

# Simultaneous bilateral minimally invasive total hip arthroplasty: A comprehensive review of the literature

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## Abstract

Several studies have reported that minimally-invasive total hip arthroplasty (MIS-THA) may significantly reduce postoperative pain and results in faster postoperative rehabilitation when compared with the traditional lateral or posterior approach. Regarding bilateral hip osteoarthritis, there is still no consensus whether simultaneous bilateral MIS-THA can be established as the treatment of choice. Therefore, we searched the international databases of Pubmed, Medline, and Cochrane Database of Systematic Reviews using the key words *minimally invasive bilateral total hip arthroplasty*. From the initial 23 articles we found five clinical studies which met our inclusion criteria. From the perspective of possible intra- and postoperative complications, one-stage bilateral MIS THA was equally safe or safer than two-stage interventions. In addition, from a clinical outcome perspective, the one-stage procedure can be considered to be preferable. Higher blood transfusion requirements, which were expected following the standard bilateral simultaneous THA, seemed to be minimized with the simultaneous bilateral MIS THA. The supine position of the patient minimized the mean operation time. Approaches using the lateral decubitus position of the patient should be avoided in simultaneous bilateral THA due to the increased operation time. There is a lack of randomized, controlled clinical trials, comparing simultaneous bilateral MIS THA with staged bilateral MIS THA. Although simultaneous bilateral MIS THA seems to be efficacious, cost-effective and safe, more clinical trials are required to establish its superiority over the sequential MIS THA.

## Introduction

Bilateral osteoarthritis (OA) of the hip is considered to be an important health problem in middle-aged patients. The national Swedish registry<sup>1</sup> showed that 17% of the patients undergoing primary total hip arthroplasty suffer from bilateral hip disease, and therefore, they require a second total hip arthroplasty to be performed on the contralateral side. The two-stage bilateral total hip arthroplasty (2-BTHA) requires less operative time and less intraoperative blood loss per operation.<sup>2</sup> However, patients need longer rehabilitation time, twice of anesthetic risk and two times admission.<sup>2</sup>

Single-stage bilateral simultaneous total hip arthroplasty (1-BTHA) is the alternative method to treat this condition. The 1-BTHA provides shorter postoperative rehabilitation time, single hospital stay and higher patient satisfaction<sup>3-5</sup> when compared with the 2-BTHA. Furthermore, recent study demonstrated that 1-BTHA was more cost-effective than 2-BTHA without any significant difference in terms of overall complications between these two treatment options<sup>6</sup>

Nevertheless, many surgeons are still concerned about the safety of 1-BTHA. Ideally, when the surgeon plans to perform a 1-BTHA, the operation should be fast, accurate and with minimal blood loss. Diwanji *et al.*<sup>7</sup> reported an average blood loss of 1513.2 ml and a mean blood transfusion of 3.3 units per patient after 1-BTHA. Moreover, the incidence of postoperative complications,<sup>8-10</sup> such as venous thromboembolic event<sup>11</sup> (VTE), cardiopulmonary complications and delirium,<sup>12-13</sup> might be higher after 1-BTHA. The post-operation complications are possibly correlated with increased time of anesthesia in combination with increased intraoperative blood loss.<sup>14,15</sup> Recently, a paradigm shift has occurred in the operative approach of these patients. Different operative techniques were introduced referring to a minimally invasive, muscle sparing total hip arthroplasty (MIS-THA) principle.<sup>2</sup> These techniques promise to reduce the intraoperative time and minimize the intraoperative blood loss.<sup>2,16,17</sup> Except for the mini posterior incision, which shows higher dislocation rate,<sup>18,19</sup> the MIS-THA may include the direct anterior approach<sup>20</sup> and the modified Watson-Jones<sup>21</sup> which takes advantage of the anatomical window between the rectus femoris and the abductor muscles.

Moreover, several studies have also reported that the MIS-THA significantly reduced postoperative pain and led to faster postoperative rehabilitation when compared

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with the respective traditional approaches.<sup>22-29</sup> In addition, a simultaneous bilateral one stage MIS-THA (1-MIS-BTHA) with either anterolateral or direct anterior approach could be performed in supine position which may facilitate the surgeon to operate on the contralateral side without the necessity of changing the patient's position (in contrast to the posterior approach). Therefore, MIS-THA could be the most suitable operative technique for the better outcome in the patients undergoing 1-BTHA.

To our knowledge, there is still no consensus whether simultaneous 1-MIS-BTHA is the modern treatment of choice in bilateral osteoarthritis or not. Despite the presence of published clinical trials comparing bilateral simultaneous 1-MIS-BTHA with 2-MIS-BTHA, we did not find any literature review on this subject.

## Materials and Methods

A literature review was conducted by two independent reviewers (MM, CK) who used the MEDLINE/PubMed database and the Cochrane Database of Systematic Reviews. These databases were queried with the terms *minimally invasive bilateral total hip arthroplasty*. To maximize the search, backward chaining of reference lists from retrieved papers was also undertaken. A preliminary assessment of only the titles and abstracts of the search results was initially performed. The second stage involved a careful review of the full-text publications.

Inclusion criteria were: i) studies assessing the clinical outcomes of patients treated with minimally invasive (MIS) simultaneous bilateral total hip arthroplasty; ii) patients suffering by bilateral hip osteoarthritis or bilateral avascular necrosis of the femoral head; iii) studies containing a clinical follow-up evaluation (with tests and/or scores) of a minimum 1-year follow-up; and iv) articles written in English, published before December 24, 2017 (end of our search).

The quality of the evidence was classified using the US Preventive Services Task Force system for ranking level of evidence.

Differences between reviewers were discussed until agreement was achieved. If no agreement could be reached, it was planned that a third author (FT) would decide. The two reviewers (MM and CK) independently

extracted data from each study and assessed variable reporting of outcome data. The methodological quality of each study and the detected bias were assessed independently by each reviewer. The primary outcomes were the mean operation time, mean blood loss, and the postoperative statistically significant improvement of the clinical scores used in comparison with the preoperative scores per study. Secondary outcome measure was the complications' rate.

## Results

From the 23 initial studies we finally chose and assessed five clinical studies, which were eligible with our inclusion-exclusion criteria. We excluded all the irrelevant studies (11), articles with clinical outcomes less than 12 months (2), studies only including patients with staged bilateral MIS THA (2), biomechanical studies (1) and case reports (2). A summary flowchart of our literature search can be found in Figure 1. This review dealt with one prospective cohort study level III,<sup>2</sup> two retrospective comparative studies level III,<sup>6,29</sup> and two retrospective case series<sup>7,27</sup> (Table 1<sup>2,6,7,27,29</sup>). We found a complete lack of randomized controlled clinical trials (RCT) of level I. The aforementioned studies included in total 770 patients (651 simultaneous and 119 staged procedures) (Table 2<sup>2,6,7,27,29</sup>). Only two out of five clinical studies (40%) used a control group to assess their results<sup>6,29</sup> (Table 1<sup>2,6,7,27,29</sup>). In addition, two

studies (40%) used a MIS two-incision procedure,<sup>6,7</sup> while one study (20%) deployed the direct anterior MIS approach,<sup>27</sup> another study (20%) the modified Watson-Jones<sup>2</sup> and the last one (20%) a modified mini posterolateral incision<sup>29</sup> (Table 2<sup>2,6,7,27,29</sup>). It is interesting that two of the studies included (40%) dealt only with patients suffering from avascular necrosis of the femoral head (Korean nationals, where the prevalence of this disease is much higher).<sup>6,29</sup>

The mean operation time of the studies using mini posterolateral approach and two-incision technique was impressively higher than that recorded in the studies of the modified Watson-Jones and the direct anterior approach (Table 3<sup>2,6,7,27,29</sup>). The mean blood loss was also higher in the studies using mini posterolateral approach and two-incision technique (Table 3<sup>2,6,7,27,29</sup>).

The complications' and revision rate was very low in all five studies included in the review (100%) (Table 3<sup>2,6,7,27,29</sup>), while they all concluded (100%) that 1S-MIS-BTHA is a safe and effective treatment option (Table 4<sup>2,6,7,27,29</sup>).

Particularly, Tamaki *et al.* reported the perioperative blood management and the perioperative complications' rate of one-stage bilateral total hip arthroplasty using the direct anterior approach.<sup>27</sup> For this purpose they retrospectively assessed 325 consecutive patients (650 hips) who underwent one-stage bilateral total hip arthroplasty through direct anterior approach. The mean intraoperative blood loss and operating time were 412 g and 87.2 min, respectively. One

**Table 1. Type of study, level of evidence, follow-up and control group or not per study.**

Author(s)	Type of study	Level of evidence	Follow-up period	Control group
Tamaki <i>et al.</i> <sup>27</sup>	Retrospective case series	IV	Two years	No
Kutzner <i>et al.</i> <sup>2</sup>	Prospective cohort study	III	Two years (mean: 28.5 months)	No
Seol <i>et al.</i> <sup>6</sup>	Retrospective case-control	III	34.4 months (12-112 months)	Yes (staged BTHA)
Divanji <i>et al.</i> <sup>7</sup>	Retrospective case series	IV	41 months	No (comparison with historical controls of previous studies)
Kim <i>et al.</i> <sup>29</sup>	Rretrospective comparative study	III	60.2 moths	Yes (versus) staged

**Table 2. Number of participants, sex, mean age and type of MIS technique.**

Author(s)	Number of patients	Sex	Mean age (years)	Type of MIS approach
Tamaki <i>et al.</i> <sup>27</sup>	325	35 males 290 females	59.0	Direct anterior
Kutzner <i>et al.</i> <sup>2</sup>	54	Not mentioned	62.7 (36.7-76.8)	Modified Watson-Jones
Seol <i>et al.</i> <sup>6</sup>	206 (147 simultaneous BTHA, 59 staged BTHA)	157 males 49 females	41.9 (A) 46.3 (B)	MIS two-incision technique
Divanji <i>et al.</i> <sup>7</sup>	62	47 males 15 females	24-69	MIS two-incision technique
Kim <i>et al.</i> <sup>29</sup>	123 patients (63 simultaneous vs 60 staged)	71 males 52 females	43.3 (all with necrosis of the femoral head)	Modified mini posterolateral with external rotators' preservation

patient (0.3%) required postoperative transfusions of allogeneic blood. postoperative local major complications occurred in six patients (0.9%), including two (0.3%) dislocations, two (0.3%) early cup migrations, and two (0.3%) periprosthetic femoral fractures. No systemic major complication was detected. They concluded that this type of 1-MIS-BTHA is a reasonable choice of treatment.

Kutzner *et al.* followed 54 patients treated with an one-stage bilateral, muscle-preserving, calcar-guided implantation technique through the modified minimally invasive anterolateral approach in supine position.<sup>2</sup> After 2 years, the mean Harris Hip Score was 98.8, while the satisfaction on visual analogue scale was 9.9/10. In addition, the authors reported low peri- and postoperative complications' rates without any implant revisions. They concluded that their technique of performing a 2-MIS-

BTHA leads to rapid mobilization and rehabilitation with excellent early clinical results and high satisfaction rates.

Moreover, Seol *et al.* compared the postoperative complications and cost-effectiveness of simultaneous and staged bilateral total hip arthroplasty (THA), using a minimally invasive two-incision technique.<sup>6</sup> Two hundred and six patients were registered and divided into a simultaneous bilateral THA group (group A, 147 patients) and a staged bilateral THA group (group B: 59 patients). Staged THA was performed on group B with an interval of at least 2 months between the initial and second surgery. Perioperative morbidity rates were similar in the two groups and overall complications were not significantly different between the groups. The average length of hospital stay was significantly shorter in group A than in group B, whereas the total medical cost was significantly higher in group B than in

group A. Finally, patients in group A required more blood transfusions than those in group B, although blood loss in the two groups were similar.

Divanji *et al.* assessed the feasibility of bilateral simultaneous minimally invasive two-incision total hip arthroplasty in a retrospective case-series of 62 patients.<sup>7</sup> The mean duration of surgery was 180.4 min and no intraoperative complications were reported. Postoperative periprosthetic fracture occurred in two patients and delayed infection in one patient. The average Harris Hip Score improved from 41.8 to 95.3. The Western Ontario McMaster Osteoarthritis Index (WOMAC) score improved from an average of 66.2 to 5.0. Early postoperative periprosthetic fracture occurred in two patients, one of whom was treated by cerclage wiring, and the other one required revision using a long stem. Thereafter, both patients recovered

**Table 3. Mean operation time, mean blood loss, and complications' rate.**

Author(s)	Mean operation time	Mean blood loss	Major complications
Tamaki <i>et al.</i> <sup>27</sup>	87.2 min	412 gr per patient One patient (0.3%) needed transfusion	Six patients (0.9%) (two dislocations, two early-cup migrations, two periprosthetic fractures)
Kutzner <i>et al.</i> <sup>2</sup>	44.6 min	5.3g/dL haemoglobin mean drop, seven patients (12.9%) needed transfusion	One intraoperative avulsion of greater trochanter, One DVT
Seol <i>et al.</i> <sup>6</sup>	Not mentioned	Mean blood loss: Group A: 892 ml, Group B: 917 mL	Group A: one case (0.68%) of deep infection and one case (0.68%), Group B: One case (1.69%) of postoperative deep infection and two cases (3.39%) of postoperative superficial infection
Divanji <i>et al.</i> <sup>7</sup>	180.4 min	Mean blood loss: 1513.2 mL	Two periprosthetic fractures and one delayed infection
Kim <i>et al.</i> <sup>29</sup>	Simultaneous Group: 172 min Staged Group: 162 min	Simultaneous Group: 1037 mL Staged Group: 1145 mL	Intraoperative fracture: Simultaneous Group: 10 patients Staged Group: seven patients Revision Rate: Simultaneous Group: two patients Staged Group: four patients

**Table 4. Type of clinical outcome variables, mean final postoperative scores and brief summary.**

Author(s)	Clinical outcome scales	Mean final scores	Brief summary
Tamaki <i>et al.</i> <sup>27</sup>	None (only radiological ingrowth fixation and complications' rate)	None	The low rate of systemic complications in this study was due to supine positioning and the minimally invasive aspect of the direct anterior approach
Kutzner <i>et al.</i> <sup>2</sup>	HHS, VAS	HHS: 98.8, VAS: 9.9/10	MIS technique in one-stage bilateral procedure leads to rapid mobilization and rehabilitation with excellent early clinical results and high satisfaction rates.
Seol <i>et al.</i> <sup>6</sup>	HHS, WOMAC	HHS: 96.4 (A) vs. 94.8 (B). WOMAC: 17.8 (A) vs. 19.2 (B)	Simultaneous bilateral THA compares favorably with staged THA in terms of outcomes, complications and cost-effectiveness.
Divanji <i>et al.</i> <sup>7</sup>	HHS, WOMAC	HHS: 95.3. WOMAC: 5.0	Bilateral simultaneous minimally invasive total hip arthroplasty using a modified two-incision technique gave satisfactory clinical, radiological, and functional results.
Kim <i>et al.</i> <sup>29</sup>	HHS, EQ-5D*, EQ-VAS*	Simultaneous Group: HHS: 95.9 Staged Group: HHS: 90.7	For medically operable patients, bilateral hip disease could be treated with a simultaneous procedure rather than a staged procedure to achieve a better surgical outcome.

HHP, Harris Hip Score; VAS, visual analogue scale; EQ-5D, EuroQol five-dimension scale; EQ-VAS, EuroQol visual analogue scale.

uneventfully. One patient had a chronic infection after 6 months of surgery and he was treated with a two-stage revision THA. The authors concluded that bilateral simultaneous minimally invasive total hip arthroplasty using a modified two-incision technique gave satisfactory clinical, radiological, and functional results.

Finally, Kim *et al.* developed a petite modified posterior approach by preserving the external rotator muscles to enhance joint stability after primary THA.<sup>28</sup> Then they tried to compare the radiological, clinical and functional outcomes of a simultaneous bilateral total hip arthroplasty (THA) with those of a staged bilateral THA with an interval between procedures <12 months.<sup>29</sup> Therefore, they conducted a retrospective comparative study including 63 patients treated with a simultaneous bilateral MIS THA and 60 patients treated with a staged bilateral MIS THA. According to their results, the mean Harris hip score, EuroQol-5D index, and EuroQol-visual analogue scale score were all statistically significantly better in the simultaneous group at the latest follow-up. They found also that the simultaneous procedure was associated with a lower incidence of postoperative prosthetic-related complications and revision surgery.

## Discussion

Bilateral disease may already be manifested when patients undergo their first THA, and in such cases either simultaneous

or staged bilateral surgery can be performed.<sup>1</sup> A recent epidemiological study showed that from the 353 female hip OA patients, 192 (54%) had unilateral OA, and 161 (46%) had bilateral OA.<sup>30</sup> Already from the early 70's, Jaffe and Charney supported the use of simultaneous bilateral THA.<sup>31</sup> Advantages of one-stage bilateral total hip arthroplasty (THA) include a single hospital stay, a shorter rehabilitation time, and decreased management costs per patient.<sup>11</sup> Reported rates for performance of simultaneous bilateral THA vary from 13.5% to 50% according to the presence of co-morbidity, patient socioeconomic status, and surgeon experience.<sup>10,31,32</sup>

However, concerns about a possible increase in the perioperative and postoperative complications' rate still remain. Berend *et al.* compared the morbidity, mortality, and outcomes of 900 simultaneous bilateral total hip arthroplasties in 450 patients and 450 unilateral total hip arthroplasties.<sup>10</sup> They found out that the pulmonary complications were significantly higher in the simultaneous bilateral group (1.6% vs 0.7%;  $P < 0.0312$ ), while the long-term patient survival, the prosthetic survival, and the functional outcomes were not significantly different between groups. Macaulay *et al.* mentioned that despite the increasing annual number of single-stage bilateral total hip arthroplasties done, complications were approximately 1.3 times more frequent than those reported after unilateral total hip arthroplasties.<sup>8</sup> According to them the primary postoperative concern is that the cardiopulmonary insult associated with two surgical wounds and surgeries can lead to

an increase in thromboembolic events.<sup>8</sup>

More recently, minimal invasive (MIS) THA has undoubtedly gained in popularity amongst surgeons as well as patients.<sup>18-20</sup> A very short incision promises less soft tissue damage, which is combined with minimum blood loss, less pain and a faster rehabilitation and recovery.<sup>21,24</sup> Critics claim that safety and efficacy of MIS have yet to be determined.<sup>22-23</sup> Frequently in combination with MIS THA, different types of short femoral stems, commercially available, preserve more femoral bone and make a possible revision surgery, in the future, less complicated. These advantages may simplify even more a simultaneous bilateral THA. In order to ensure a safe procedure and high quality of postoperative function, one-stage bilateral THA needs to provide certain characteristics like short surgery duration, low blood loss and distinct muscle-sparing technique.<sup>33</sup>

To the best of our knowledge, this literature review was the first which focused on the clinical outcome of the simultaneous bilateral minimal invasive THA (1-MIS-BTHA).

The advantage of the study, which was conducted by Tamaki *et al.*, was mainly the large sample size of patients included.<sup>27</sup> On the other hand, the design of this study was of low quality (level of evidence IV). The authors collected their clinical data retrospectively, while they did not have any control group, like for example patients treated with a staged MIS THA (2-MIS-THA). The study by Kutzner *et al.* was not controlled and the statistical analysis was poor (no statistical significance with the preoperative scores was mentioned in the text), while the number of patients was low and they had only short-term follow-up.<sup>2</sup> As a result, the quality of the evidence provided by this particular study was rather low. Even more, the authors acknowledged in another study including both bilateral and unilateral MIS THA patients that their department is a reference clinic of the investigated, a fact which might raise concerns regarding the validity of their conclusions.<sup>34</sup> Therefore, their results have to be confirmed by other medical centres.

In contrast to the two just above-mentioned studies, the obvious advantage of the trial of Seol *et al.* was that it included a control group.<sup>6</sup> Nevertheless, the data were collected retrospectively, while the number of patients in group B was almost three times smaller than the patients of group A. All patients included in this study had avascular necrosis of the femoral head, which is the predominantly encountered hip joint disease in the country where the study was performed (Korea). This disease is the main

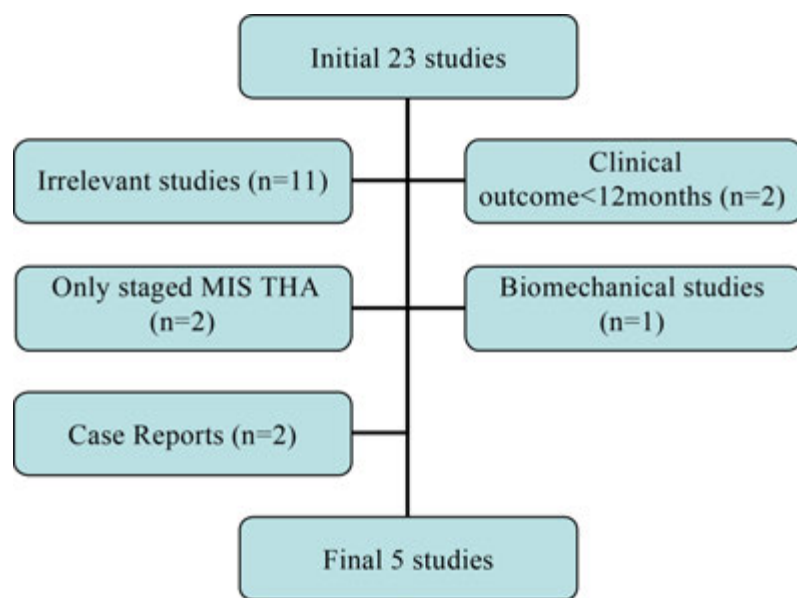


Figure 1. Study selection flow chart.

reason for THA (about 80%), more than degenerative hip joint osteoarthritis.<sup>35,36</sup> This might lower the mortality rate, since the patients are usually young and healthy, and because a high level of activity can be expected after rehabilitation. For other age and disease patients groups, different rates of complications would be expected.<sup>37-40</sup>

A certain limitation of the study conducted by Divanji *et al.* was its retrospective design, which lacked a control group from the same interval.<sup>7</sup> Furthermore, different types of acetabular and femoral components were used. Certain measures, such as radiographic outcome parameters, are prone to interobserver variation. Moreover, the authors compared their clinical results to those of previously published studies, a fact that precludes any statistical analysis. An interesting point of the study of Kim *et al.*<sup>29</sup> was that the mean intraoperative time (Table 3<sup>2,6,7,27,29</sup>) was found four times longer than the study of Kutzner *et al.*<sup>2</sup> (supine modified Watson-Jones approach) and two times longer than the study of Tamaki *et al.*<sup>27</sup> (direct anterior approach). The retrospective design in combination with the relatively small population included were clear limitations of that study. Furthermore, the authors did not included hip diseases other than avascular necrosis of the femoral head, so that their results may not be applicable to patients with other conditions such as primary or secondary osteoarthritis.

Overall, it was illustrated that the 1S-MIS-BTHA is a safe and effective procedure in patients with bilateral osteoarthritis or avascular necrosis of the femoral head. It was illustrated that in simultaneous bilateral THA cases the supine position of the patient was preferable than the lateral decubitus position, because it impressively diminished the mean operation time.

However, we found a complete lack of randomized controlled studies (RCT) for the subject in question of this literature review. Well designed level I clinical trials are needed in order to assess more accurately the superiority (or not) of the 1S-MIS-BTHA over the staged MIS-THA as well as to compare the 1S-MIS-BTHA with the simultaneous conventional BTHA.

## Conclusions

Approaches using the lateral decubitus position of the patient should be rather avoided in simultaneous bilateral THA due to the increased operation time. There is a lack of randomized, controlled clinical trials, comparing simultaneous bilateral MIS THA with staged bilateral MIS THA. Although

simultaneous bilateral MIS THA seemed to be efficacious, cost-effective and safe, more clinical trials are required to establish its superiority over the sequential MIS THA.

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