Comparison of the Outcome in Bilateral Staged Total Hip Arthroplasty: Modified Two-Incision Minimally Invasive Technique versus the Conventional Posterolateral Approach

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This retrospective study was undertaken to compare the outcomes of staged bilateral total hip arthroplasty (THA) by the conventional approach with those of two-incision minimally invasive (MIS-2) THA in terms of clinical and radiological results, complications, and patient preferences. Twenty-two patients aged 30 to 80 years underwent staged bilateral THA. The conventional posterolateral approach was used on the first hips treated and a modified MIS-2 approach on the second hips. The mean time between the first and second procedures was 73.8 months, and the patients were followed up for at least 12 months after both procedures. At the last follow-up visits, THA via the MIS-2 approach was found to provide significantly earlier partial-weight-bearing ambulation, better postoperative Harris hip scores, and better ability to sit cross-legged and was found to be more preferred by patients than conventional THA. There were no significant differences in the complication rates for the two approaches. The present results show that MIS-2 THA is as safe as the conventional posterolateral approach in experienced hands and presents no additional complication risks.

Key Words: Arthroplasty; Hip; Risk

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INTRODUCTION

Total hip arthroplasty (THA) using a smaller incision has generated substantial interest among orthopedic surgeons and patients during the past decade. In the early era of minimally invasive (MIS) THA, single-incision approaches were usually performed by decreasing the incision length of either a posterior or an anterior approach to less than 10 cm. The two-incision minimally invasive (MIS-2) technique constitutes a novel theoretical approach to hip replacement. This technique enables access to the hip joint because it uses intermuscular and internervous planes while minimizing damage to the muscles and tendons around the hip joint.1 By reducing the extent of tissue disruption, this technique may reduce intraoperative bleeding, reduce postoperative pain, and lead to more rapid functional recovery.2 However, the use of intraoperative fluoroscopy for accurate reaming and prosthesis placement during MIS-2 is essential owing to the limited direct visualization.

Despite these potential advantages, several reports have claimed that the MIS-2 approach has higher complication rates than does the conventional approach.3 These include the risk of proximal femoral fracture4 and injury to the femoral and lateral femoral cutaneous nerves.3,5 In a cadaveric study by Mardones et al.6 in which degrees of muscle damage following THA performed by using the two-incision and the mini-posterior techniques were compared, it was concluded that although both approaches resulted in some degree of muscle damage, two-incision hip replacement results in more damage to the gluteus medius and gluteus minimus muscles and external rotators. Understandably, this technically demanding approach has an associated learning curve.7

After modifying the Mears technique, we achieved good results and lower complication rates in short-term follow up.8 These include the risk of proximal femoral fracture9 and injury to the femoral and lateral femoral cutaneous nerves.9,8 In a cadaveric study by Mardones et al.6 in which degrees of muscle damage following THA performed by using the two-incision and the mini-posterior techniques were compared, it was concluded that although both approaches resulted in some degree of muscle damage, two-incision hip replacement results in more damage to the gluteus medius and gluteus minimus muscles and external rotators. Understandably, this technically demanding approach has an associated learning curve.7

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Two-Incision MIS vs Conventional Posterolateral Approach for Bilateral THA

FIG. 1. Diagram illustrating the incisions of total hip arthroplasty in the lateral position. (A) Conventional posterolateral approach and (B) modified two-incision minimally invasive approach.

16 posterior incision through the intermuscular interval between the gluteus medius and piriformis for femoral component insertion.

After our experiences of conventional and MIS-2 THA, we decided to compare the outcomes of patients who underwent staged bilateral THA with these two approaches. We hypothesized that the MIS-2 technique would give early postoperative benefits in patient function with an increase in complication rates and that patients would prefer the MIS-2 technique to the conventional posterolateral technique.

MATERIALS AND METHODS

We included patients who underwent staged bilateral THA in which the conventional posterolateral approach (Fig. 1A) was used on the first hip and the MIS-2 approach (Fig. 1B) was used later on the second hip. We excluded patients with prior surgery at both hips before the index THA, neuromuscular disorders, or a leg length discrepancy of more than 2 cm. We retrospectively reviewed 22 patients who underwent bilateral THA from December 2003 to June 2006. The conventional posterolateral approach was performed either by the experienced surgeon or by other surgeons at other hospitals. All modified MIS-2 THAs were performed by the experienced orthopedic surgeon. Of the hips treated by the conventional posterolateral approach, 19 were treated with cementless stem fixation and 3 with cemented stem insertion; cementless cups were inserted in all 22 hips. Regarding articulation, 9 hips received ceramic-on-ceramic articulation, 7 hips metal-on-metal, and 6 hips metal-on-polyethylene. All MIS-2 THA hips were treated with cementless fixation, and 19 patients received ceramic-on-ceramic articulation and 3 patients metal-on-metal articulation.

Demographic data and pre- and postoperative 1-year and 2-year Harris hip scores (HHSs) and Western Ontario and McMaster Universities Arthritis Index (WOMAC) scores were recorded. Preoperative HHSs and WOMAC scores were also obtained for patients who underwent conventional surgery at other centers. Patients were also asked which side they preferred and the reasons for their preferences. Details of intra- and postoperative complications were noted. Postoperative radiographs of both hips were obtained at the final follow-up and were analyzed by a blinded orthopedic surgeon. Anteversion of the acetabular component, lateral opening angle, femoral component alignment within the femoral canal, radiological leg length discrepancy, percentage canal fill, and femoral component subsidence were included in the radiologic evaluation.

Statistical analysis was performed by using the Mann-Whitney U test in SPSS software version 19.0 (SPSS Inc., Chicago, IL, USA) on all numerical variables (length of hospitalization, time to partial weight bearing, HHS, WOMAC score). We used the Fisher’s exact test for categorical variables (functional variables, such as squatting, sitting cross-legged, and preference). Statistical significance was accepted for p values of < 0.05.

RESULTS

No patient was lost to follow-up and all 22 patients were available for review. There were 11 male and 11 female patients of an average age of 59.6 years (range, 30-80 years). The reasons for total hip replacement were avascular necrosis of the femoral heads in 15 patients, osteoarthritis of the hips in 6 patients, and bilateral hip fractures that occurred 6 years apart in 1 patient (Table 1). Average follow-up after MIS-2 THA was 43.7 months (range, 12-101 months) and that after conventional THA was 118.9 months (range, 14-267 months). The overall average follow-up was 81.3 months (range, 12-267 months).

1. Duration of admission and weight-bearing ambulation

In all patients, MIS-2 THA was performed as a second procedure. The average time between the two surgeries was 73.8 months (range, 4-240 months). All MIS-2 THA procedures and 8 of the 22 conventional THA procedures were performed by the senior author. The remaining 14 conventional THA procedures were performed in other institutions. The average duration of hospital admission
for MIS-2 THA was 10 days (range, 6-27 days) and that for conventional THA was 13 days (range, 10-34 days); the average overall duration of admission was 15 days. Patients tolerated weight-bearing crutch walking following MIS-2 THA on the 3rd postoperative day (range, 1-6 days) and after conventional THA on the 6th day (range, 2-8 days) (Table 2).

2. Clinical results

The patients who experienced bilateral femoral neck fractures were excluded from the HHS and WOMAC score assessment because scoring before surgery could not be performed. The mean preoperative, 1-year postoperative, and 2-year postoperative HHSs of the MIS-2 THA hips were 47.7 (range, 25-63), 94.7 (range, 84-100), and 91.9 (range, 82-100), respectively, and the corresponding scores for the conventional THA hips were 46.1 (range, 30-60), 92.1 (range, 81-100), and 90.9 (range, 79-100), respectively. The mean preoperative, 1-year postoperative, and 2-year postoperative mean WOMAC scores for the MIS-2 THA hips were 74.7 (range, 56-97), 22.3 (range, 9-34), and 23.1 (range, 9-35), respectively, and the corresponding scores for the conventional THA hips were 77.7 (range, 59-110), 25.3 (range, 9-39), and 26.7 (range, 9-39), respectively.

Of the 22 patients, 8 underwent both surgeries by the senior author. In this group of patients, average preoperative, 1-year postoperative, and 2-year postoperative HHS scores for the MIS-2 hips were 45.9, 97.6, and 96.1, respectively, whereas the average values for the conventionally treated hips were 43.5, 96.8, and 95.6, respectively. The average preoperative, 1-year postoperative, and 2-year postoperative WOMAC scores for the MIS-2 hips were 73.3, 21.7, and 20.3, respectively, and the average WOMAC scores for the conventionally treated hips were 70.9, 24.1, and 22.6, respectively.

3. Other functional results

At the 1-year and 2-year postoperative visits, 12 patients had no difficulty running, but the other 10 could not. However, of these 10, nine patients admitted that this was probably because they had not tried to run. The other patient was not able to run owing to discomfort in the conventionally treated hip. Seventeen patients had no difficulty sitting cross-legged and five were not able to do so. Of these

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**Table 1. Demographics of the patients**

| Parameters                  | Number of patients | Age (years) | Gender | Diagnosis          |
|-----------------------------|--------------------|-------------|--------|--------------------|
| Number of patients          | 22 (44 hips)       | 59.6 (30-80)| 11     | 15                 |
| Gender                      |                    |             | 11     | 6                  |
| Male                        |                    |             | Female | 1                 |
| Female                      |                    |             | 1      | 1                 |
| Diagnosis                   |                    |             | Avascular necrosis | 15 |
|                             |                    |             | Osteoarthritis    | 6   |
|                             |                    |             | Neck of femur fracture | 1 |

**Table 2. Clinical results**

| Parameters                     | Conventional (N=22 hips) | MIS-2* (N=22 hips) | p value |
|--------------------------------|--------------------------|--------------------|---------|
| Follow-up (months)             | 118.9 (14-267)           | 43.7 (12-101)      | 0.00†   |
| Duration of admission (days)   | 13 (10-34)               | 10 (6-27)          | 0.89    |
| Duration of PWBCW (days)       | 6 (2-8)                  | 3 (1-6)            | 0.00†   |
| HHS Preoperative               | 46.1 (30-60)             | 47.7 (25-63)       | 0.23    |
| Postoperative 1 year           | 92.1 (81-100)            | 94.7 (84-100)      | 0.13    |
| Postoperative 2 years          | 90.9 (79-100)            | 91.9 (82-100)      | 0.47    |
| Last follow-up                 | 90.7 (78-100)            | 93.0 (81-100)      | 0.06    |
| WOMAC Preoperative             | 77.7 (59-110)            | 74.7 (56-97)       | 0.19    |
| Postoperative 1 year           | 25.3 (9-39)              | 22.3 (9-34)        | 0.33    |
| Postoperative 2 years          | 26.7 (9-39)              | 23.1 (9-35)        | 0.14    |
| Last follow-up                 | 27.0 (9-38)              | 23.7 (9-35)        | 0.09    |
| Functional abilities (Number of hips able to perform) at postoperative 1 year and 2 years |                  |                    |         |
| Running                        | 12                       | 13                 | 0.23    |
| Sitting cross-legged           | 17                       | 21                 | 0.04†   |
| Squatting                      | 17                       | 20                 | 0.08    |
| Complications                  | 1                        | 1                  |         |
| Preference at postoperative 1 year and 2 years (No preference =7) | 4                       | 11                 | 0.005†  |

*aModified two-incision minimally invasive approach, †Statistically significant. PWBCW: partial weight-bearing crutch walking, HHS: Harris hip score.*
five, one had limitations in both hips, and in the other four
the conventionally treated hip prevented cross-legged
sitting. Seventeen patients were able to squat without
difficulty. In two of the patients not able to squat, this in-
ability was due to limitations in both hips. The remaining
three patients felt that the conventionally treated hip pre-
vented squatting. Eleven patients preferred the MIS-2
THA hip and cited faster rehabilitation (3 patients), less
pain (3 patients), and less discomfort (5 patients) as
reasons. Four patients preferred the conventionally treat-
ed hip and citing squeaking (1 patient), clicking (1 patient),
and mild discomfort following exertion (2 patients) in the
MIS-2 THA hip as reasons. However, the two patients who
complained of squeaking or clicking were implanted with
ceramic-on-ceramic articulation. Seven patients expressed
no preference for one hip over the other.

4. Radiologic results

The average lateral opening angle was 41.10 (range,
35.1-45.20) for conventional posterolateral THA and 40.80
(range, 35.8-45.30) for MIS-2 THA. The average angles of
anteversion for conventional posterolateral THA and MIS-2
THA were 14.90 (range, 10.2-18.60) and 16.50 (range,
11.1-19.50), respectively. All the femoral components were
implanted in neutral to 50 of valgus during MIS-2 THA.
However, 1 stem was implanted in slight varus (1.90) dur-
ing conventional THA. No patient had a limb length dis-
crepancy of more than 5 mm postoperatively, and no femo-
ral component showed subsidence of more than 3 mm in ei-
ther group. Femoral canal filling by prosthesis was ex-
cellent in all cases.

5. Complications

No infection, dislocation, intraoperative fracture, or
deep vein thrombosis was encountered in any patient. In
one patient, the hip implanted conventionally at another
institution was found to be in a varus position, but this hip
remains asymptomatic. In another, abductor weakness
was noted on the conventional side, which persisted at 5
years postoperatively. In addition, one patient developed
a postoperative fever following MIS-2 THA, which was at-
tributed to a urinary tract infection. The fever and infection
were resolved by medication and did not adversely affect
the outcome of hip surgery. Another patient complained of
mild anterolateral thigh numbness in the MIS-2 THA side,
and this persisted at 4 years postoperatively but did not in-
terfere with daily activities.

DISCUSSION

The current definition of MIS THA involves any hip ar-
throplasty procedure in which the length of the wound and
surgical dissection are modified to minimize the tissue
damage associated with hip replacement.11 The reported
benefits of MIS THA include reduced hospital stay, faster
recovery, less blood loss, and better cosmetic results. Thus,
it is no surprise that journals and popular media have de-
voted significant attention to this topic and that patients
are demanding such surgery.12

Our study had several limitations. As in any retro-
spective review, some information was lacking, especially
when multiple institutions were involved in patient care.
In addition, patient numbers were small. However, our
ability to compare results in the same patients reduced or
eliminated variabilities introduced by weight, comorbidity,
bone quality, activity level, and gender. On the other hand,
although both procedures were performed in the same pa-
tsients, in 14 patients, conventional posterolateral THA
was performed by different surgeons. As a result, outcome
comparisons are fraught by different surgical techniques,
anesthesia, pain and rehabilitation protocols, surgeons,
prostheses, articulation, and institutions. These short-
comings are why we opted to focus on patient satisfaction
levels, rather than on only clinical outcome measures.
Furthermore, blood loss and operative times were not com-
pared in the present study because some hips were treated
conventionally at other centers, and intra- and perioper-
ative details were not available for review.

In this study, patients were found to mobilize sooner and
to require crutches for significantly less time after MIS-2
THA. Despite a lack of peer-reviewed literature on MIS
THA, especially randomized trials,12,13 some data support
a reduction in blood loss and faster recovery after MIS. In
a study by Chimento and Sculco14 it was found that patients
in the mini-incision group (an 8-cm long incision) lost sig-
nificantly less blood than did patients in a standard in-
cision group (15-cm incision) and more rapidly achieved a
normal gait pattern. Wenz et al.15 compared 124 minimally
invasive anterolateral THAs with 65 standard antero-
lateral THAs and found that the minimally invasive group
had lower operative times and transfusion requirements
and achieved earlier functional recovery without any in-
crease in complications or component malposition. In this
previous study, three times as many patients were able to
ambulate on day 1 and 50% more patients met all discharge
criteria by day 3 after MIS THA. Furthermore, patients in
the minimally invasive group were able to sit up, stand, and
transfer more rapidly than did the patients in the conven-
tional group. This finding was supported by Berger et al.,16
who reported substantially faster recoveries. In fact, those
authors reported being able to discharge all 100 patients
within 23 hours postoperatively. In the present study, al-
though MIS-2 patients had longer hospital stays than
found in these previous studies,15,16 hospital stay was
shorter than in the conventional group. Moreover, this dif-
ference in hospital stays is probably explained by the medi-
cal insurance reimbursement system in Korea, which al-
lows hospital stay for up to 3 weeks postoperatively in un-
complicated cases. Thus, patients tend to opt to remain in
the hospital to recuperate without incurring any extra cost.

In a study by Ogonda et al.,13 109 patients treated by use
of a mini-incision technique were compared with 110 pa-
tients treated by use of a standard approach. In terms of
early outcomes (follow-up at 6 weeks), no significant differ-
ence was found between the two patient groups for any outcome parameter measured. The authors concluded that the mini-incision technique is safe and reproducible, although this technique offers no significant benefit. Lawlor et al.\(^\text{17}\) in a prospective randomized blinded trial compared total hip replacement using a minimally invasive approach versus a standard incision approach in terms of early postoperative functional levels, and concluded that there was no difference between the two approaches in the ability of patients to mobilize and perform functional tasks necessary for safe discharge. Khan et al.\(^\text{18}\) reported that patients in their less invasive group showed significantly better WOMAC scores than did their standard group for up to 12 months. At 24 months, however, this difference failed to reach statistical significance. The findings of the present study concur. No intergroup difference in WOMAC score was observed at the final follow-up. However, the HHS was significantly better with MIS-2 THA.

In this series, complication rates were similar for the two approaches. In a previous study by Kim,\(^\text{19}\) a comparison of primary THA performed by using a modified posterolateral minimally invasive technique with a standard postero-lateral approach in patients who underwent simultaneous bilateral THA showed no significant difference in postoperative outcomes, but a higher infection rate for MIS THA. In the present study, however, no infection developed in the MIS-2 THA arm.

Pagnano et al.\(^\text{20}\) reported in their series of 26 patients who underwent staged bilateral THA with MIS-2 on one hip and mini-posterior THA on the other that no early functional outcome differences were evident. In this previous study, 16 patients preferred mini-posterior THA and two patients had no preference, whereas in the present study, 11 patients preferred MIS-2 THA, 4 preferred conventional posterolateral THA, and 7 patients expressed no preference. In the present study, no significant difference was found between the functional abilities of the two study groups, which shows that the hips treated by MIS-2 THA function sooner, as well as if not better than the hips treated by conventional THA by use of the posterolateral approach.

Furthermore, in the present study, radiologic evaluations showed acceptable femoral and acetabular component placement and limb length restoration after MIS-2 THA, which refutes the argument that component positioning is compromised during minimally invasive procedures.\(^\text{21}\)

In summary, we found THA via MIS-2 to be as safe as the conventional posterolateral approach in experienced hands and to not present any additional risk of complications. Furthermore, MIS-2 THA provided significantly earlier partial weight-bearing ambulation, better postoperative HHS, and better ability to sit cross-legged; was more preferred by patients than conventional THA; and achieved satisfactory clinical and radiological results.

**CONFLICT OF INTEREST STATEMENT**

None declared.

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