Simultaneous Versus Staged Total Hip Arthroplasty
A Review

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Abstract
Total hip arthroplasty (THA) is considered one of the most effective treatments for hip arthritis, but the decision to perform simultaneous bilateral THA versus staged bilateral THA remains a source of controversy based primarily on the analysis of the risks and benefits of each approach. Many surgeons are reluctant to consider simultaneous total hip arthroplasty even though the procedure is associated with a shorter total hospitalization, shorter recovery and rehabilitation time, and decreased cost. However, in this review, we find that despite higher blood loss in the simultaneous group, there are no significant differences in terms of cardio-pulmonary complications, thromboembolic events, stroke, surgical site infection, and rate of allogeneic transfusion between simultaneous and staged procedures. In addition, careful patient selection (ASA 1 and 2) can further minimize the risks of simultaneous bilateral total hip arthroplasty and increase the likelihood of consistent successful outcomes.

Total hip arthroplasty (THA) is considered one of the most effective treatments for hip arthritis caused by osteoarthritis (OA), rheumatoid arthritis (RA), osteonecrosis, post-traumatic arthritis, and other etiologies. It is projected that by 2030, the number of primary THAs performed in the USA will grow by 174% to 572,000 procedures annually. For the aging population, THA has played a major role in maintaining independence and quality of life. THA reliably relieves pain and restores function in patients with symptomatic arthritis and has been estimated to be one of the most beneficial and cost-effective major medical interventions.

When compared with other medical interventions, the cost to quality-adjusted life years ratio for THA is almost unparalleled. THA is, thus, a very common orthopaedic procedure with a reported incidence of THA after contralateral THA ranging from 16% to 85%. According to Trojani and coworkers, 10% of patients require contralateral THA within 1 year after the initial procedure. Thus, a substantial proportion of patients undergoing unilateral THA require subsequent contralateral THA. For this reason, in addition to the financial benefits, there has been an increased interest in simultaneous bilateral THA. The decision to perform simultaneous bilateral THA versus staged bilateral THA remains a source of controversy based primarily on the analysis of the risks and benefits of each approach.

The risks and complications associated with THA are mostly influenced by the patient’s overall state of health at the time of the procedure. This has generally been assessed using the American Society of Anesthesiologists (ASA) classification system. Since Ritter and Randolph performed the first detailed study of the functional outcome of simultaneous bilateral THA in 1976, there has been ongoing discussion regarding the advantages and disadvantages of one-stage versus two-stage procedures.

While most published reports have compared the outcome of simultaneous bilateral THA with that of unilateral procedures, studies comparing the outcome of simultaneous bilateral THA with staged bilateral THA are relatively few. Most clinical studies have reported the safety of simultaneous bilateral THA in the low risk (ASA 1 and 2) patient population. Other studies have documented that in patients classified as higher risk (ASA 3 and 4), simultaneous bilateral THA has resulted in a higher incidence of
complications. However, it is uncertain how outcomes and complications following staged bilateral THA compare to those following simultaneous bilateral THA.

There are clear advantages of simultaneous bilateral THA, including a single hospital stay, shorter total hospitalization, shorter recovery and rehabilitation time, and decreased cost. In this review article, we report the current concepts and controversies surrounding simultaneous bilateral THA and staged bilateral THA in order to develop guidelines for selecting patients who would be most appropriate for simultaneous bilateral THA.

Definitions
We defined simultaneous bilateral THA as surgery to replace both hips by the same surgical team during the same anesthesia exposure during a single hospital stay. Staged bilateral THA is defined as two surgeries to replace both hips performed during separate hospitalizations and separated by no more than 1 year.

We performed a review of the English language orthopaedic literature from 1976 to 2013 and identified a total of 22 comparative studies on bilateral THA procedures. Nine of these studies compared the outcomes of simultaneous bilateral THA with unilateral total hip arthroplasty.13,17,20-26 Eleven of these studies compared the outcomes of simultaneous bilateral THA with staged bilateral THA directly.4,9-11,14-16,26-29 Two of these studies focused primarily on the major complications of any form of hip arthroplasty (unilateral total hip arthroplasty, staged bilateral THA, or simultaneous bilateral THA).30,31

Advantages of Simultaneous Bilateral Total Hip Arthroplasty
Of the 11 studies reviewed that compared simultaneous bilateral THA with staged bilateral THA directly, 10 of the articles favored simultaneous bilateral THA over staged bilateral THA due to decreased hospitalization time, reduced cost, shorter operation time, and improved clinical results (Table 1). One study did not favor simultaneous bilateral THA because of increased perioperative complications, increased risk of reoperation, and decreased reimbursement to the hospital and surgeon.15 Nonetheless, many investigators now agree simultaneous bilateral THA carries many clinical and economic benefits with proper patient selection.

Decreased Hospitalization Time
Numerous studies have shown that patients undergoing simultaneous bilateral THA spend considerably less cumulative time in the hospital than patients undergoing staged bilateral THA (Table 1).4,10-12,14,16,32 Bhan and colleagues reported a mean hospital stay for patients undergoing simultaneous bilateral THA of 7.25 days compared to a cumulative 10-day hospital stay for those undergoing staged bilateral THA.14 Macauley and associates also noted a 5 to 6-day shorter hospital stay for the simultaneous bilateral THA group.12 They also reported a reduced loss of employment productivity secondary to the shorter hospitalization and overall recovery time associated with the simultaneous bilateral THA.12

Single Anesthetic Exposure
Despite improvements in anesthesia, the risks associated with anesthesia (general, endotracheal, and regional) must be taken into consideration. The avoidance of a second anesthesia event, as would be required with staged bilateral THA, accounts for some of the risk reduction associated with simultaneous bilateral THA.33

Lower Cost
The cost of simultaneous bilateral THA is considerably lower than staged bilateral THA (Table 1). The reduced cost has been attributed to a variety of factors, including decreased hospitalization, lower patient management costs, and reduced loss of employment productivity for the patient.4,11-13,17,19,27,29-32 Reduced patient management costs are achieved with simultaneous bilateral THA as a result of

<table>
<thead>
<tr>
<th>Study</th>
<th>Study Type</th>
<th>Number of Patients</th>
<th>LOS</th>
<th>EBL</th>
<th>PRBC</th>
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<tr>
<td>Rasouli, et al 2014</td>
<td>Retrospective</td>
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<tr>
<td>Lorenze, et al 1998</td>
<td>Retrospective</td>
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<td>Staged</td>
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*Operation type with greater value listed in box. Staged values are cumulative over the two operations.
Excellent Patient Satisfaction and Clinical Results
Consistent with early results first presented by Charnley and Jaffe in 1971, simultaneous bilateral THA has been shown to result in excellent patient satisfaction and clinical outcomes.\textsuperscript{34} Trojani and coworkers reported that 97\% of their patients would be willing to repeat the same procedure.\textsuperscript{2} Aghayev and colleagues performed a recent review of the European joint replacement registry and found that better functional outcomes were reported with simultaneous bilateral THA compared to staged bilateral THA.\textsuperscript{12} Berend associates attributed the improved functional outcomes of simultaneous bilateral THA to the observation that contralateral hip disability did not adversely affect the replaced hip as it would in staged bilateral THA.\textsuperscript{21} They also suggest that simultaneous bilateral THA may be superior to staged bilateral THA in the ability to correct deformity, such as severe bilateral flexion contracture. Some investigators have reported that volume and experience is a significant predictor of outcome for simultaneous bilateral THA and that simultaneous bilateral THA is economically and functionally efficacious when performed by experienced surgeons and specialty orthopaedic centers.\textsuperscript{16,19,35}

Concerns about Simultaneous Bilateral Total Hip Replacement
There has been controversy regarding the relative safety of simultaneous bilateral THA when compared to staged bilateral THA.\textsuperscript{4,8,10,11,13-15,17-22,25,27,28,30,31} Areas of focus have included thromboembolic complications, need for blood transfusions, rates of surgical site infections, rates of discharge to rehabilitation facilities, and reimbursements.

Thromboembolic Complications
Thromboembolic complications are relatively common following unilateral total hip arthroplasty, staged bilateral THA, and simultaneous bilateral THA.\textsuperscript{8,36} The reason for increased thromboembolic risk with simultaneous bilateral THA has been attributed to prolonged operative time, intraoperative trauma from positioning, and postoperative immobility. Numerous earlier studies have shown increased thromboembolic risk with simultaneous bilateral THA.\textsuperscript{12,20,21,23,36} However, more recent studies of simultaneous bilateral THA have shown no increase in pulmonary embolism risk, assuming appropriate prophylactic measures are taken (Table 1).\textsuperscript{13,14,16,26,36} Ritter and Stringer attribute this finding to improved anesthesia, anticoagulation therapies, and earlier postoperative ambulation. Many studies over the past three decades have also suggested that there is no difference in perioperative mortality between staged bilateral THA and simultaneous bilateral THA, though many of the studies warn that this finding may be related to the relatively small cohort size.\textsuperscript{9,11,13,14,20,22-25,31,36,37}

Increased Allogeneic Blood Transfusion
Multiple studies have shown that total blood loss is lower in simultaneous bilateral THA compared to cumulative blood loss during both staged bilateral THA procedures (Table 1). However, studies have also consistently demonstrated a greater need for allogeneic blood transfusion in the simultaneous bilateral THA group.\textsuperscript{11,14,16,17,31,37} The increased allogeneic transfusion rate in simultaneous procedures is clearly due to increased blood loss during the longer, single operative setting. Some investigators suggest that autologous blood transfusion should be considered, either by preoperative donation or by intraoperative blood salvage.\textsuperscript{36} Other investigators recommend preoperative hemoglobin levels of at least 14 g/L to minimize intraoperative and postoperative need for transfusion.\textsuperscript{8} The evidence is clear that simultaneous bilateral THA is more likely to require blood transfusion. However, this in itself should not be considered a deterrent, unless the risks of a blood transfusion are too significant, or the patient specifically indicates that transfusion is not permissible because of religious or personal reasons.

Higher Rates of Surgical Site Infection
Berend and coworkers have reported a surgical site infection complication rate of 1.8\% for simultaneous bilateral THA, which was significantly higher than the rate for staged bilateral THA.\textsuperscript{15} Other studies comparing simultaneous bilateral THA and unilateral BTHA did not find increased rates of surgical site infection.\textsuperscript{13,35} Berend and coworkers noted that the increased wound infection rate may be explained by the use of the lateral decubitus position.\textsuperscript{15} However, Della Valle observed a 0.1\% infection rate for simultaneous bilateral THA using the same lateral decubitus position.\textsuperscript{15,38} Yet to be determined is whether the surgical site infection rate of each hip when simultaneous bilateral THA is performed is greater than that associated with unilateral THA.

Higher Rates of Discharge to Rehabilitation Facility
Some investigators have argued that the simultaneous procedure places an increased burden on our healthcare system.\textsuperscript{13,15} Berend and coworkers found that only 53\% of their simultaneous bilateral THA patients met the physical therapy goals for discharge to home during the hospital admission, compared with 80\% of the staged bilateral THA group.\textsuperscript{15} As a result, 41\% of the simultaneous bilateral THA group were discharged to inpatient rehabilitation facilities, compared with only 19\% of the staged bilateral THA group.\textsuperscript{15} Nonetheless, numerous articles have observed significantly shorter hospital stays and concurrent cost savings for simultaneous bilateral THA compared to the
two separate hospitalizations required with staged bilateral THA.\textsuperscript{4,10,11,15,16,18,19,29}

\textbf{Reduced Hospital and Surgeon Reimbursement}

Berend and coworkers have noted a 28\% reduction in hospital reimbursement for simultaneous bilateral THA, and a 15\% reduction in reimbursement to the surgeon performing the procedure.\textsuperscript{13} In October 1992, the Medicare insurance program reduced reimbursement to surgeons by 50\% for a second arthroplasty performed within 3 months of the first arthroplasty. Interestingly, this 50\% reduction for the second operation performed under the same anesthetic does not appear to have impacted the frequency of simultaneous bilateral THA.\textsuperscript{4} Despite the reduced reimbursement, many reports confirm the economic savings to the healthcare system with simultaneous bilateral THA.\textsuperscript{4,11-13,17,19,21,27,29,30-32}

\textbf{Discussion}

The greatest predictors of morbidity and mortality for simultaneous bilateral THA are patient age and ASA score.\textsuperscript{12,28} Thus, careful patient selection can minimize operative risk. Multiple investigators have suggested that age greater than 75 years should be considered a contraindication for simultaneous bilateral THA;\textsuperscript{12,23,30} others have suggested that age should not be a contraindication and that simultaneous bilateral THA on patients over 75 years of age with typical comorbidities of advanced age is safe.\textsuperscript{12,40}

Additionally, many investigators emphasize the role of anesthesiologists in the decision to perform simultaneous bilateral THA.\textsuperscript{12} To this end, ASA scores have proven important predictors of patient outcomes, regardless of age. The majority of investigators conclude that simultaneous bilateral THA should be reserved for patients with mild systemic disturbances and an ASA score of 2 or less.\textsuperscript{12,13,16,17,24,29,37,39} These investigators have shown that with modern surgical and transfusion techniques, there is no increased risk of stroke, surgical site infection, and cardiac or thromboembolic events with simultaneous bilateral THA compared to unilateral total hip arthroplasty or staged bilateral THA in this patient population.

Interestingly, multiple investigators have also suggested that the risk of perioperative morbidity and mortality in simultaneous bilateral THA is the same for patients with ASA scores of 3 or 4 as it is for patients with ASA scores of 2 or less.\textsuperscript{11,14,25} In some centers, ASA of more than 2 is a contraindication to simultaneous bilateral THA. However, others have shown that in centers that regularly perform simultaneous bilateral THA on more sickly patients the results can be satisfactory while emphasizing that surgeon expertise and skill is critical to satisfactory outcomes.\textsuperscript{16,35}

In the process of patient selection, there are numerous contraindications to simultaneous bilateral THA that must be considered. Patients with a documented history of thromboembolic conditions are not optimal candidates for simultaneous bilateral THA because of the increased risk of thrombophlebitis.\textsuperscript{12} Patients with diabetes and obesity have also been shown to have higher rates of surgical site infection.\textsuperscript{12} In addition, patients with a history of cardiac disease and especially myocardial infarction are not considered candidates for simultaneous bilateral THA.

The available literature strongly suggests that simultaneous bilateral THA is a safe and cost-effective alternative to staged bilateral THA in patients under 75 years of age with an ASA score of 2 or less. From a clinical perspective, simultaneous bilateral THA is particularly indicated in a patient with disabling bilateral arthritis when the contralateral hip is anticipated to impede recovery and rehabilitation following unilateral THA.\textsuperscript{12}

\textbf{Conclusion}

Interest in simultaneous bilateral THA has grown in recent years as a result of increased demand due to the aging patient population and the many studies that have demonstrated the benefits of simultaneous bilateral THA.\textsuperscript{8,9,13,14,17,29} The advantages of simultaneous bilateral THA include shorter hospitalization, reduced time lost from work, cost effectiveness, high patient satisfaction, and a reduced total rehabilitation time. Nonetheless, many surgeons are reluctant to consider simultaneous bilateral THA because of medical concerns that are felt to outweigh the orthopaedic goals. However, studies show that careful patient selection can minimize these medical concerns and increase the likelihood of consistent successful outcomes. In healthy patients (ASA 1 or 2), simultaneous bilateral THA is as safe as a unilateral procedure. Despite higher blood loss in the simultaneous group, there are no significant differences in terms of cardiopulmonary complications, thromboembolic events, stroke, surgical site infection, and rate of allogeneic transfusion.\textsuperscript{17} Although it remains uncertain if staged bilateral THA will result in a decrease in associated risks and complications compared to simultaneous bilateral THA in high risk patients (ASA 3 and 4), some studies have demonstrated that simultaneous bilateral THA is equally safe in these patients as well.\textsuperscript{11,25} However, more data will be needed before simultaneous bilateral THA can be routinely considered in this high risk patient population.

\textbf{Disclosure Statement}

None of the authors has a financial or proprietary interest in the subject matter or materials discussed in the manuscript, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

\textbf{References}


