobayer Al Mahmud[1], Shariful Alam[1], Humayun Kabir[1], Ananya Shankhary Brishti[2]

[1]Department of Orthopedics, National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, Bangladesh
[2]Dhaka Medical College Hospital, Dhaka, Bangladesh

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***Correspondence:**
Dr. Pathik Biswas,
E-mail: pathikbiswas2012@gmail.com

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ABSTRACT

Background: Avascular necrosis (AVN) of the femoral head is a progressive disorder causing joint destruction and functional impairment, particularly in younger adults. Total hip arthroplasty (THA) is the standard treatment for advanced AVN and non-cemented prostheses are increasingly preferred because of their biomechanical advantages and long-term stability. This study evaluated the functional outcomes of non-cemented THA in AVN patients under 50 years of age.

Methods: A prospective observational study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh, from September 2021 to March 2024. Thirty-four patients with late-stage AVN (Ficat & Arlet Stage III and IV) underwent non-cemented THA. Functional outcomes were assessed preoperatively and postoperatively using the Harris Hip Score (HHS), range of motion (ROM), pain severity, walking distance and need for support. Data were analyzed using SPSS version 25, with $p<0.05$ considered statistically significant.

Results: The mean age was 35.50±7.01 years and 73.53% were male. Mean HHS improved significantly from 37.12 preoperatively to 91.44 postoperatively ($p=0.001$), with 61.8% achieving excellent outcomes (HHS >90). Significant improvements were observed in pain severity, limping, support dependency and walking distance ($p=0.001$). ROM also improved significantly, with 64.71% achieving a postoperative ROM of 161°–210°. Complications were minimal, including superficial surgical site infection in 5.88% and limb length discrepancy in 2.94%.

Conclusions: Non-cemented THA provides significant pain relief and improvement in mobility, ROM and functional outcomes in AVN patients under 50 years, with minimal complications, supporting its use in younger active patients.

Keywords: Avascular necrosis, Functional outcome, Harris hip score, Hip replacement, Non-cemented prosthesis, Osseointegration, Total hip arthroplasty, Young adults

INTRODUCTION

AVN of the femoral head is a progressive, debilitating condition characterized by compromised blood supply, leading to osteocyte death, subchondral collapse and eventual hip joint degeneration.[1] The prevalence of AVN has increased in recent years, particularly among younger adults below the age of 50, largely due to risk factors such as long-term corticosteroid use, excessive alcohol consumption, trauma, sickle cell disease and idiopathic causes.[2] The global burden of AVN is considerable, affecting approximately 20,000 patients annually, with its prevalence varying significantly by geographical location and population risk factors.[3,4] Patients with AVN suffer from severe functional impairment, experiencing chronic pain, progressive loss of mobility and a substantial decline in overall quality of life, often leading to early disability and unemployment.[5] Given the irreversible nature of femoral head necrosis, timely and effective intervention is critical to prevent further joint destruction. Several

treatment modalities exist for AVN, with selection depending on the stage of the disease and the patient's functional demands. In early-stage AVN (pre-collapse), joint-preserving procedures such as core decompression, vascularized bone grafting and osteotomies are commonly performed in an attempt to restore femoral head perfusion and delay progression to arthritis.[6] Core decompression, which involves drilling into the necrotic bone to relieve intraosseous pressure and promote revascularization, has shown moderate success, particularly when combined with autologous bone marrow aspirate concentrate.[2] However, survival analysis has indicated that core decompression alone yields limited long-term efficacy, with a high likelihood of requiring THA within a few years.[7] Vascularized bone grafting has demonstrated superior outcomes in delaying femoral head collapse, particularly in young patients with early-stage AVN, but is associated with technical challenges and donor site morbidity.[8] Once the femoral head has collapsed (Stages III-IV AVN), joint-preserving procedures become less viable and THA remains the definitive treatment for restoring hip function.[9] THA has become the preferred surgical intervention for end-stage AVN, particularly in younger patients when joint salvage techniques fail. The choice between cemented and non-cemented THA remains a subject of ongoing debate, particularly concerning long-term prosthesis survival, osseointegration and complication rates. Cemented THA has historically been favored due to its immediate implant stability and well-documented longevity, particularly in older and osteoporotic patients.[10] However, studies have shown that cemented THA may be associated with higher rates of aseptic loosening and long-term wear-related complications in younger, more active individuals.[11]

By contrast, non-cemented THA, which relies on bone ingrowth for long-term fixation, has emerged as a superior option for younger, high-demand patients.[1] This approach utilizes porous-coated implants that facilitate osseointegration, resulting in improved long-term prosthesis stability and reduced risk of cement-related complications.[12] Recent research comparing cemented and non-cemented THA has demonstrated distinct advantages of non-cemented implants in younger patients with AVN. A study evaluating non-cemented THA in AVN patients aged 21–40 years found that 94% of femoral stems achieved successful osseointegration, with lower revision rates compared to earlier-generation cemented implants.[1] Similarly, a 10 years follow-up study of metal-on-metal, non-cemented THA in AVN patients under 65 years found an implant survival rate of 92.5%, with comparable functional outcomes to those seen in patients with osteoarthritis.[12]

Furthermore, non-cemented prostheses have been associated with faster postoperative bone integration, shorter healing times and a lower incidence of periprosthetic osteolysis and aseptic loosening compared to cemented THA.[13] Despite these advantages, non-cemented THA is not without its challenges. Early postoperative complications, including stress shielding, periprosthetic fractures and initial micromotion, remain concerns, particularly in cases of poor bone stock. However, advances in implant design, including hydroxyapatite-coated acetabular components, have led to improved primary stability and enhanced bone remodeling, making non-cemented THA a more viable lifelong solution for younger patients. A study analyzing hydroxyapatite-coated, non-cemented THA in young patients showed 96% implant survivorship at five years, with no significant radiographic loosening or failure of osseointegration.[14]

This evidence supports the growing preference for non-cemented THA in younger AVN patients who require durable, long-lasting solutions for hip joint replacement. Given the limited data on non-cemented THA outcomes in younger AVN patients in Bangladesh, this study aims to evaluate the functional outcomes, implant longevity and complication rates of non-cemented THA in adults under 50 years. Specifically, the study will assess postoperative functional improvement using the Harris Hip Score, prosthesis survival over a defined follow-up period and complications such as aseptic loosening, periprosthetic fractures and revisions. By focusing on a younger patient population, this research will provide clinically significant insights into the long-term effectiveness of non-cemented THA in high-demand individuals and contribute valuable data to the growing body of literature on optimal hip replacement strategies for AVN.

METHODS

This prospective observational study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh, from September 2021 to March 2024. A total of 34 patients were included using purposive non-randomized sampling based on the availability of patients meeting the selection criteria. Inclusion criteria comprised patients below 50 years of age, of both sexes, diagnosed with late-stage AVN of the femoral head (Ficat and Arlet Stage III & IV), affecting either unilateral or bilateral hips. Exclusion criteria included a history of prior hip replacement, active infections, progressive neurological diseases and malignancies with poor life expectancy.

Data were collected using a structured data collection form, incorporating demographics, presenting symptoms, clinical findings, medical history, radiological investigations, preoperative conditions and postoperative outcomes, verified by the supervising guide. Each patient was informed about the study objectives, procedure, risks and benefits and written informed consent was obtained. The diagnosis of AVN of the femoral head was confirmed through detailed history-taking, clinical examination and relevant investigations. History-taking focused on symptom onset, trauma history, medication use (especially corticosteroids) and past treatments. Clinical examination included joint mobility assessment, pain grading, presence

of deformities, limb length discrepancy, muscle atrophy and neurovascular status. Radiological evaluation included X-ray pelvis (anteroposterior and lateral views), while MRI was performed when necessary. Laboratory investigations encompassed hematological (CBC, ESR), biochemical (serum creatinine, blood glucose, electrolytes, lipid profile), infection screening (HBsAg, Anti-HCV, Mantoux test in suspected cases) and immune markers (RA factor, HLA-B27 in specific cases). Preoperative preparation involved detailed counseling about treatment options, expected outcomes and possible complications, with informed consent taken for surgery. Pre-anesthetic evaluations were conducted and patients fasted for six hours before surgery.

Preoperative templating determined the approximate implant size and antibiotic prophylaxis was administered with intravenous cefuroxime (1.5 g) and flucloxacillin (500 mg) at anesthesia induction, followed by cefuroxime (750 mg) IV every 8 hours for three days, then oral cefuroxime (500 mg) 12-hourly for four days. Patients were positioned in the true lateral position and aseptic skin preparation was done using hexidine scrub and povidone-iodine solution. Surgical procedure: THA was performed using a lateral transgluteal (Hardinge) approach with a non-cemented femoral and acetabular component. Postoperative pain management, mobilization and rehabilitation protocols were followed per institutional guidelines. Follow-up evaluations were conducted at six weeks, three months, six months and every six months thereafter. At each visit, clinical assessment was performed using the HHS and radiological evaluation (X-ray pelvis AP view) was done to assess implant stability and complications. For bilateral cases, follow-up began after the second THA. Data collection and analysis: Data were collected using structured questionnaires, entered and analyzed using SPSS version 25. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized as mean and SD.

Paired t-tests were used to compare preoperative and postoperative functional outcomes, with $p<0.05$ considered statistically significant. Institutional and ethical approval: Ethical clearance was obtained from the Institutional Review Board (IRB) of NITOR, Dhaka, Bangladesh. All procedures followed institutional ethical guidelines, ensuring confidentiality and voluntary participation. The study did not impose additional economic burdens or unnecessary investigations on patients.

RESULTS

The study included 34 patients, with a mean age of 35.50±7.01 years. The majority of patients (47.06%) were within the 31–40 years age group, followed by 29.41% in the 41–50 years category and 23.53% in the 20–30 years group. Males constituted the majority (73.53%), while females comprised 26.47% of the study population. Regarding occupational status, the highest proportion of patients were business professionals (38.24%), followed by service holders (35.29%) and housewives (20.59%), while students accounted for the lowest proportion (5.88%). Among the 34 study patients, the most common etiological factor for AVN was idiopathic (52.94%), followed by post-traumatic causes (26.47%). Post-infective AVN accounted for 14.71%, while steroid-induced AVN was the least common (5.88%). In terms of the affected side, the right hip was involved in 55.88% of cases, while 26.47% had left hip involvement. Bilateral AVN was observed in 17.65% of the patients. Postoperative complications were observed in a small proportion of patients, with the majority (91.18%) experiencing no complications. SSSI occurred in 5.88% of cases, while LLD was noted in 2.94% of the patients. No major complications such as deep infections, prosthesis dislocation or periprosthetic fractures were reported in the study.

Table 1: Distribution of baseline characteristics (n=34).

Baseline demographics	Frequency	%
Age (in years)		
20–30	8	23.53
31–40	16	47.06
41-50	10	29.41
Mean±SD	35.50±7.01	
Sex		
Male	25	73.53
Female	9	26.47
Occupational status		
Business	13	38.24
Service	12	35.29
Housewife	7	20.59
Student	2	5.88

Table 2: Distribution of the study patient by injury related characteristics.

Variables	Frequency	%
Etiological association		
Idiopathic	18	52.94
Post-traumatic	9	26.47
Post-infective	5	14.71
Steroid induce	2	5.88
Affected side		
Right	19	55.88
Left	9	26.47
Both	6	17.65

Table 3: Distribution of the study patient by post-operative complications (n=34).

Complications	Frequency	%
Superficial surgical site infection (SSSI)	2	5.88
Limb length discrepancy (LLD)	1	2.94
No complications	31	91.18

Table 4: Distribution of the study patient by pre and post-operative functional characteristics scores.

Criteria	Pre-operative score	Post-operative score (at last follow-up)	Mean score difference	t-value	P value
Severity of pain	17.05±3.14	42.48±4.19	24.53±5.33	26.82	0.001
Limping	5.20±0.29	9.76±1.44	4.56±1.62	16.43	0.001
Support	2.03±0.41	9.65±1.11	7.62±1.37	32.4	0.001
Walking distance	4.29±0.53	9.59±1.24	5.29±0.89	23.9	0.001

Table 5: Distribution of the study patient by pre- and post-operative range of motion of affected hip (n=34).

Range of motion	Pre-operative		Post-operative (at last follow up)		P value
	N	%	N	%	
211º-300º	0	0.00	9	26.47	0.001
161º-210º	0	0.00	22	64.71	
101º-160º	28	82.35	3	8.82	
61º-100º	6	17.65	0	0.00	
31º-60º	0	0.00	0	0.00	
0º-30º	0	0.00	0	0.00	

Table 6: Functional Outcome according to HHS (n=34).

Outcome	Pre-operative		Post-operative (at last follow up)		Mean score difference	t-score	P value
	N	%	N	%			
Poor (<70)	34	100	0	0	54.32±5.59	88.22	0.001
Fair (70-79)	0	0	3	8.8			
Good (80-89)	0	0	10	29.4			
Excellent (>90)	0	0	21	61.8			
Mean Score	37.12		91.44				

The functional outcomes of patients significantly improved following non-cemented THA, as evidenced by the pre- and post-operative functional scores. The severity of pain showed a significant reduction, with the mean score increasing from 17.05±3.14 preoperatively to 42.48±4.19 postoperatively (mean difference: 24.53±5.33, p=0.001). Limping scores also improved notably, from 5.20±0.29 preoperatively to 9.76±1.44 postoperatively (mean difference: 4.56±1.62, p=0.001). Similarly, the need for walking support decreased, reflected by an increase in

the support score from 2.03±0.41 preoperatively to 9.65±1.11 postoperatively (mean difference: 7.62±1.37, p=0.001). Additionally, the walking distance score significantly improved from 4.29±0.53 preoperatively to 9.59±1.24 postoperatively (mean difference: 5.29±0.89, p=0.001).

The statistically significant p values (<0.05 for all parameters) indicate a marked improvement in functional capacity, mobility and pain relief following surgery. The ROM of the affected hip significantly improved following non-cemented THA. Preoperatively, the majority of patients (82.35%) had a restricted ROM between 101º-160º, while 17.65% had severely limited motion (61º-100º). Postoperatively, a substantial shift toward improved mobility was observed, with 64.71% of patients achieving a ROM of 161º-210º and 26.47% reaching an even higher ROM of 211º-300º. Only 8.82% of patients had a ROM between 101°-160° postoperatively, compared to 82.35% before surgery. No patients remained in the severely restricted ROM categories (0º-100º) at the last follow-up. The statistically significant p value (0.001) indicates that THA led to a marked and meaningful improvement in hip joint mobility. The functional outcome of patients, as assessed by the HHS, showed a significant improvement following non-cemented THA. Preoperatively, all patients (100%) had poor functional scores (<70), with a mean HHS of 37.12. However, at the last follow-up, none of the patients remained in the poor outcome category. The majority (61.8%) achieved an excellent functional outcome (>90), while 29.4% had a good outcome (80-89) and 8.8% had a fair outcome (70-79). The mean HHS increased to 91.44, with a mean score difference of 54.32±5.59. The observed improvement was statistically significant (p=0.001), indicating a highly favorable impact of THA on hip function, mobility and overall patient quality of life.

DISCUSSION

The present study aimed to evaluate the functional outcomes of non-cemented THA in patients under 50 years of age with AVN of the femoral head, demonstrating significant improvements in postoperative pain relief, mobility, ROM and functional performance. The mean age of the study population was 35.50±7.01 years, with the 31–40 years age group being the most affected (47.06%), findings that align with other studies indicating that AVN predominantly affects younger adults, often in their 30s to 50s.[15]

The male predominance (73.53%) in this study is also consistent with previously reported male-to-female ratios in AVN-related THA populations, where males comprised 70% or more of cases.[16] This gender discrepancy may be attributed to higher exposure to risk factors such as alcohol consumption, trauma and corticosteroid use among males. In terms of etiology, idiopathic AVN was the most common cause (52.94%), followed by post-traumatic (26.47%) and post-infective AVN (14.71%), with steroid-induced AVN accounting for only 5.88%. Similar findings have been observed in previous studies, where idiopathic and post-traumatic AVN were the most frequently encountered etiologies.[17,18] A notable difference, however, is the higher prevalence of steroid-induced AVN in Western populations, where long-term corticosteroid therapy for systemic conditions such as lupus and organ transplantation significantly contributes to AVN incidence.[19]

Laterality analysis revealed that the right hip was affected in 55.88% of cases, the left in 26.47% and bilateral involvement was seen in 17.65%, a pattern consistent with previous literature.[18] Postoperative complications in this study were minimal, with 91.18% of patients experiencing no complications. Only 5.88% developed SSSI and 2.94% had LLD, findings that mirror those reported in similar studies, where infection rates were under 6% and LLD was an infrequent complication.[16,20] Additionally, no cases of deep infections, prosthetic dislocations or major complications were observed, which aligns with previous reports that cementless THA in AVN patients has a lower risk of early prosthetic failure compared to cemented THA.[17] The functional outcomes assessed through the HHS demonstrated a highly significant improvement (p=0.001). Preoperatively, 100% of patients had poor HHS scores (<70), whereas postoperatively, 61.8% achieved excellent scores (>90), 29.4% had good scores (80-89) and 8.8% had fair scores (70-79).

These results are highly comparable to previous studies, where 86–92% of patients achieved excellent or good functional outcomes following THA for AVN.16,21 The mean HHS increased from 37.12 preoperatively to 91.44 postoperatively, with a mean difference of 54.32±5.59, similar to reports where postoperative HHS improved from ~34–45 to 90–96.22 The significant enhancement in mobility, pain reduction and overall hip function observed in this study supports the well-established efficacy of THA as the treatment of choice for late-stage AVN.[20] Specific functional domains also showed remarkable improvements. Pain severity decreased significantly, with scores rising from 17.05±3.14 preoperatively to 42.48±4.19 postoperatively (p=0.001). These findings align with previous research, which demonstrated that THA effectively eliminates pain in over 80% of AVN patients at long-term follow-up.[22]

Limping scores improved significantly, from 5.20±0.29 preoperatively to 9.76±1.44 postoperatively (p=0.001), with comparative studies indicating that 84% of AVN patients show limping reduction after THA.[23] The need for support devices decreased substantially, from 2.03±0.41 preoperatively to 9.65±1.11 postoperatively (p=0.001), supporting previous reports that 80–92% of THA patients become fully independent postoperatively.[16] Walking distance also significantly improved, with scores rising from 4.29±0.53 to 9.59±1.24 (p=0.001), further reinforcing the well-documented mobility benefits of THA in AVN patients.[17,24,25] The range of motion (ROM) of the

affected hip also improved significantly (p=0.001). Preoperatively, 82.35% of patients had a ROM of 101°-160°, while 17.65% had 61°-100°. Postoperatively, 64.71% achieved a ROM of 161°-210° and 26.47% reached 211°-300°, with no patients remaining in the severely restricted ROM categories. These findings are in agreement with studies reporting mean postoperative ROM improvements from ~140° preoperatively to over 250° postoperatively.[26] The findings of this study further reinforce the suitability of non-cemented THA in younger, active AVN patients, as it offers superior osseointegration, eliminates cement-related complications and achieves long-term prosthetic stability.[17] Additionally, previous research suggests that cementless THA provides better long-term survivorship, particularly in younger patients who require greater implant durability.[21]

Limitations

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This study demonstrated that non-cemented THA is a highly effective and safe treatment for AVN of the femoral head in patients under 50 years of age, with significant improvements in pain relief, mobility, ROM and functional outcomes. The HHS increased significantly from 37.12 preoperatively to 91.44 postoperatively (p=0.001), with 61.8% of patients achieving excellent functional outcomes (>90 HHS). Additionally, walking distance, support dependency, limping and ROM improved substantially, reflecting the strong role of THA in restoring functional independence and quality of life.

Postoperative complications were minimal, with no major adverse events or prosthesis failures, reinforcing the safety profile of non-cemented THA. The findings of this study are consistent with previous research, further supporting non-cemented THA as an optimal surgical solution for younger AVN patients due to superior osseointegration, reduced risk of aseptic loosening and long-term implant stability. Despite its strengths, the study is limited by its single-center design and relatively small sample size. Future research with larger multicenter cohorts and long-term follow-up is recommended to further establish the durability and effectiveness of non-cemented THA in AVN management.

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