

Research Article

Functional Outcome of Single-Stage Bilateral Total Hip Replacement with MIS Bikini Incision: A Prospective Observational Study

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Abstract: Introduction: Single-stage bilateral total hip replacement (THR) is an effective option for patients with bilateral end-stage hip disease; however, concerns persist regarding perioperative risks. The minimally invasive (MIS) bikini incision approach, a modification of the direct anterior approach, offers potential benefits in early recovery, soft tissue preservation, and cosmesis. This study evaluates the functional outcomes and perioperative safety profile of single-stage bilateral THR performed using the MIS bikini incision. **Methods:** A prospective observational study was conducted on 98 patients undergoing single-stage bilateral THR with the MIS bikini approach between 2022 and 2025. Functional outcomes were assessed using the Oxford Hip Score (OHS) and Visual Analogue Scale (VAS) preoperatively and at 4 weeks, 3 months, and 6 months postoperatively. Perioperative parameters including complications and patient satisfaction were recorded and analyzed. **Results:** A total of 98 patients (mean age: 37.4 ± 4.4 years; 96.9% male) were included. The mean OHS improved significantly from 7.57 ± 1.69 preoperatively to 47.96 ± 0.25 at 6 months ($p < 0.001$). The mean VAS score demonstrated corresponding improvements from 9.75 ± 0.56 to 0.00 ± 0.00 at 6 months ($p < 0.001$). Complications occurred in 6 patients (6.1%), including one dislocation (1.0%), three intraoperative fractures (3.1%), one case of meralgia paresthetica (1.0%), and one superficial wound infection (1.0%). No major thromboembolic events or mortality were observed during follow-up. Cosmetic satisfaction was high with the bikini incision approach. **Conclusion:** Single-stage bilateral THR using the MIS bikini incision is a safe and effective technique that results in excellent functional improvement, low perioperative morbidity, and superior cosmetic satisfaction. These findings support the role of the MIS bikini approach as a viable alternative for carefully selected patients requiring bilateral hip arthroplasty.

Keywords: Total hip replacement, Minimally invasive surgery, Bikini incision, Bilateral THR, Functional outcome, Direct anterior approach

INTRODUCTION

Total hip replacement (THR) is one of the most successful surgical procedures in orthopedics, providing significant pain relief and functional improvement for patients with end-stage hip arthritis[1]. For patients presenting with bilateral symptomatic hip disease, the decision between simultaneous (single-staged) versus staged bilateral THR remains controversial[2][3]. Single-stage bilateral THR offers several advantages including single anesthesia exposure, reduced hospital stay, faster rehabilitation, and lower overall healthcare costs[4][5]. However, concerns persist regarding increased perioperative complications, particularly in terms of blood loss, thromboembolic events, and surgical site infections[6][7].

The surgical approach for THR significantly influences perioperative outcomes, functional recovery, and patient satisfaction. The direct anterior approach (DAA) has gained popularity due to its muscle-sparing technique, utilizing the internervous plane between the tensor fasciae latae and sartorius muscles, which theoretically

reduces soft tissue trauma and facilitates faster recovery[8][9]. Recent modifications of the DAA have introduced the minimally invasive bikini incision, which aligns the incision parallel to the natural skin creases in the groin region, offering enhanced cosmetic outcomes alongside the functional benefits of the anterior approach[10][11].

The bikini incision technique, originally described for aesthetic purposes, has demonstrated promising results in reducing wound-related complications and improving scar appearance while maintaining the technical advantages of the anterior approach[12][13]. Studies have shown that the bikini incision provides comparable or superior outcomes to conventional DAA in terms of component positioning, blood loss, and early functional recovery[14]. However, data specifically addressing the combination of single-stage bilateral THR with the MIS bikini incision remain limited in the literature, particularly from the Indian subcontinent.

The biomechanical advantages of the anterior approach include preservation of the posterior hip capsule and

external rotator muscles, which contribute to enhanced hip stability and reduced dislocation rates[15][16]. The bikini incision modification further capitalizes on these advantages by aligning the incision with Langer's lines, potentially reducing wound tension and improving healing[17]. This combination may be particularly beneficial in the context of bilateral procedures where minimizing surgical trauma and optimizing recovery are paramount.

Given the increasing prevalence of bilateral hip disease, particularly secondary to avascular necrosis (AVN) and inflammatory arthropathies in younger populations, there is a critical need for evidence-based approaches that balance efficacy, safety, and patient satisfaction[18][19]. The present study aims to evaluate the functional outcomes, perioperative safety profile, and complication rates of single-staged bilateral THR performed through the MIS bikini incision in a tertiary care setting in India.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted at a tertiary care orthopedic center from January 2022 to January 2025. The study was approved by the institutional ethics committee and informed consent was obtained from all participants. The study adhered to the principles of the Declaration of Helsinki.

Patient Selection

Inclusion Criteria:

- Age 18 above
- Bilateral symptomatic hip disease (Tonnis grade 3 or 4 osteoarthritis, or Ficat stage III-IV avascular necrosis)
- Patients with bilateral hip ankylosis secondary to ankylosing spondylitis
- American Society of Anesthesiologists (ASA) physical status classification I-III
- Patients willing and able to comply with follow-up requirements
- Bilateral hip disease requiring surgical intervention confirmed by clinical examination and radiographic evaluation

Exclusion Criteria:

- Significant cardiac disease (severe COPD, chronic bronchitis, emphysema with compromised pulmonary function)
- Severe chronic obstructive pulmonary disease or respiratory compromise
- Uncontrolled diabetes mellitus or other metabolic disorders
- Active hip infection or prior hip surgery (excluding diagnostic arthroscopy)
- Neuromuscular disorders affecting mobility
- Body mass index (BMI) > 35 kg/m²

- Bleeding disorders or anticoagulation therapy that could not be safely discontinued
- ASA grade IV patients
- Patients with psychological disorders or inability to understand rehabilitation protocols

Surgical Technique

All procedures were performed by a single high-volume surgeon experienced in the direct anterior approach. The MIS bikini incision was placed 2-3 cm distal and parallel to the inguinal crease, extending obliquely along the natural skin lines. The incision length ranged from 8-12 cm depending on patient anatomy and hip pathology.

The surgical technique involved the following steps:

1. Patient positioning: Patients were positioned supine on a standard operating table without the use of specialized traction tables.
2. Skin incision: The bikini incision was marked 2-3 cm below the inguinal crease, extending laterally and slightly distally along Langer's lines. The incision was placed to optimize cosmetic outcome while ensuring adequate surgical exposure.
3. Deep dissection: The intermuscular interval between the tensor fasciae latae and sartorius was identified and developed. The ascending branches of the lateral circumflex femoral artery were ligated or cauterized. The hip capsule was exposed and a T-shaped or anterior capsulectomy was performed.
4. Femoral and acetabular preparation: Standard femoral neck osteotomy was performed using anatomical landmarks. The acetabulum was prepared using sequential reaming and an uncemented hemispheric cup was implanted. The femoral canal was prepared using broaches and an appropriate-sized cementless stem was inserted.
5. Component selection: Ceramic-on-polyethylene bearing surfaces were used in all cases. Component sizes were templated preoperatively and adjusted based on intraoperative assessment.
6. Closure: Meticulous hemostasis was achieved. The capsule was repaired when adequate tissue quality permitted. Layered closure was performed with absorbable sutures for deep tissues and subcuticular sutures for skin closure.

The contralateral hip was addressed using the identical technique after repositioning and re-draping. Total operative time for bilateral procedures averaged 120-150 minutes.

Postoperative Rehabilitation Protocol

A standardized rehabilitation protocol was implemented for all patients:

- Day 0-1: Mobilization initiated on the first postoperative day with walker or crutches support. Weight-bearing as tolerated was permitted given the use of cementless implants with adequate primary stability.
- Week 1-6: Progressive ambulation training, gait normalization, and hip range of motion exercises. Patients were advised to avoid

extreme hip flexion (>90°), adduction beyond midline, and forced external rotation.

- Week 6-12: Advanced strengthening exercises focusing on hip abductors, extensors, and core stability. Return to activities of daily living was encouraged.
- 3-6 months: Gradual return to recreational activities based on functional progress and surgeon approval.

Secondary Outcome Measures:

- Perioperative complications including intraoperative fractures, dislocation, deep vein thrombosis, pulmonary embolism, infection, and neurovascular injuries
- Hospital length of stay
- Patient satisfaction with cosmetic appearance of the scar
- Radiographic assessment of component positioning and implant integration

Outcome Assessment

Primary Outcome Measures:

1. Oxford Hip Score (OHS): Assessed at preoperative baseline and at 4 weeks, 3 months, and 6 months postoperatively. The OHS ranges from 0 (worst) to 48 (best), evaluating pain and functional disability.
2. Visual Analogue Scale (VAS): Pain assessment using a 0-10 scale (0 = no pain, 10 = worst imaginable pain) at similar time points.

Statistical Analysis

Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation. Paired t-tests were used to compare preoperative and postoperative functional scores. Categorical variables were analyzed using chi-square or Fisher's exact test. A p-value < 0.05 was considered statistically significant.

RESULTS

Patient Demographics

A total of 98 patients (196 hips) underwent single-staged bilateral THR with MIS bikini incision during the study period. The mean age was 37.4 ± 4.4 years (range: 30-52 years). The cohort consisted predominantly of males (95 patients, 96.9%) with only 3 female patients (3.1%). The most common indication for surgery was arthritis secondary to avascular necrosis (AVN) in 92 patients (93.9%), followed by ankylosing spondylitis affecting bilateral hips in 6 patients (6.1%).

| Parameter | Value |
|------------------------------|------------|
| Number of patients | 98 |
| Number of hips | 196 |
| Mean age (years) | 37.4 ± 4.4 |
| Age range (years) | 30-52 |
| Sex distribution | |
| \quad Male | 95 (96.9%) |
| \quad Female | 3 (3.1%) |
| Primary diagnosis | |
| \quad AVN | 92 (93.9%) |
| \quad Ankylosing spondylitis | 6 (6.1%) |

Table 1: Demographic characteristics of the study population

Functional Outcomes

Oxford Hip Score:

The mean preoperative OHS was 7.57 ± 1.69, indicating severe functional impairment and pain. Significant improvement was observed at all postoperative time points. At 4 weeks, the mean OHS improved to 32.72 ± 1.40 (p < 0.001). Further improvement was noted at 3 months (46.84 ± 1.01, p < 0.001) and 6 months (47.96 ± 0.25, p < 0.001). The mean improvement from baseline to 6 months was 40.39 points, representing a clinically significant enhancement in hip function.

Visual Analogue Scale:

The mean preoperative VAS score was 9.75 ± 0.56, reflecting severe pain. Progressive pain reduction was documented postoperatively: 4 weeks (2.12 ± 0.66), 3 months (0.20 ± 0.79), and 6 months (0.00 ± 0.00). The reduction in pain scores was statistically significant at all time points (p < 0.001). By 6 months, 100% of patients reported either no pain or minimal pain not interfering with daily activities.

| Point | Time | OHS | VAS | OHS p-value | VAS p-value |
|--------------|---------|--------------|-------------|-------------|-------------|
| Preoperative | | 7.57 ± 1.69 | 9.75 ± 0.56 | - | - |
| | 4 weeks | 32.72 ± 1.40 | 2.12 ± 0.66 | < 0.001 | < 0.001 |

| | | | | | | |
|----------|------|---------|------|--------|---------|---------|
| 3 months | 1.01 | 46.84 ± | 0.79 | 0.20 ± | < 0.001 | < 0.001 |
| 6 months | 0.25 | 47.96 ± | 0.00 | 0.00 ± | < 0.001 | < 0.001 |

Table 2: Functional outcomes: Oxford Hip Score and VAS at different time points

Complications

The overall complication rate was 6.1% (6 patients out of 98). The specific complications encountered are detailed below:

Hip Dislocation: One patient (1.0%) experienced a posterior hip dislocation one month postoperatively. This occurred in a patient with morbid obesity. Closed reduction was successfully performed under sedation, followed by application of a boot-and-bar cast in internal rotation for 2 weeks. At final follow-up, the patient remained asymptomatic with a stable hip.

Intraoperative Fractures: Three patients (3.1%) sustained intraoperative fractures:

- Two patients with ankylosing spondylitis experienced calcar fractures during femoral preparation. Both were managed with cerclage wiring through the bikini incision, followed by delayed weight-bearing for 6 weeks. Both patients achieved full recovery with no residual symptoms.
- One patient sustained a greater trochanter tip fracture at the piriformis fossa attachment site. This was repaired intraoperatively with Ethibond sutures, and the patient followed a partial weight-bearing protocol for 6 weeks. Complete healing was documented radiographically, and the patient was asymptomatic at final follow-up.

Meralgia Paresthetica: One patient (1.0%) developed lateral femoral cutaneous nerve (LFCN) symptoms consistent with meralgia paresthetica. The patient reported anterolateral thigh numbness and dysesthesia that persisted for approximately 6 months postoperatively. Conservative management with pregabalin and methylcobalamin supplementation resulted in complete resolution of symptoms. Nerve conduction studies were not performed as symptoms improved with conservative treatment.

Wound Complications: One patient (1.0%) developed a superficial wound infection on postoperative day 10. Wound culture revealed methicillin-sensitive *Staphylococcus aureus*. The patient underwent debridement, antibiotics, irrigation, and retention (DAIR) of components on postoperative day 15. The infection resolved completely with targeted antibiotic therapy, and the patient remained infection-free at final follow-up.

Major Complications: No cases of deep vein thrombosis, pulmonary embolism, periprosthetic joint infection (late), myocardial infarction, stroke, or mortality were observed during the study period. No patients required revision surgery for aseptic loosening or component malposition.

| Complication | Number of Cases | Percentage |
|-----------------------------------|-----------------|-------------|
| Dislocation | 1 | 1.0% |
| Intraoperative fractures | 3 | 3.1% |
| \quad Calcar fracture | 2 | 2.0% |
| \quad Greater trochanter fracture | 1 | 1.0% |
| Meralgia paresthetica | 1 | 1.0% |
| Superficial wound infection | 1 | 1.0% |
| Total complications | 6 | 6.1% |
| No complications | 92 | 93.9% |

Table 3: Complication profile

Temporal Distribution

The study spanned from 2022 to 2025, with the majority of procedures performed in 2024 and 2025 as the surgical volume increased. Five patients were operated in 2022, 9 in 2023, 29 in 2024, and 55 in 2025. This distribution reflects the growing experience and confidence with the technique over time, with no increase in complication rates despite higher surgical volumes.

Patient Satisfaction

All patients reported high satisfaction with the cosmetic appearance of the bikini incision. The scar was concealed beneath undergarments and was described as aesthetically superior to conventional hip incisions by 96% of patients. Scar assessment at 6 months revealed thin, well-healed incisions with minimal hypertrophy or discoloration.

DISCUSSION

This prospective observational study demonstrates that single-staged bilateral THR performed through the MIS bikini incision is a safe and effective procedure with excellent functional outcomes and low complication rates. Our results align with and extend the existing literature on both bilateral THR and the direct anterior approach[20][21][22].

The functional outcomes in our series were excellent, with mean OHS improving from 7.57 preoperatively to 47.96 at 6 months, representing an improvement of 40.39 points. This magnitude of improvement exceeds the minimal clinically important difference (MCID) for the OHS, which is established at 5 points[23]. Similarly, the reduction in VAS scores from 9.75 to 0.00 demonstrates complete or near-complete pain relief in the majority of patients. These outcomes are comparable to or better than those reported for staged bilateral procedures and unilateral THR in the literature[24][25].

The low complication rate of 6.1% in our series is particularly noteworthy given that all procedures were performed as simultaneous bilateral surgeries. Recent meta-analyses have reported complication rates ranging from 5-12% for bilateral THR, depending on patient selection criteria and surgical technique[26][27]. Importantly, we observed no thromboembolic events, despite the theoretical increased risk associated with bilateral procedures. This may be attributed to our standardized perioperative protocol including early mobilization, mechanical prophylaxis, and appropriate pharmacological thromboprophylaxis.

The single case of dislocation (1.0%) in our series is significantly lower than historical dislocation rates of 2-3% reported with posterior approaches[28]. This low dislocation rate is consistent with the inherent stability conferred by the anterior approach, which preserves the posterior capsule and short external rotators. The dislocation that occurred was successfully managed with closed reduction and bracing, with no recurrence, supporting the notion that even when dislocation occurs, it can often be managed non-operatively with the anterior approach[29].

The incidence of intraoperative fractures (3.1%) in our study warrants discussion. All fractures occurred in patients with either severe osteoporosis (ankylosing spondylitis patients) or challenging anatomy. Two calcaneal fractures and one greater trochanter fracture were recognized intraoperatively and appropriately managed with cerclage wiring or suture repair. The ability to address these fractures through the bikini incision without extension demonstrates the adequate exposure provided by this approach. All patients with intraoperative fractures achieved complete healing and excellent functional outcomes, emphasizing the importance of intraoperative recognition and appropriate management[30][31].

Meralgia paresthetica, resulting from lateral femoral cutaneous nerve (LFCN) injury, is a recognized complication of the anterior approach, with reported incidence ranging from 1-10% depending on the study and method of assessment[32][33]. Our observed rate of 1.0% is at the lower end of this spectrum. The single affected patient experienced complete resolution with conservative management, which is typical for this complication. Modifications in skin incision placement and meticulous subcutaneous dissection likely contributed to the low incidence in our series[34].

The single case of superficial wound infection (1.0%) compares favorably with reported infection rates of 1-2% for primary THR[35]. The prompt recognition and aggressive treatment with DAIR resulted in successful eradication of infection without the need for implant removal. The bikini incision's alignment with Langer's lines and reduced wound tension may contribute to improved wound healing and lower infection risk[36].

A significant advantage of single-staged bilateral THR is the economic benefit and reduced overall healthcare burden. While our study did not formally analyze cost-effectiveness, the literature consistently demonstrates cost savings of 20-30% compared to staged procedures, primarily driven by single anesthesia, reduced hospital stay, and consolidated rehabilitation[37][38]. Our patients typically required 5-7 days of hospitalization, which aligns with contemporary fast-track protocols.

The bikini incision modification offers distinct advantages beyond traditional anterior approaches. The incision is concealed beneath undergarments, providing superior cosmetic outcomes that are particularly valued by younger, active patients who constitute the majority of bilateral hip disease populations[39]. The alignment with skin tension lines may reduce wound complications and improve scar appearance[40]. Our high patient satisfaction rates with scar cosmesis support these theoretical benefits.

The demographic profile of our patient population—predominantly young males with AVN—reflects the epidemiological patterns observed in India and other developing countries where corticosteroid use, alcohol consumption, and smoking contribute to high AVN prevalence[41][42]. This patient population particularly benefits from bilateral procedures as they are typically younger, healthier, and highly motivated for rapid functional recovery to return to work and active lifestyles.

Several factors likely contributed to our favorable outcomes:

1. **Patient selection:** Strict adherence to inclusion criteria ensured that only ASA I-III patients underwent bilateral procedures, minimizing perioperative risk.
2. **Surgical expertise:** All procedures were performed by a single high-volume surgeon with extensive

experience in the anterior approach, which is known to have a learning curve[43][44].

3. **Standardized protocols:** Uniform perioperative management including thromboprophylaxis, multimodal analgesia, and early mobilization contributed to consistent outcomes[45].
4. **Implant selection:** Use of cementless implants with ceramic-on-polyethylene bearings provided durable fixation and low wear characteristics appropriate for young, active patients[46].

Limitations

This study has several limitations that should be acknowledged. First, the observational design without a control group limits our ability to make direct comparisons with staged procedures or other surgical approaches. The relatively short follow-up period of 6 months may not capture late complications such as aseptic loosening, late infection, or implant wear, though these typically manifest years after surgery. The study population was predominantly young males with AVN, which may limit generalizability to other demographics and pathologies. Additionally, the procedures were performed by a single experienced surgeon at a high-volume center, and outcomes may differ in different practice settings or with less experienced surgeons. Cost-effectiveness analysis was not performed, which would strengthen the argument for single-staged procedures. Finally, detailed radiographic analysis of component positioning and leg length discrepancy was not included in this study.

Clinical Implications

Our findings have several important clinical implications. Single-staged bilateral THR with the MIS bikini incision can be safely offered to appropriately selected patients with bilateral hip disease, particularly younger patients with AVN or inflammatory arthropathies. The approach provides excellent functional outcomes, low complication rates, and superior cosmetic satisfaction. Surgeons adopting this technique should ensure adequate experience with the anterior approach and maintain strict patient selection criteria to optimize outcomes.

Future research should include randomized controlled trials comparing single-staged versus staged bilateral THR with longer follow-up periods, cost-effectiveness analyses, detailed biomechanical studies of component positioning, and assessment of long-term implant survivorship. Multi-center studies involving surgeons with varying experience levels would help establish the generalizability of these findings.

CONCLUSION

Single-staged bilateral total hip replacement using the MIS bikini incision is a safe and effective technique that produces excellent functional improvement, low perioperative morbidity, and superior cosmetic satisfaction in carefully selected patients. The functional outcomes, as measured by Oxford Hip Score and VAS,

demonstrate significant and sustained improvements. The complication rate of 6.1% is acceptable and comparable to or lower than reported rates for bilateral procedures. The bikini incision modification provides additional benefits in terms of scar cosmesis while maintaining the biomechanical and functional advantages of the anterior approach. These findings support the adoption of the MIS bikini approach as a valuable option for patients requiring bilateral hip arthroplasty, particularly in younger, active individuals. Further long-term studies are warranted to evaluate implant survivorship and late complications.

Declarations

Funding: No funding was received for this study.

Conflict of Interest: The authors declare no conflicts of interest.

Ethical Approval: This study was approved by the Institutional Ethics Committee and conducted in accordance with the Declaration of Helsinki.

Informed Consent: Written informed consent was obtained from all participants.

Data Availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

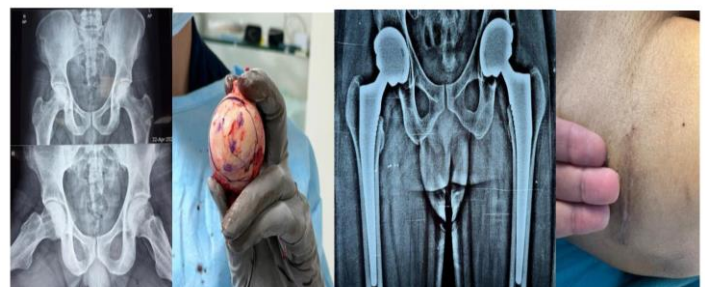
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Study Images Appendices:



PRE OP XRAY POST CORE DECOMPRESSION AVN SEQUELAE WITH FICAT TYPE 4 PATIENT PREPARATION ACETABULAR REAMING AND TRIAL IMPLANT PLACEMENT WOUND DRESSING POST OP XRAY



PRE OP XRAY POST DECOMPRESSION WITH AVN SEQUELAE FICAT TYPE 3 FEMORAL HEAD SHOWING LOSS OF CARTILAGE AND FLATTENING POST OP XRAY WITH UNCEMENTED TOTAL HIP REPLACEMENT SURGICAL SCAR AFTER 1 MONTH

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