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Original Research Article

Study of functional outcome and complications of total hip replacement in avascular necrosis of femoral head due to sickle cell disease

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Abstract

Background: Sickle cell disease (SCD) is an autosomal recessive genetic disorder marked by the production of abnormal sickle hemoglobin, which reduces red blood cell pliability. This results in vascular occlusion, leading to tissue ischemia and infarction. Bone involvement is a common manifestation, ranging from acute vaso-occlusive crises to chronic complications such as avascular necrosis (AVN). AVN of the femoral head frequently progresses to hip osteoarthritis, severely affecting joint function. Total hip replacement (THR) can significantly improve pain and mobility. This study evaluates the functional outcomes and complications of THR in patients with SCD.

Methodology: A total of 25 patients with SCD underwent THR. Functional outcomes were assessed using the Harris Hip Score (HHS) at 6-week, 3-month, and 6-month follow-ups.

Results: The mean age of patients was 26.80 ± 9.35 years. The mean preoperative HHS was 58.25 ± 4.32, which improved to 90.33 ± 4.44 at 6 months postoperatively. At the 6-month follow-up, 15 patients (62.5%) showed excellent outcomes, 8 patients (33.3%) had good outcomes, and 1 patient (4.2%) had a fair result. Complications included limb length discrepancy in 3 patients (12%), dislocation in 2 patients (8%), superficial infection in 2 patients (8%), and 1 postoperative death (4%).

Conclusion: Total hip arthroplasty is an effective and reliable treatment for AVN of the hip secondary to sickle cell anemia. It significantly reduces pain, restores function, and enhances quality of life in affected patients.

Keywords: Sickle cell disease, Total hip arthroplasty, Avascular necrosis of femoral head.

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1. Introduction

Sickle cell disease (SCD) is an autosomal recessive hemoglobinopathy characterized by chronic hemolytic anemia and vaso-occlusive crises resulting from the polymerization of deoxygenated hemoglobin S (HbS). This leads to the formation of rigid, sickle-shaped erythrocytes with reduced deformability, predisposing individuals to microvascular obstruction and subsequent tissue ischemia. Patients homozygous for HbS (HbSS) are at particularly high risk for osteonecrosis due to repeated episodes of vascular occlusion. Compound heterozygotes, including those with HbSC and sickle β-thalassemia, also exhibit a significant incidence of osteonecrosis.[1]

Initially reversible, red cell sickling becomes irreversible after repeated hypoxic cycles, leading to obstruction of the small vessels in the metaphyseal bone. The femoral head, with its end-arterial blood supply and limited collateral circulation, is particularly vulnerable. Persistent hypoxia and thrombosis exacerbate sickling, initiating a cycle that results in infarction, necrosis, femoral head collapse, and progressive joint degeneration. Chronic anemia further contributes to skeletal changes, including marrow hyperplasia, cortical thinning, and medullary expansion, compromising bone strength and implant stability.[2]

Osteonecrosis of the femoral head affects approximately 20–50% of individuals with SCD, most commonly in the second and third decades of life. These patients pose unique

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perioperative challenges due to chronic anemia, high sickled hemoglobin burden, and end-organ dysfunction, with increased risks of postoperative crisis, infection, and wound complications. Despite these concerns, total hip arthroplasty (THA) remains the most effective intervention for advanced femoral head collapse, offering significant improvements in pain and function. However, surgical hesitancy due to concerns over early failure, complex revisions, and medical comorbidities often delays treatment, contributing to prolonged disability, recurrent admissions, opioid dependence, and fixed deformities.[3]

The hip joint is a primary weight-bearing structure, essential for daily mobility and quality of life. Avascular necrosis is a leading cause of hip pain and dysfunction in young adults and, if untreated, invariably progresses to secondary osteoarthritis. THA has proven to be a reliable surgical solution, alleviating pain and restoring function in millions worldwide. Outcomes following THA are influenced by a multitude of factors, including patient age, preoperative status, comorbidities, obesity, surgical technique, implant characteristics, perioperative complications, and psychosocial factors.[4,5] Patient engagement in postoperative rehabilitation is also critical for optimal recovery.[6]

Evaluating long-term outcomes of THA, particularly in SCD patients, requires systematic assessment of functional recovery. Increasingly, patient-reported outcome measures (PROMs) are being utilized to quantify improvements and facilitate comparisons across treatment modalities.[7,8] These data are essential for refining surgical approaches, informing implant development, and guiding clinical decision-making.

This study aims to evaluate the functional outcomes and associated complications of total hip arthroplasty in patients with avascular necrosis of the femoral head secondary to sickle cell disease.

2. Materials and Methods

This cross-sectional study was conducted in the Department of Orthopaedics at Sri Aurobindo Medical College and Postgraduate Institute, Indore. A total of 25 patients diagnosed with avascular necrosis (AVN) of the femoral head secondary to sickle cell disease were enrolled. Inclusion criteria included patients classified as Ficat and Arlet stage III or IV, indicating advanced disease necessitating surgical intervention. All patients underwent uncemented total hip arthroplasty (THA) via the posterior (Southern) surgical approach.

Functional outcomes were evaluated using the Modified Harris Hip Score (HHS), a validated 100-point scale that assesses pain, function, range of motion, and deformity. Scores were interpreted as follows: 90–100 (excellent), 80–89 (good), 70–79 (fair), 60–69 (poor), and <60 (failed). Postoperative clinical and functional assessments were performed at 6 weeks, 3 months, and 6 months to monitor patient recovery and surgical outcomes (**Figure 2**-**Figure 5**).

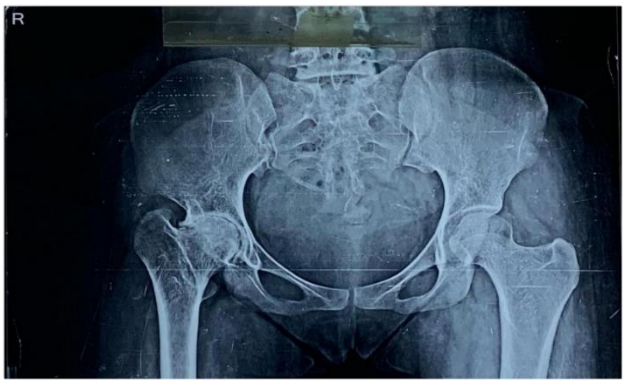

Figure 1: Pre-operative x-ray

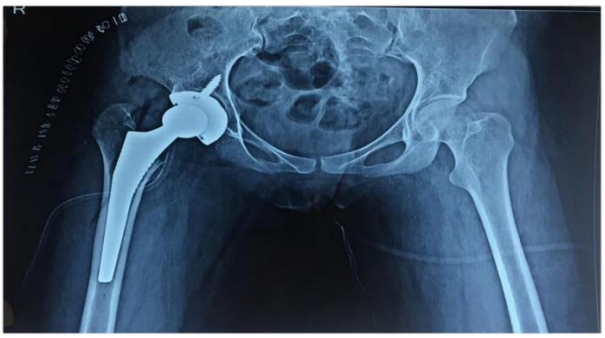

Figure 2: Post-operative x-ray

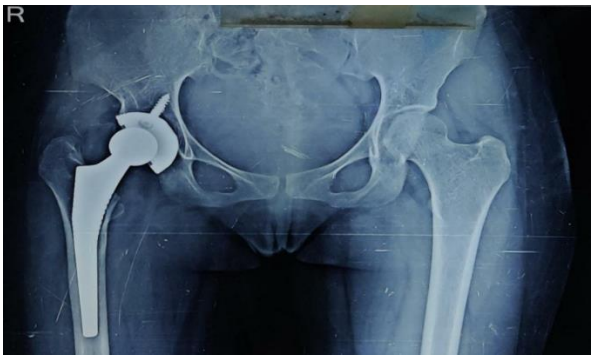

Figure 3: 6 week follow-up

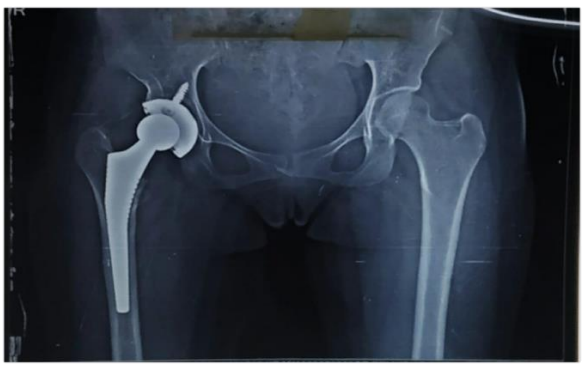

Figure 4: 3 Months follow-up

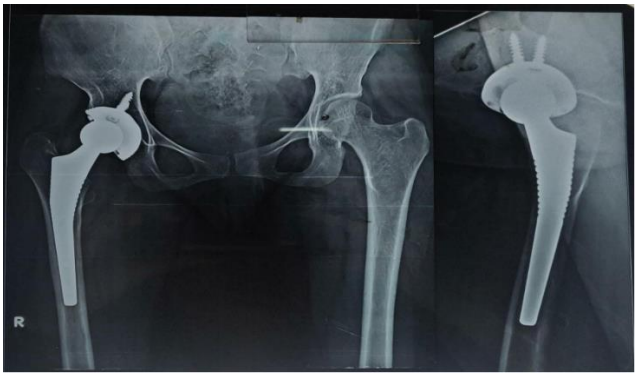

Figure 5: 6 months follow-up

3. Observations and Results

Of the 25 patients included in the study, the majority (56%) were in the 21–30 years age group. Age distribution was as follows: 6 patients (24%) were aged ≤20 years, 14 patients (56%) were aged 21–30 years, 3 patients (12%) were aged 31–40 years, and 2 patients (8%) were older than 40 years (**Figure 6**). The mean age of the patients was 26.80 ± 9.35 years, with an age range of 16 to 53 years.

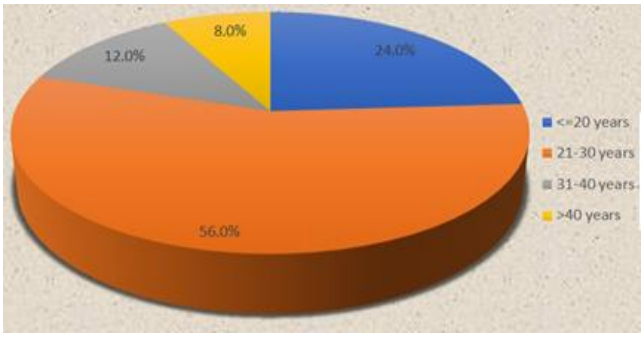

Figure 6: Shows the distribution of patients according to age

There were 7 (28%) females and 18 (72%) males in the present study (**Figure 7**).

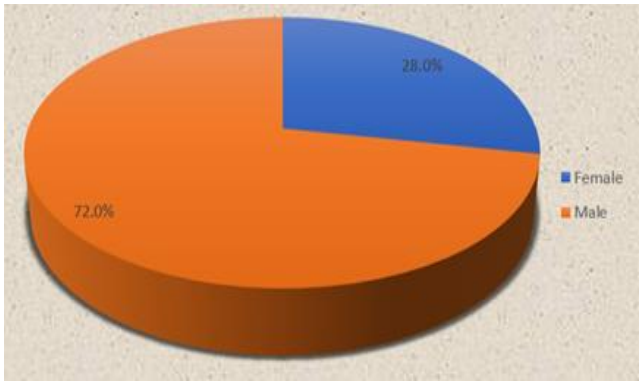

Figure 7: Shows the distribution of patients according to sex

Out of the 25 patients included, positive family history of total hip replacement was present in 4 (16%) patients, while it was absent in 21 (84%) patients. Most of the patients had a negative family history of total hip replacement.

Table 1: Distribution of patients according to functional outcome at 6 months

Functional Outcome at 6 Months	Number	Percentage
Excellent	15	62.5
Good	8	33.3
Fair	1	4.2
Poor	0	0.0
Total	24	100.0

Out of 25 patients included in the study, there was a 1 death. So, the functional outcome using Harris Hip Score was evaluated in 24 patients. According to Harris Hip Score at 6 months, excellent outcome was seen in 15 (62.5%) patients, good in 8 (33.3%) patients, and fair in 1 (4.2%) patient (**Table 1**). In most of the patients i.e. 95.8%, the functional outcome was good to excellent.

Table 2: Distribution according to postoperative complications

Complications	Number	Percentage
No complications	17	68
Limb length discrepancy	3	12
Dislocation	2	8
Infection	2	8
Death	1	4
Total	25	100.0

Of the 24 patients who were analysed for functional outcome, the postoperative complications seen were limb length discrepancy in 3 (12%) patients, dislocation of hip joint in 2 (8%) patients, infection in 2 (8%) and death of 1 (4%) patient due to sickle cell crisis. In 17 (68%) patients, there were no postoperative complications (**Table 2**).

Statistical analysis was performed using the paired t-test, and a P value <0.05 was considered statistically significant.

The mean Harris Hip Score (HHS) demonstrated a consistent and significant improvement over time. The mean preoperative HHS was 58.25 ± 4.32. At 1 month postoperatively, the mean score increased to 68.58 ± 4.44 (P = 0.001 compared to preoperative score). At 3 months, it further improved to 80.46 ± 5.73 (P = 0.001 compared to 1-month score). By 6 months, the mean HHS reached 90.33 ± 4.44, which was significantly higher than the 3-month score (P = 0.001) (**Table 3**).

Table 3: Comparison of mean Harris Hip Score at different time points

Time Point	Frequency	Harris Hip Score [Mean ± SD]	't' value, df	P value
Preoperative	24	58.25 ± 4.32	-15.962, df=23	0.001*
At 1 month	24	68.58 ± 4.44		
At 1 month	24	68.58 ± 4.44	-14.338, df=23	0.001*
At 3 months	24	80.46 ± 5.73		
At 3 months	24	80.46 ± 5.73	-18.539, df=23	0.001*
At 6 months	24	90.33 ± 4.44		

Table 4: Comparison according to functional outcome at 6 months

S. No.	Study	Year	Harris Hip Score			
			Excellent	Good	Fair	Poor
1	Joshua M. Hickman et al	1997	58%	28%	12%	2%
2	Philippe Hernigou et al	2008	61%	20%	6%	3%
3	Kimon Issa et al	2013	72%	23%	5%	0%
4	Mohamed Zubair Farook et al	2018	60%	32%	5%	3%
5	**Our Study**	**2024**	62.5%	33.3%	4.2%	0%

These findings indicate a statistically significant and continuous improvement in functional outcomes from the preoperative period through to the 6-month follow-up, underscoring the effectiveness of total hip arthroplasty in patients with sickle cell disease-related AVN.

4. Discussion

The results of the study are compared with the known similar studies given in the western literature.

According to Harris Hip Score at 6 months, excellent outcome was seen in 15 (62.5%) patients, good in 8 (33.3%) patients, and fair in 1 (4.2%) patient (**Table 4**).

In most of the patients i.e. 95.8%, the functional outcome was good to excellent.

Of the 24 patients who were analysed for functional outcome, the postoperative complications seen were limb length discrepancy in 3 (12.5%) patients, dislocation of hip joint in 2 (8.3%) patients and infection in 2 (8.3%) patients. In 17 (70.8%) patients, there were no postoperative complications.

Sickle cell disease (SCD) patients are particularly vulnerable to osteonecrosis of the femoral head due to microvascular occlusion from sickled erythrocytes, often resulting in significant pain and functional impairment at a young age. Total hip arthroplasty (THA) has become a reliable solution for advanced stages of avascular necrosis (AVN) in this population, although it poses distinct surgical and perioperative challenges.

Our study aligns with previous research in demonstrating the clinical efficacy of uncemented THA in patients with SCD, with 95.8% of patients achieving excellent to good outcomes at the six-month follow-up using the Modified Harris Hip Score. While the short-term results are promising, the complexity of managing SCD perioperatively remains a critical factor influencing overall outcomes.

Joshua M. Hickman et al. reported a five-year follow-up of cementless components in 13 hips with no loosening, although some required reoperations due to osteolysis and polyethylene liner wear. Notably, none experienced catastrophic component failure, suggesting long-term reliability of uncemented implants despite reoperation risk.[9] Similarly, Hernigou et al. observed a 3% infection rate and aseptic loosening rates of 8% for cups and 5% for stems at an average of 14 years, highlighting the potential complications but also the durable benefit of THA in SCD patients.[10]

Issa et al. found no significant difference in aseptic implant survivability between SCD and non-SCD patients with osteonecrosis ($p = 0.85$), reporting a 95% survivorship at a mean follow-up of 7.5 years.[11] This reinforces the notion that implant longevity in SCD can be comparable to other AVN etiologies if managed appropriately. Similarly, Farook et al. (2018) noted a 17.6% revision rate in a cemented prosthesis cohort, with a 5.8% rate of prosthetic joint infection and osteolysis as the leading cause of revision.[12]

Kenanidis et al. conducted a meta-analysis involving 971 THAs in SCD patients and reported an overall revision rate of 16.8%, with aseptic loosening more common in cemented implants.[13] Intraoperative complications were predominantly associated with uncemented THAs, particularly femoral fractures and perforations. These findings underscore the technical demands of THA in this group, often related to altered bone architecture due to chronic marrow hyperplasia.

The increased infection susceptibility in SCD patients is multifactorial, stemming from compromised immunity and poor bone vascularity.[14] In our study, two patients developed late deep infections, which were managed successfully with aggressive antibiotic therapy. Perioperative optimization—including transfusion protocols, hydration, oxygenation, and temperature maintenance—is essential to minimize risks such as sickle cell crises (SCC) and transfusion reactions. Despite these measures, one patient succumbed to a postoperative SCC, underscoring the critical nature of vigilant perioperative care.

Several recent studies have reinforced the durability of THA in SCD. Gulati et al. found no cases of loosening, infection, or dislocation over 3.8 years in 50 THAs.[15] Azam et al. reported a 92.6% survival rate at 7.5 years in 87 uncemented hips, while Ilyas et al. documented 94.1% survivorship at 15 years in 133 hips, with only a 3.76% deep infection rate.[16] These studies reflect the advances in both surgical technique and perioperative management, which have significantly improved outcomes.

Our study supports this trend, demonstrating favourable short-term functional outcomes with a manageable complication rate (32%). With increasing awareness, early diagnosis, and optimized perioperative protocols, THA has become a safe and effective intervention for young SCD patients debilitated by AVN of the femoral head. Though complications remain, especially in resource-limited settings, the procedure significantly enhances quality of life and functional independence.

5. Conclusion

1. THR is a well-documented surgical procedure. It relieves pain and functional disability experienced by patients with moderate to severe arthritis of the hip, secondary to AVN and improving their quality of life in patients with Sickle cell anemia.
2. Increasing numbers of patients receiving hip replacements every year, it is important to have a knowledge of the possible factors that may influence the outcomes of surgery in individual patients. We tried to find association of age, sex and involved side with outcome of THA, However, could not ascertain any significant association between them.
3. In this review, we made efforts to find association between family history of sickle cell disease, type of sickle cell anemia and history of blood transfusion with outcome of THA, and found no significant link between the functional outcome and complications after 6 months follow up.
4. THA was associated with various complications like infection, dislocation, limb length discrepancy and even death due to sickle cell crisis in 1 of our patient. But comparision with preoperative Harris Hip Score with 6 month post operative follow up suggest excellent outcomes.
5. In most of the patients i.e. 95.8%, the functional outcome was good to excellent. Despite few patients had complications like dislocation or infection we can safely conclude that THA is very helpful in alleviating the pain and providing better quality of life to the patient.

6. Source of Funding

None.

7. Conflict of Interest

None.

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