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Comparison of outcomes and cost-effectiveness of simultaneous and staged total hip arthroplasty using the anterolateral-supine approach

Hiroaki Kurishima[1,2*], Norikazu Yamada[1], Atsushi Noro[1], Hidetatsu Tanaka[2], Yu Mori[2] and Toshimi Aizawa[2]

Abstract

Background To date, no study has compared simultaneous bilateral total hip arthroplasty (simBTHA) with staged BTHA (stgBTHA) using the anterolateral-supine approach (ALSA). This study compared the outcomes and cost-effectiveness of simBTHA and stgBTHA using ALSA.

Methods This retrospective cohort study was conducted on patients who required bilateral ALSA THA at the time of their initial medical evaluation between August 2015 and January 2023. Patients were divided into two groups: simBTHA and stgBTHA. Demographic data, including age, sex, body mass index (BMI), and American Society of Anesthesiologists Physical Status (ASA-PS) scores, were collected. Operative outcomes such as surgical time, blood loss, autologous and allogeneic blood transfusions, and time to ambulation were compared. Clinical outcomes were assessed using the Japanese Orthopaedic Association (JOA) hip score, Japanese Orthopaedic Association Hip-disease Evaluation Questionnaire (JHEQ), and Forgotten Joint score-12 (FJS-12). Postoperative complications, revisions, readmissions, and mortality within 90 days were also recorded. The total cost, length of stay (LOS), and time interval between surgeries in the stgBTHA group were analyzed.

Results A total of 129 patients were included: 104 in the simBTHA group and 25 in the stgBTHA group. The preoperative ASA-PS significantly differed between the two groups ($P < 0.01$), but other demographic data were not significantly different. The simBTHA group had significantly shorter surgical times (156 min) compared to the stgBTHA group (175 min) ($p = 0.02$). Blood loss was similar between the two groups (670 mL for simBTHA and 629 mL for stgBTHA). There were no significant differences in the time to ambulation, postoperative complications, or clinical outcomes between the two groups. However, the simBTHA group had a significantly lower total cost (83.2%, $p < 0.01$) and shorter LOS (20.5 days) compared to the stgBTHA group (30 days) ($p < 0.01$). No significant differences in complication rates, revisions, or readmissions were observed between the groups.

*Correspondence:
Hiroaki Kurishima
marronile@gmail.com

Full list of author information is available at the end of the article

Conclusions SimBTHA with ALSA provides comparable clinical outcomes to stgBTHA while offering significant advantages in terms of reduced costs and shorter hospital stays. For patients with suitable health conditions, simBTHA is a preferable choice due to its faster recovery and greater cost-effectiveness.

Keywords Simultaneous bilateral total hip arthroplasty, Staged bilateral total hip arthroplasty, Anterolateral-supine approach (ALSA), Cost-effective analysis

Introduction

Total hip arthroplasty (THA) is among the most successful orthopedic procedures, boasting high rates of favorable postoperative outcomes [1]. When both hips require THA, the surgical options include simultaneous or staged bilateral surgery [2]. Simultaneous bilateral THA (simBTHA), which involves performing both procedures under a single anesthetic during the same hospital stay, may reduce overall costs and accelerate recovery. However, while simBTHA allows for early completion of treatment, it involves greater surgical invasiveness compared to unilateral or staged procedures. This increased invasiveness is associated with a higher risk of blood transfusions, complications, and mortality.

Several systematic reviews [2–4] have compared simBTHA and staged bilateral THA (stgBTHA), exploring various approaches. Performing simBTHA in the supine position offers distinct advantages over the lateral decubitus position, such as eliminating the need for patient repositioning and enabling concurrent surgery. This can reduce anesthesia duration and potentially lower complication rates [5]. Therefore, a comprehensive analysis of simBTHA and stgBTHA performed in the supine position is warranted.

The anterolateral-supine approach (ALSA THA), introduced in 2007, represents a less common but effective alternative to the direct anterior approach (DAA) [6]. Similar to the DAA, ALSA provides advantages such as muscle preservation, low rates of dislocation, and minimal leg length discrepancy (LLD) [7–9]. Since 2015, we have utilized the ALSA technique in our practice and performed numerous simultaneous bilateral ALSA THAs, leveraging the benefits of the supine position. While several studies have evaluated simultaneous and staged bilateral DAA THA [10–13], no research to date has specifically focused on ALSA THA.

We hypothesize that simultaneous bilateral ALSA THA is as safe as staged bilateral THA performed in other positions, while offering additional benefits such as shorter operative times, reduced LLDs, and lower total costs. To test this hypothesis, this study compares simultaneous and staged bilateral ALSA THAs by examining demographic data, clinical and operative parameters, and overall costs.

Materials and methods

Patients

This single-center retrospective cohort study was approved by our Institutional Review Board. Patients who required bilateral THA at the time of their initial medical evaluation and underwent bilateral ALSA THA at our hospital between August 2015 and January 2023 were included. SimBTHA was generally recommended; however, stgBTHA was performed if patients expressed concerns about same-day surgery or if potential factors were identified that could prolong surgical time or increase the risk of complications. Patients with prior hip surgery or a postoperative follow-up period of less than one year were excluded. The remaining patients were categorized into two groups based on whether they underwent simBTHA or stgBTHA.

Surgical methods

All surgeries were performed by four experienced surgeons (NY, AN, HT, and HK) utilizing the ALSA technique [8, 14]. When feasible, preoperative autologous blood donation was arranged, with the simBTHA group donating 800 mL and the stgBTHA group donating 400 mL per operation at least one week before surgery. In both groups, both legs were draped during surgery to assess for LLD without an image intensifier or navigation system.

In the simBTHA group, surgery on the contralateral side commenced during the closure of the first side. Autologous blood recovery devices were used for all patients in the simBTHA group and selectively for patients in the stgBTHA group who were receiving anticoagulant therapy or unable to donate autologous blood. Starting from the first postoperative day, all patients without intraoperative fractures were permitted full weight-bearing as tolerated.

Clinical and operative parameters

Demographic data, including age, sex, weight, body mass index (BMI), American Society of Anesthesiologists Physical Status (ASA-PS) score, and reasons for selecting stgBTHA were collected. Operative outcomes were evaluated based on total surgical time, intraoperative blood loss, autologous and allogeneic blood transfusions, time to ambulation after surgery, and LLD. Clinical outcomes were assessed preoperatively and at the latest follow-up using the Japanese Orthopaedic Association (JOA) hip

score [15], the Japanese Orthopaedic Association Hip-disease Evaluation Questionnaire (JHEQ), which includes a hip condition visual analog scale (VAS) and a total score [16], and Forgotten Joint score-12 (FJS-12) [17]. Postoperative complications, revisions, readmissions, and deaths within 90 days of discharge were recorded for all patients. Complications were classified as major or minor according to existing literature [18–20].

To evaluate social impact, the total cost, length of stay (LOS), and time interval between surgeries in the stg-BTHA group were analyzed.

Statistical analysis

Statistical analyses were conducted using the EZR software [21]. Normality was assessed using the *Shapiro–Wilk* test. If normality was confirmed, the paired *t*-test was used for two-group comparisons, and the *Tukey–Kramer* test was applied for multiple-group comparisons. Even when normality was not satisfied, the paired *t*-test or *Tukey–Kramer* test was employed based on the Central Limit Theorem, provided that the distribution was not strongly skewed and the sample size was deemed sufficient. If these conditions were not met, the *Mann–Whitney U* test was used for two-group comparisons, and the *Kruskal–Wallis* test was applied for three or more groups. *Fisher*'s exact test was performed for categorical variables. Statistical significance was defined at $P < 0.05$.

Table 1 Demographic data

Parameters	simBTHA	stgBTHA	*p*-value
Sex, n (%)			0.72
Male	10 (9.6)	3 (12.0)	
Female	94 (90.4)	22 (88.0)	
Median age, yrs (range)	62 (32–78)	64 (39–83)	0.58
Median weight, kg (range)	59.0 (42.9–91.0)	60.2 (38.1–121.7)	0.26
Median BMI, kg/cm^2(range)	25.55 (17.2–35.3)	25.10 (18.0–45.6)	0.36
Diagnosis			0.33
Osteoarthritis	101	23	
Osteonecrosis	2	2	
Subcapital femoral fragility fracture	1	0	
ASA-PS, n (%)			< 0.01†
1	24 (23.1)	3 (12.0)	
2	72 (69.2)	13 (52.0)	
3	8 (7.7)	9 (36.0)	
Median preoperative LLD, mm (range)	3.10 (0.0–14.0)	5.04 (0.0–13.0)	0.06
Median preoperative JOA score of right hips, pts (range)	43(19–84)	35 (15–69)	0.09
Median preoperative JOA score of left hips, pts (range)	43 (21–82)	39 (19–76)	0.06
Median preoperative JHEQ hip condition VAS, mm (range)	99.5 (50–100)	100.0 (50–100)	0.77
Median preoperative JHEQ total scores, pts (range)	13 (0–34)	12 (3–38)	0.91

The Mann–Whitney U test and Fisher's exact test were used for the analysis

* $P < 0.05$ by the Mann-Whitney U test

† $P < 0.05$ by the Fisher's exact test

THA, total hip arthroplasty; BMI, body mass index; ASA-PS, American Society of Anesthesiologists physical status; JOA, Japanese orthopaedic association; JHEQ, Japanese orthopaedic association hip-disease evaluation questionnaire

Results

A total of 130 patients underwent bilateral THA during the study period. After excluding one patient with a follow-up period of less than one year, 129 patients were included in the analysis: 104 patients (208 hips) in the simBTHA group and 25 patients (50 hips) in the stg-BTHA group. The *Shapiro–Wilk* test indicated that none of the parameters followed a normal distribution. The demographic data of the participants are summarized in Table 1. There were no significant differences between the two groups in terms of sex, age, weight, BMI, diagnosis, LLD (patients with > 15 mm LLD were excluded), preoperative JOA hip scores, and JHEQ scores (collected from 73.6% of participants). However, a significant difference was observed in ASA-PS scores ($P < 0.01$).

Patient selection for StgBTHA

Twelve patients opted for stgBTHA based on personal preference. Seven patients with excessive obesity were assigned to the stgBTHA group to avoid prolonged operative time. Additionally, stgBTHA was selected for patients with anemia ($n = 2$), extremely low body weight ($n = 2$), cardiac disease ($n = 1$), and renal impairment ($n = 1$) to mitigate the risk of complications.

Operative outcomes

The operative outcomes are detailed in Table 2. The median total surgical time in the simBTHA group was 156 min, significantly shorter than the 175 min observed in the stgBTHA group ($P = 0.02$). Median intraoperative blood loss was 670 mL in the simBTHA group and 629 mL in the stgBTHA group, with no statistically significant difference ($P = 0.69$). The rates of autologous and allogeneic blood transfusion in the simBTHA group were 96.2% and 15.4%, respectively, compared with 88.0% and 24.0% in the stgBTHA group, though these differences were not significant ($P = 0.13$ and $P = 0.37$, respectively).

Postoperative recovery

Three patients requiring non-weight-bearing postoperatively due to fractures were excluded from the ambulation analysis. The median time to ambulation in the simBTHA group was two days (range: 1–6). For the stgBTHA group, median ambulation time was two days (range: 1–4) after the first stage and two days (range:

Table 2 Operative result

Parameters	simBTHA	stgBTHA	*p*-value
Median total surgical time, min (range)	156 (88–251)	175 (113–271)	0.02*
Median total intraoperative blood loss, ml (range)	670 (190–2620)	629 (320–1612)	0.69
Autologous blood transfusion, n (%)	100 (96.2)	22 (88.0)	0.13
Allogenic blood transfusion, n (%)	16 (15.4)	6 (24.0)	0.37
Median time to ambulation after surgery, days (range)	2 (1–6)	1stg 2 (1–4) 2stg 2 (1–7)	0.08
Median postoperative LLD, mm (range)	2.31 (0.0–11.85)	0.805 (0.0–11.98)	0.25
Median postoperative JOA score of right hips, pts (range)	96(54–100)	97 (66–100)	0.73
Median postoperative JOA score of left hips, pts (range)	95 (74–100)	95 (64–100)	0.48
Median postoperative JHEQ hip condition VAS, mm (range)	0 (0–60)	0 (0–40)	0.54
Median postoperative JHEQ total scores, pts (range)	70 (28–84)	67 (18–84)	0.20
Median FJS-12, pts(range)	79.2 (8.3–100)	70.8 (31.3–100)	0.08

The Mann–Whitney U test, Fisher's exact test, and Kruskal–Wallis test were used in this analysis

* $P < 0.05$ by the Mann-Whitney U test

LLD, leg length discrepancy; JOA, Japanese orthopaedic association; JHEQ, Japanese orthopaedic association hip-disease evaluation questionnaire; VAS, visual analog scale; FJS, forgotten joint score

Table 3 Complications

Parameters	simBTHA	stgBTHA	*p*-value
Major Complications			
Periprosthetic fracture	4 (3.8)	0 (0)	1.00
Stem perforation	1 (1.0)	0 (0)	1.00
Cerebral infarction	1 (1.0)	0 (0)	1.00
Minor Complications			
DVT	4 (3.8)	0 (0)	1.00
Fracture of trochanteric tip	3 (2.9)	3 (12.0)	0.09
Wound re-suture	4 (3.8)	0 (0)	1.00
Superficial SSI	1 (1.0)	0 (0)	1.00
Hypotension	1 (1.0)	0 (0)	1.00
Transient atrial fibrillation	0 (0)	1 (4.0)	0.19
Revision	1 (1.0)	0 (0)	1.00
Re-admission in 90 days	1 (1.0)	0 (0)	1.00
Death in 90 days	0 (0)	0 (0)	1.00

Data were presented as numbers and percentages (%). Fisher's exact test was used for the analysis

BTHA, bilateral total hip arthroplasty; DVT, deep vein thrombosis

1–7) after the second stage. No significant differences in ambulation time were observed among the three procedures ($P = 0.08$).

Postoperative LLD, excluding cases of stem perforation, was 2.31 mm in the simBTHA group and 0.805 mm in the stgBTHA group, with no significant difference ($P = 0.25$). Two revisions were omitted from the clinical score analysis. Although JOA scores were collected from all patients, the JHEQ (hip condition VAS and total score) and FJS-12 scores were obtained for 91.4% of the patients. No significant differences in any clinical score were detected between the groups.

Complications

The surgical complications are presented in Table 3. Major complications in the simBTHA group included four cases (3.8%) of periprosthetic fractures, one case (1.0%) of stem perforation, and one case (1.0%) of cerebral infarction. No major complications occurred in the stgBTHA group, and the difference between groups was not significant.

Minor complications in the simBTHA group included four cases (3.8%) of deep vein thrombosis (DVT), four cases (3.8%) of wound resuturing, three cases (2.9%) of trochanteric tip fractures, one case (1.0%) of superficial surgical site infection, and one case (1.0%) of hypotension. In the stgBTHA group, minor complications included three cases (12.0%) of trochanteric tip fractures and one case (4.0%) of transient atrial fibrillation, with no significant differences between groups.

One revision due to stem perforation and one readmission due to wound complications occurred in the simBTHA group, with no significant differences in revision or readmission rates between groups ($P = 1.00$). No deaths were reported within 90 days in either group.

Cost and length of stay (LOS)

The median costs were 3,436,255 Japanese yen for simBTHA and 4,127,640 Japanese yen for the stgBTHA group, representing a statistically significant difference ($P < 0.01$). The median LOS was 20.5 days (range: 9–69) in the simBTHA group, compared to 30 days (range: 22–54) for the total of two admissions in the stgBTHA group, with the simBTHA group showing significantly shorter LOS ($P < 0.01$). The median interval between the two surgeries in the stgBTHA group was five months (range: 2–12).

Discussion

This study demonstrated that the clinical outcomes of the simBTHA group were comparable to those of the stgBTHA group, with no increase in complications, revision rates, or readmissions. Moreover, the simBTHA group had a significant advantage in terms of lower costs and shorter LOS. However, surgeons must carefully consider patients' health conditions, as the ASA-PS scores differed significantly between the two groups. Despite this, simBTHA emerges as a socially preferable option due to its cost-effectiveness and faster recovery. This trend appears to be similar in both Italy and Canada [10, 13].

One of the notable benefits of simBTHA is its shorter recovery duration, as stgBTHA requires an interval between the two procedures. Although tissue damage might be greater in simBTHA, the time to ambulation was similar between the two groups. These results are consistent with trends observed in previous studies [11, 12]. However, it is important to consider that the average LOS in Japan is significantly longer than in other countries within the Organisation for Economic Cooperation and Development (OECD) due to differences in healthcare systems [22]. Therefore, comparing LOS across studies may not be entirely appropriate. For this analysis, time to ambulation may serve as a more relevant metric for international comparisons. From the perspective of patients seeking rapid recovery, simBTHA remains the preferable choice.

In terms of operative data, blood loss and transfusion rates did not differ significantly between the groups. However, operative time was significantly shorter in the simBTHA group, largely due to the simultaneous closure of the first side and the initiation of the second side. Studies comparing simBTHA and stgBTHA in the lateral decubitus position [23] reported similar operative times across both groups, suggesting that the supine position may contribute to reduced surgical time. This is particularly advantageous as shorter operative times have been associated with lower complication rates, especially for procedures exceeding 80 min [5].

The tolerance for LLD following THA remains unclear [24, 25], but shorter LLD has been linked to higher patient satisfaction [26]. While Kim et al. highlighted the benefits of simBTHA in minimizing postoperative LLD [27], this study found no significant differences in LLD between the two groups. The supine position, which allows for better control of LLD compared to the lateral decubitus position [28]; likely explains the overall minimal LLD observed in this study.

Ramezani et al. conducted a systematic review of approximately 10,000 THAs, revealing that simultaneous THA reduces the risk of DVT and systemic, local, and pulmonary complications [2]. However, they also noted a higher incidence of PE and periprosthetic fractures with simBTHA. In our study, the simBTHA group had slightly higher rates of DVT, local complications, and periprosthetic fractures, while no cases of PE were observed. These findings may be attributed to the supine surgical position and early initiation of rehabilitation, which could mitigate risks. Importantly, no significant differences in complication rates were detected between the two groups.

This study has several limitations. First, the sample size for the stgBTHA group was relatively small due to the institutional preference for simBTHA. Although the data were sufficient for statistical analysis, the outcomes might differ with a larger stgBTHA cohort. Second, the sample size was insufficient to evaluate rare complications such as severe blood loss, PE, or cardiac events. Future systematic reviews or studies with larger populations will be necessary to comprehensively assess these critical complications. Third, we conducted blood tests only before autologous blood donation. Therefore, we were unable to calculate the estimated blood loss based on our blood test results.

Conclusions

The simBTHA group exhibited outcomes comparable to those of the stgBTHA group, with no observed increase in complications, revision surgeries, or readmission rates. Additionally, simBTHA was associated with lower costs and a shorter LOS. For patients deemed to have adequate physical health, simBTHA may represent a safe and socially advantageous option, facilitating faster recovery.

Abbreviations

ALSA	anterolateral-supine approach
ASA-PS	American society of anesthesiologists physical status
BMI	body mass index
DAA	direct anterior approach
DVT	deep vein thrombosis
FJS-12	forgotten joint score-12
JHEQ	Japanese orthopaedic association hip-disease evaluation questionnaire
JOA hip score	Japanese orthopaedic association hip score
LLD	leg length discrepancy
LOS	length of stay
simBTHA	simultaneous bilateral total hip arthroplasty
stgBTHA	staged bilateral total hip arthroplasty
THA	total hip arthroplasty
VAS	visual analog scale

Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by H.K., N.Y., A.N., and H.T. The first draft of the manuscript was written by H.K. and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Japanese Red Cross Sendai Hospital (2023-01).

Competing interests

The authors declare no competing interests.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Author details
[1]Department of Orthopaedic Surgery, Japanese Red Cross Sendai Hospital, 2-43-3 Yagiyamahoncho, Taihaku-Ku, Sendai 982-8501, Miyagi, Japan
[2]Department of Orthopaedic Surgery, Tohoku University Graduate School of Medicine, 1-1 Seiryo- machi, Aoba-Ku, Sendai 980-8574, Miyagi, Japan

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