A Prospective Study of Minimally Invasive Anterolateral Approach in the Supine Position Versus Direct Anterior Approach Total Hip Arthroplasty. Early results

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Abstract

Background

Both of Minimally Anterolateral Approach (MIS-ALA) and Direct Anterior Approach (DAA) have been reported to be advantageous in Total Hip Arthroplasty (THA), reducing postoperative pain and permit quicker rehabilitation by preserving muscle insertions. There is little literature concern the difference of them. Therefore, we conducted a prospective study to assess the difference of early clinical outcomes, radiological, and patient-reported outcomes between the two minimally invasive approaches of MIS-ALA and DAA.

Methods

The subjects were 98 patients, with 50 in the MIS-ALA group and 48 in the DAA group. Patients with complete data were evaluated preoperatively and postoperatively at 2, 6 and 12 weeks. Clinical measurements including the ability to climb stairs and walk, a 6 minutes walk test (6MWT) distances, the Forgotten Joint Scale (FJS-12), Japanese Orthopaedic Association (JOA) Hip scores, radiological evaluation, and complications data were collected.

Results

There were no significant differences in clinical outcomes and implant alignments between MIS-ALA and DAA groups. In regards to patient-reported outcomes, the FJS-12 was significantly higher in the MIS-ALA group than in the group DAA at 2 and 6 weeks postoperatively. However, there was no significant difference in the FJS-12 between the two groups at 12 weeks after surgery. The differences also included shorter operative times, less blood loss, lower Hb drop, and fewer blood transfusions in the MIS-ALA group. The incidence of lateral femoral cutaneous nerve (LFCN) neuropraxia after surgery was 7 (14.6%) in the DAA group, zero occurred in the MIS-ALA group. One fracture was identified with each group and managed conservatively.

Conclusion

Both MIS-ALA and DAA approaches yielded excellent and similar early clinical outcomes. However, better patient-reported outcomes could be achieved by MIS-ALA THA. The MIS-ALA was a safer approach for shorter operative times, less blood loss, lower Hb drop, fewer blood transfusions and LFCN neuropraxia compared with DAA. A longer follow-up is needed to examine differences between these procedures.

Introduction

Primary Total Hip Arthroplasty (THA) is generally considered to be one of the most successful surgeries in modern medicine ^{1,2}. Which leads to pain relief, functional recovery, and improvement in the quality of life. Technological advancements matched with low revision rates have seen candidates undergoing THA becoming younger ³. The demands of patients for THA are not only related to the resolution of pain and restoration of function but also a faster recovery ⁴.

Total hip arthroplasty (THA) performed through a minimally invasive approach provides earlier pain relief and functional recovery, and has recently been widely used ⁵⁻⁷. The direct anterior approach (DAA) causes less soft tissue trauma and shorter hospitalization than conventional approaches owing to it follows intermuscular interval, separates the anatomic interval between the tensor fasciae latae and the sartorius muscles to reach the hip joint ^{8,9}. On the other hand, the minimally anterolateral approach (MIS-ALA) separates the intermuscular plane between the tensor fasciae latae and the gluteus medius muscles, which was the modified Watson-Jones approach and was first reported by Bertin et al ¹⁰ in 2004. Both of MIS-ALA and DAA have been reported to be advantageous in THA, reducing postoperative pain and permit quicker rehabilitation by preserving muscle insertions ¹¹⁻¹³.

However, to our best knowledge, there have been limited comparative studies available presenting clinical outcomes performed by a single surgeon via the MIS-ALA and DAA approaches. To devote to a better understanding of the effects of MIS-THA on clinical and other parameters, we conducted a prospective study to assess the difference of early clinical outcomes, radiological, and patient-reported outcomes between the two minimally invasive approaches of MIS-ALA and DAA.

Materials And Methods

Patients

From January 2017 to January 2018, we recruited 98 patients (98 hips) with hip osteoarthritis of terminal stage who underwent primary unilateral cementless THA. The inclusion criteria for the study were patients had an underlying diagnosis of hip osteoarthritis, age between 20 and 80 years, American Society of Anaesthesiologists grade (ASA) less than or equal to 3, and a body mass index (BMI) not more than 30 kg/m². The exclusion criteria were who had a previous history of the hip surgery, rheumatoid arthritis, neuromuscular disease, deformity in limb joints other than the hip joint. Patients were randomized to MIS-ALA (n = 50) or DAA groups (n = 48), using computer-generated cards.

Operative Techniques

All surgeries were performed by one senior surgeon, who started MIS-ALA and DAA in 2011, and the surgeon had practiced more than 100 THAs via MIS-ALA and more than 200 THAs via DAA before this study.

In group MIS-ALA, the patient was placed supine on the fracture table, an oblique skin incision about 9–11 cm was made depend on the build of the patient, extending distally from 2 cm lateral and distal to the anterior superior iliac spine and ending at the top of the greater trochanter. The subcutaneous tissue and fascia were opened. The intermuscular interval between the anterior border of gluteus medius and the tensor fasciae latae was entered by blunt dissection with the insertion of the index finger until the femoral neck was reached. The vessels crossing this interval was ligated, tensor fascia latae, glutei medius, and minimus was not be split or detached. The capsule was divided in a circular arc fashion along the base of the femoral neck and preserved. The acetabulum was prepared and the acetabular component was inserted using a traditional fashion. For preparation of the femur, the surgeon places the involved lower limb in external rotation, adduction, and the fracture table was extended for 15° to provide a hyperextension position. An elevating retractor was inserted posterior to the greater trochanter to lift the femur for more extensive exposure. After insertion of implants and check of stability and length, the hip capsule was sutured, hemovac drain was not routinely placed and suture the wound in a standard layered fashion.

In group DAA, it utilizes a fracture table with the patient in the supine position. A skin incision, 8–12 cm long, was started about 3 cm lateral and distal to the anterior superior iliac spine and along the anterior margin of the tensor fasciae latae. The intermuscular space was opened bluntly between the sartorius muscles and tensor fasciae latae. The capsule was exposed anteriorly, a femoral neck osteotomy was performed. For femoral preparation, the posterior capsule was partial released and the greater trochanter could be elevated with a retractor to provide sufficient exposure. The femoral components was inserted in the same manner as that in group MIS-ALA with press fit fixation utilized. No redon drainage was intra-articularly placed, and routine closure was performed.

Perioperative Interventions

All participants received the same standardized preoperative and postoperative treatment, including pain management and rapid rehabilitation. All patients received prophylactic antibiotics and thromboprophylaxis. Physical therapy was initiated on the first postoperative day. All patients were allowed to abandon the crutches for full weight bearing to tolerance, depending on the individual immediate postoperative recovery and clinical condition. Patients were discharged from hospital after a minimum hospital stay of 2 days (range 2–6 days).

Clinical Evaluations

we recorded patients' background data and surgical data, including operating time, intraoperative blood loss, length of skin incision, etc. On postoperative day 1 hemoglobin (Hb) was measured, and the number of blood transfusion was also recorded. Evaluations were conducted by two physical therapists blinded to the approaches employed at the following time points: preoperatively and postoperatively at 2, 6 and 12 weeks. Clinical results were evaluated using the ability to climb stairs and walk, a 6 minutes walk test (6MWT) distances¹⁴, visual analog scale (VAS, 1–10 point scale), the Forgotten Joint Scale (FJS-12), and Japanese Orthopaedic Association (JOA) Hip scores. The FJS-12 is a self-administered questionnaire that estimates patients' awareness of their knee or hip joint during activities of daily living, symbolizing a specific but very subjective patient-reported outcomes measure, and the eventual score range from 0 (worst) to 100 (best)¹⁵. JOA score has four subcategories: pain (Pain,40 points), range of motion (ROM,20 points), ability to walk(Gait,20 points), and activities of daily living (ADL,20 points), a high JOA score is indicative of better hip function¹⁶. Presence of any other complications after operating were recorded during follow-up.

Radiographic Evaluations

Preoperative, 24 hours postoperative, 12 weeks postoperative, digitalized radiographs with an anteroposterior pelvis and cross-table lateral were performed routinely in all cases. Radiographs obtained at 12 weeks postoperative were examined to assess cup alignment (inclination angle, radiographic anteversion angle), and stem alignment (graded as valgus, neutral or varus)¹⁷ Anatomical anteversion evaluated in 24 hours postoperative computed tomography (CT) was converted into radiographic anteversion¹⁸. All radiographs were examined by two independent reviewers, they were not directly involved with patient treatment and thus were blinded from all clinical information during the assessment of radiographic implant alignment.

Statistics

We compared clinical outcomes and implant alignment between MIS-ALA and DAA groups. Continuous scales were compared with the two-sample t test or Wilcoxon's rank-sum test, categorical variables were compared by pearson's χ^2 test or Fisher exact probability test using SPSS version 20.0 (SPSS Inc, Chicago, IL). With a p-value < 0.05 considered statistically significant.

Results

Clinical Outcomes

Demographic data were comparable for the MIS-ALA and DAA groups (Table 1). There were no significant differences in age, gender, BMI, operative side, ASA status, Crowe classification, 6 MWT, preoperative VAS or preoperative JOA hip score between MIS-ALA and DAA groups ($P > 0.05$). Surgical wounds, postoperative hospital stay, at all time points for postoperative VAS scores were also not significantly different ($P > 0.05$). (Table 2)

The surgery time was significantly shorter in the MIS-ALA group than in the group DAA [(62.4 ± 9.05) min vs (71 ± 8.01) min, $P < 0.001$]. The blood loss for MIS-ALA subjects was (132.6 ± 43.31) ml vs (159.23 ± 37.25) ml for the DAA patients ($P = 0.002$). The Hb drop was also significantly lower on the first day postoperatively for MIS-ALA group ($P < 0.001$). 2(4.0%) participants and 9(18.8%) participants in the MIS-ALA and DAA groups respectively required blood transfusions for anaemia, this difference was statistically significant ($P = 0.021$). (Table 2)

Postoperatively the MIS-ALA group had no significant differences who were using stairs normally, walking unlimited, 6MWT and wear shoes and socks with ease at 2, 6 and 12 weeks postoperatively compared to the DAA group ($P > 0.05$). In comparison of JOA scores in both groups 2 and 6 and 12 weeks after surgery, there were no statistically significant differences for any of the parameters measured ($P > 0.05$). In regards to patient-reported outcomes, the FJS-12 was significantly higher in the MIS-ALA group than in the group DAA at 2($P = 0.006$) and 6 weeks ($P = 0.028$) postoperatively (64.5 ± 17.96 vs 55.52 ± 13.18, 74.9 ± 13.98 vs 68.65 ± 13.84, respectively). There was no significant difference in the FJS-12 between the two groups at 12 weeks after surgery ($P = 0.582$). (Table 3)

Radiological Outcomes

There were no statistically significant differences in films positioning of implants between the MIS-ALA and DAA groups ($P > 0.05$; Table 2). On 12-week radiographs the MIS-ALA group had an average cup inclination of 41.96° ± 4.45 compared to an average cup inclination for the DAA group was 40.71° ± 4.09. Acetabular anteversion was 16.64° ± 5.63 for the MIS-ALA and 15.92° ± 5.01 for the DAA group respectively. No cups in either the MIS-ALA or DAA groups presented with a sign of migration at 12 weeks. The MIS-ALA group had 2 (4.0%) stem implanted with varus compared to 3 (6.2%) in the DAA group, but this difference was not statistically significant ($P = 0.963$). Femoral implants that subsided stabilized without radiological evidence of subsidence of > 3 mm in both groups at 12 weeks.

Complications

Surgical complications were described in Table 4. One fracture was identified with each group and managed conservatively. In the MIS-ALA group, a symptomatic partial fracture of the major trochanter postoperatively at identified 2 weeks due to a fall that did not require surgical fixation. In the DAA group, which was an intra-operative femoral perforation on broaching and was protected full weight-bearing for 6 weeks. The minor complication profile was inclined significantly to the DAA group as a result of the high incidence of lateral femoral cutaneous nerve (LFCN) neuropraxia. The leading symptom with the patient was dysesthesia of lateral thigh. The incidence of LFCN neuropraxia after surgery was 7(14.6%) in the DAA group, zero occurred in the group MIS-ALA, this difference was statistically significant ($P = 0.016$). There were no complications of calcar fracture or postoperative dislocation discovered 12 weeks postoperatively. (Table 4)

Discussion

Primary early clinical outcomes following MIS-ALA and DAA THA were similar in this study. These measures including the ability to climb stairs and walk, 6MWT, VAS pain, and JOA scores. Hospital stay postoperative was also similar for both groups. The similar clinical outcomes suggest that pain relief and functional recovery over the total hip were not significantly different for both groups, which may be owe to the reduced invasiveness of both surgical approaches. Although the overall similarity of the MIS-ALA and DAA outcomes, some significant differences were confirmed in other domains. Early postoperative data, 2 and 6 weeks postoperative FJS-12 score were significantly better for the MIS-ALA group, this shows that better patient-reported outcomes can be achieved by MIS-ALA THA. Nevertheless, the present study revealed that 12 weeks after surgery the FJS-12 score was similar between the MIS-ALA and DAA groups. Differences in favour of the MIS-ALA also included shorter operative times, less blood loss, lower Hb drop, fewer blood transfusions and LFCN neuropraxia.

The operation steps associated with the MIS-ALA, in part, explained the shorter surgical times with less blood loss, lower Hb drop, and fewer blood transfusions. The decreased blood loss was generally on the femoral side, related to an easier visualization of posterolateral capsular bleeders associated with the MIS-ALA. When THA was performed via the DAA, during elevation of the proximal femur release a portion of the posterolateral capsule and piriformis were at times necessary. Surgeon experience also played a great role, with over 100 MIS-ALA cases vs 200 DAA cases earlier to the study. However, the longer surgical time and more blood loss were not offset by better pain relief, faster function improved, and earlier discharge in the DAA group.

This study presented favorable implant alignments in THA with the both minimally invasive techniques. The MIS-ALA and DAA groups showed similar alignments both of cup and stem. Component positioning has a marked impact on the function and duration of THA^{19–21}. The MIS-ALA and DAA surgical approaches can expose the hip joint intermuscular and internervous interval with the advantage of a lower chance of dislocation without higher revision risk^{22, 23}. Kwarai et al²⁴ reported that cup anteversion in DAA nearly 4° larger than MIS-ALA in the supine position. Inconsistent with our results. The larger anteversion in DAA could be due to the difference in rotation and tilt angles of the pelvis in the supine position. This could lead to the flexor muscles and femoral weight. During the cup procedure, the ipsilateral pelvis posteriorly could be retracted. According to Kobayashi et al²⁵ research, it's a little difficult to insert the femoral stem in the position of neutral via DAA owing to the exposure of the proximal femur. Different with Kobayashi et al reports, the proximal femur could obtain adequate exposure to find the entry point in the DAA group and there was no statistically significant difference in stem implant alignment compared with the MIS-ALA group. The adequate exposure was obtained by longer surgical time to manage femur side.

The risk of minor surgical complications in our study favoured the MIS-ALA group due to the 14% incidence of LFCN neuropraxia in the DAA group. LFCN neuropraxia was a typical complication of DAA. Ozaki et al^{26, 27} demonstrated that LFCN neuropraxia mainly resolves spontaneously over time after

THA. The study's incidence was similar to previous reported range in the literature^{28–31}. There were no connections between LFCN neuropraxia and 6MWT or JOA scores but had higher FJS-12 scores in MIS-ALA group. This was supported by Ozaki et al²⁶.

This study has several limitations. First, it was an early evaluation of only 12 weeks after surgery. Longer follow-up was needed to compare the effects of the MIS-ALA and DAA methods on LFCN neuropraxia, FJS-12 scores, and implant alignment after THA. Second, the study could not be full blinded due to the visible difference in the surgical incisions. All radiographs review were blinded by two independent reviewers. In addition, only cementless stem was utilized. Generally, it was just needs narrower exposure of the proximal femur for a cementless stem to prepare the femur than did a cemented stem^{24,32}. In this manner, minimally invasive surgery becomes less technically demanding and generates an advantage for the cementless stem.

Conclusion

Both MIS-ALA and DAA approaches yielded excellent and similar early clinical outcomes. However, some significant differences were confirmed in other domains. Better patient-reported outcomes could be achieved by MIS-ALA THA, as time went on, there were no significant differences in patient-reported outcomes between the two groups at 12 weeks after surgery. Differences in favour of the MIS-ALA included shorter operative times, less blood loss, lower Hb drop, fewer blood transfusions and LFCN neuropraxia.

Abbreviations

THA
Total Hip Arthroplasty
MIS-ALA
Minimally Anterolateral Approach
DAA
Direct Anterior Approach
6MWT
6 minutes walk test distances
FJS-12
Forgotten Joint Scale
JOA
Japanese Orthopaedic Association
LFCN
Lateral femoral cutaneous nerve
ASA
American Society of Anaesthesiologists grade
BMI
Body mass index
VAS
Visual analog scale
CT
Computed tomography

Declarations

Acknowledgements

The authors declare that the content of this article was composed in the absence of any financial or personal relationships that might inappropriately influence this study

Authors' contributions

HL and LY: wrote the paper. HL and JL: collected the data and participated in writing and revising the paper. SL and QT: performed all the analysis. JX: designed the whole study, completed all operations and helped to perform manuscript review. All authors read and approved the final manuscript.

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Code availability

Not applicable.

Ethics approval and consent to participate

This study was approved by Clinical Trials and Ethics Committee of Fujian Province Hospital. All patients provided consent for surgery and to have their data included in this study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent for publication

All authors have stated for consents of publications. Availability of data and materials The datasets used and/or analyzed during the current study are fully available on reasonable request.

Competing interests

The authors declare that the content of this article was composed in the absence of any financial or personal relationships that might inappropriately influence this study

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Tables

Table 1 Demographic Data on the Patients.

Variable	MIS-ALA	DAA	P-Value
Age (y)	62.44±7.07	62.21±8.22	0.881
Males/Females (n)	17(34.0%)/33(66.0%)	23(47.9%)/25(52.1%)	0.161
BMI (kg/m ²)	22.46±4.23	22.96±3.11	0.509
Operative side – right (n)	23(46.0%)	25(52.1%)	0.547
ASA score (I:II:III)	11/30/9	9/34/5	0.460
Crowe (I:II:III:IV)	13:34:3	14:31:3	0.935
6 MWT (m)	289±51.36	279.17±57.05	0.372
Pre-op VAS (points)	7.32±1.02	7.23±1.12	0.675
Pre-op JOA (points)			
Pain	16.74±4.58	16.73±5.37	0.991
ROM	12.98±2.99	12.21±3.29	0.227
Gait	10.54±3.45	11.02±3.49	0.494
ADL	11.32±3.63	10.35±3.08	0.160
Total	51.58±9.69	50.31±9.77	0.521

Table 2 Surgical and Immediate Post-Operative Data

Variable	MIS-ALA	DAA	P-Value
Surgery time (min)	62.4±9.05	71±8.01	<0.001
Incision (cm)	9.86±0.99	10.04±1.07	0.385
Blood loss (ml)	132.6±43.31	159.23±37.25	0.002
Hb drop (g/L)	29.56±8.02	36.4±7.12	<0.001
Blood transfusion (n)	2(4.0%)	9(18.8%)	0.021
post-op hospital stay (day)	4.6±1.14	4.77±1.17	0.467
VAS (points)			
1 day post-op	4.2±0.99	4.38±0.82	0.343
3 day post-op	2.82±0.83	2.79±0.8	0.863
7 day post-op	2.24±0.52	2.38±0.57	0.222
Cup Inclination (°)	41.96±4.45	40.71±4.09	0.151
Cup Anteversion (°)	16.64±5.63	15.92±5.01	0.504
Femoral Stem Position (n)			0.963
Valgus	0(0%)	0(0%)	
Neutral	48(96.0%)	45(93.8%)	
Varus	2(4.0%)	3(6.2%)	

Table 3 Post-Operative Outcomes data

Variable	2 Weeks			6 Weeks			12 Weeks		
	MIS-ALA	DAA	P-Value	MIS-ALA	DAA	P-Value	MIS-ALA	DAA	P-Value
VAS (points)	2.16±1.2	2.29±1.32	0.607	1.86±1.16	1.85±1.24	0.981	1.4±1.14	1.13±0.84	0.180
Stairs Normally (n)	16(32.0%)	14(29.2%)	0.761	24(48.0%)	26(54.2%)	0.542	42(84.0%)	36(75.0%)	0.269
Distance Unlimited (n)	25(50.0%)	20(41.7%)	0.408	38(76.0%)	39(81.3%)	0.527	42(84.0%)	42(87.5%)	0.621
Shoes and Socks with Ease (n)	21(42.0%)	24(50.0%)	0.427	36(72.0%)	32(66.7%)	0.567	42(84.0%)	43(89.6%)	0.415
6MWT(m)	225±87.74	238.54±86.17	0.443	346.6±86.26	332.29±72.24	0.377	410.6±82.69	425.83±86.44	0.375
FJS-12	64.5±17.96	55.52±13.18	0.006	74.9±13.98	68.65±13.84	0.028	80.2±13.21	78.54±16.44	0.582
JOA (points)									
Pain	29.2±4.5	30.81±5.17	0.102	36.76±2.54	36.02±2.42	0.143	38.98±1.8	38.44±2.61	0.232
ROM	13.88±3.27	14.5±3.59	0.373	16.28±1.33	16.52±2.41	0.539	16.96±1.73	17.38±1.95	0.267
Gait	13.6±2.96	12.94±3.48	0.312	14.1±3.87	15.33±3.22	0.090	18.06±1.75	17.42±2.56	0.148
ADL	13.9±3.02	14.44±2.7	0.356	15.04±3.52	15.88±3.55	0.245	16.76±1.51	17.25±1.64	0.127
Total	70.58±7.49	72.69±9.09	0.213	82.52±7.62	84.33±6.77	0.217	90.76±3.16	90.48±6.97	0.797

Table 4 Surgical complications

Complication	MIS-ALA	DAA	P-Value
Superficial infection (hips)	0	0	1.00
Deep infection	0	0	1.00
DVT	0	0	1.00
Calcar fracture	0	0	1.00
Major trochanteric fracture	1(2%)	1(2.1%)	1.00
LCFN neuropraxia	0	7(14.6%)	0.016
Nerve palsy	0	0	1.00
Post-operative dislocation	0	0	1.00
Post-operative femoral fracture	0	0	1.00
Cup migration	0	0	1.00
Stem subsidence >3 mm	0	0	1.00
Thigh pain	0	0	1.00
Bursitis	0	0	1.00