Timing and Selection of Lower Extremity Arthroplasty Procedures: Which to Perform First and When to Consider Simultaneous Bilateral Procedures

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Abstract

» For patients with both lumbar spine pathology, hip and knee degenerative joint disease, it is important to consider the implications of surgically addressing each anatomic region first.

» Performing total hip arthroplasty before lumbar spine fusion may decrease the risk of dislocation and revision surgery; however, if spinal fusion is performed first, it may be protective to wait 1 to 2 years to lower the risk of complications.

» In all patients with concurrent hip and low back symptoms, it is recommended that an evaluation of both areas is performed before proceeding with either surgical intervention.

» If arthroplasty procedures are to occur in a staged fashion, adverse events in high-risk patients may be mitigated by waiting for more than 1 year between procedures. Staged procedures performed less than 30 days apart are at increased risk of medical and surgical complications.

» Simultaneous bilateral total joint arthroplasty procedures should likely be avoided in more elderly patients, those with higher body mass index and those with a greater burden of medical comorbidities due to the increased risks of postoperative complications

The incidence of lower extremity (LE) total joint arthroplasty (TJA) continues to rise in the United States[1]. Many patients with degenerative joint disease have multiple joints affected, including the lumbar spine and unilateral or bilateral hips and knees. The burden of disease in terms of number of joints involved, and severity of symptoms, should be considered when planning surgical intervention. The presence of ipsilateral hip or knee pain following index total knee arthroplasty (TKA) or total hip arthroplasty (THA) is associated with poorer postoperative pain and functional outcomes[2]. Patient-reported outcomes following primary TKA (pTKA) are associated with preoperative lumbar pain and nonoperatively treated lower-extremity painful joints, with the degree of functional impairment directly associated with the severity and number of joints involved[3].

Nearly one-quarter of patients undergo a subsequent arthroplasty procedure of the contralateral joint within 5 to 8 years following their index procedure[4]. The strongest predictors of subsequent replacement procedures include obesity and index procedure

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being TKA rather than THA[3]. Another study evaluating population-based cohorts and incidence of subsequent TJA procedures found following an index THA, 29% underwent contralateral THA within 20 years[5] and 45% of patients were likely to undergo contralateral TKA within 20 years following an index TKA[4]. A retrospective review found the incidence of contralateral TKA after index TKA was 40% with a cumulative incidence of 13% of undergoing any THA[6]. The incidence of contralateral THA after index THA was 8% with a 32% incidence of any TKA following index THA[6].

When considering multiple LE arthroplasty procedures, including staged or simultaneous, the medical health of the patient, risks of anesthesia, postoperative medical and surgical complications, and cost of care should be considered. In a study of pTKA patients, medical complications postoperatively were more likely to recur following staged replacement of the contralateral knee when compared with the index TKA[7]. Increasing age and cardiac disease were independent risk factors for increased episode of care costs in patients undergoing simultaneous bilateral THA or TKA[8].

These studies necessitate the importance of addressing ipsilateral LE joint involvement to optimize pain and functional outcomes following arthroplasty and indicate the prevalence of subsequent procedures is quite high. Optimizing the timing and sequence of such arthroplasty procedures to improve outcomes while maintaining cost effectiveness and minimizing complications is of increasing importance. Surgeons should consider the potential increased physical toll of performing a simultaneous bilateral TJA (bTJA) in a single anesthetic event. In addition, surgeons should realize reimbursements financially disincentivize this treatment strategy, despite simultaneous procedures potentially being more cost-effective and likely a more efficient allocation of resources[9].

Timing of Lumbar Spine Procedures and THA

Many patients with arthritis of the hip have concomitant pathology of the lumbar spine with the prevalence of low back pain in patients with severe hip osteoarthritis (OA) quoted as high as 21.1% to 49.4%[10,11]. Patients with hip OA tend to have worse low back pain using the Oswestry Disability Index, but they also tend to show greater improvement in pain postoperatively following THA compared with patients with knee OA undergoing TKA[10]. These patients with concomitant pain in the hip and spine may require surgical intervention for 1 or both regions, which can pose unique challenges due to differences in sagittal spine balance and pelvic tilt which may affect arthroplasty component positioning[12]. Significant lumbar spinal pathology and instrumentation can dramatically affect spinopelvic motion, such that THA components are at risk of impingement or dislocation if this pathology is not accounted for during implantation of the hip prosthesis[12-14]. Some debate remains if it is best to proceed with treatment of the lumbar spine or hip pathology first to optimize component positioning in an attempt to lessen the risk of adverse events[12,15].

Several retrospective studies have found that performing THA before proceeding with lumbar spinal fusion (LSF) led to a decreased rate of dislocation[16,17]. Bala et al. found that THA following LSF was associated with a significantly increased rate of dislocation, periprosthetic joint infection (PJI), cellulitis, and revision THA but lower rates of wound complications postoperatively when compared with patients undergoing LSF following THA[16]. This study also found patients undergoing THA with lumbar spinal pathology that had not yet undergone LSF were at increased risk of dislocation, PJI, cellulitis, and THA revision compared with patients undergoing LSF after THA[16]. Mohamed et al. had similar findings with patients with LSF before THA having significantly greater risk of dislocation at 90 days and 1 year postoperatively compared with those who underwent THA first[18]. Similarly, Malkani et al. found that patients undergoing primary THA with prior LSF (within 5 years) had a 106% increased risk of prosthetic dislocation compared with patients whose LSF was performed at least 5 years following their THA[17]. In comparison with patients who undergo THA before LSF, the risk of revision THA was more than 40% higher in patients with preexisting LSF, with dislocation as the most common indication for revision[17]. Wu et al. evaluated patients with coexisting lumbar spine and degenerative hip disease and found that patients who underwent THA first had lower rates of undergoing subsequent spine surgery than patients who had lumbar spine surgery first[19]. Patients with higher grade hip OA had lower odds of requiring spine intervention while patients with progressive neurologic deficits or claudications had increasing odds of spine surgery[19].

By contrast, other studies have found no difference in dislocation or revision rates based on the order of THA or LSF[12,20]. A retrospective review evaluated patients who received both THA and LSF, and no statistical difference in hip instability rates were found regardless of which procedure was performed first[12]. Increased rates of instability were found in patients with sacral fusion and revision lumbar spine fusion[12]. The study also suggests that if the THA is performed after the LSF, it may be protective to wait 1 year between procedures to minimize compensatory pelvic tilt changes that may affect component positioning[12]. Welling et al. evaluated if LSF performed before or following THA, within 1 year, affected dislocation rates, and no significant difference was found[20]. In another retrospective review of patients undergoing primary THA with 69% having their spinal fusion performed after their THA (mean time between procedures of 36.1 months, range 1-345) and the remainder having their

spinal fusion before undergoing THA (mean time between procedures of 21,1 months, range 1-70), only patients with their THA performed after spinal fusion experienced dislocation (19%)[21]. There was no difference in the number of spinal levels fused between cohorts, but patients who experienced postoperative dislocations had decreased standing lordosis and increased pelvic incidence to lumbar lordosis (PI-LL) mismatch. In this study, no differences in acetabular component positioning, head size, use of dual mobility or stem offset between groups, as well as no difference in spinopelvic parameters between cohorts was present. Interestingly, 75% of the dislocations were in patients in whom a posterior approach was used for their primary THA[21].

By contrast, another study found that patients with concurrent hip and lumbar spine pathology who underwent primary THA before LSF (median time of 612.5 days between procedures) were at significantly higher risk of dislocation, infection, revision THA, and surgical site complications when compared with primary THA patients without LSF[22]. These risks were higher than patients undergoing THA following LSF (median time 516.6 days between procedures), who were only found to be at increased risk of revision and were not found to have increased rates of dislocation, PJI, or surgical site complications in comparison with primary THA patients without a spinal fusion history. In this study, using a multivariable analysis for patients with concurrent hip and spinal pathology undergoing THA before and following LSF, a significantly increased rate of postoperative opioid consumption was seen at 1, 3, 6, and 12 months compared with patients undergoing primary THA without lumbar pathology. In patients with a remote history (at least 2 years prior) of LSF undergoing THA, no increased risk of total 30-day complications was found in comparison with THA patients without a history of spinal fusion. Using multivariate analysis, these patients with a remote spinal fusion history undergoing THA did not have higher rates of dislocation but did experience a higher rate of revision and opioid utilization at multiple time points following primary THA[22].

In conclusion, controversy remains regarding the optimal sequence of surgically addressing both hip and spinal pathology in patients with concurrent disease (Table I). Studies have demonstrated up to a 61.7% to 82% improvement in low back pain after having THA, which is thought to be related to improved spinopelvic mobility including increased lumbar lordosis and lower PI-LL mismatch[11,23,24]. Several studies indicate that in patients with both hip and spinal pathology that performing THA before LSF may lower the risk of postoperative dislocation and revision THA rates compared with having the spinal fusion performed first. Several studies indicate that if a spinal fusion is performed first that it may be protective to wait 1 to 2 years to perform THA as to minimize additional pelvic tilt changes and reduce the rate of dislocation[12,22]. Certain urgent indications for surgical intervention in patients with concurrent hip and spine disease such as acute and progressive neurologic compromise may dictate which procedure is best to perform first. In practice, the collaboration between spine surgeons and arthroplasty surgeons may or may not be present. However, in all patients with concurrent hip and low back symptoms, it is recommended that an evaluation of both areas is performed before proceeding with either surgical intervention as additional preoperative considerations and workup may be necessary to ensure the patient's unique spinopelvic mobility is accounted for, particularly during THA component positioning[12,13].

Optimal Sequence of TKA vs THA

Joint arthroplasty of the hip or knee may influence LE biomechanics and alignment, load redistribution, and gait mechanics such that patients experience variable symptoms of their adjacent LE joints following surgery. A retrospective review of patients undergoing pTKA for OA found the cumulative incidence of any THA following surgery was 13% at 8 years[6]. For patients who underwent pTHA for OA, the cumulative incidence of any TKA following surgery was 8% at 8 years[6]. This suggests that while patients may require bilateral arthroplasty of the same joint (40% incidence of contralateral TKA after primary procedure at 8 years and 32% incidence of contralateral THA after primary THA at 8 years), only a small portion of patients required arthroplasty of an adjacent joint despite having radiographic OA. By contrast, a review of patients who underwent hip reconstruction, including primary and revision THA, hip resurfacing, or conversion THA, 55% reported ipsilateral knee pain and 18% reported contralateral knee pain preoperatively[25]. Postoperative ipsilateral knee pain improved in 90% of patients without specific knee intervention, suggesting some of their symptoms may be driven by their hip pathology due to referred pain[25]. Some surgeons believe that by performing a THA first, especially in the setting of hip flexion contractures, the sagittal imbalance of the patient is corrected such that the patient can effectively walk following their subsequent TKA heel-to-toe when working with rehabilitation to prevent further development of a contracture.

Debate persists regarding the optimal sequence of ipsilateral THA and TKA to improve outcomes and survivorship with limited studies published. One retrospective review of 56 patients split into 2 matched cohorts based on sequence of ipsilateral primary TJA (TKA followed by THA and THA followed by TKA) found no difference in postoperative outcomes analyzed[26]. There were no statistical differences in Harris Hip Score, Knee Society Score, Short Form-12 score, or radiographic findings preoperatively or at the latest follow-up[26].

Several factors should be considered when determining the appropriate sequence of ipsilateral LE arthroplasty procedures. These include flexion contractures or severely limited range of motion (ROM), which may affect

TABLE I Summary of References for Timing of Lumbar Spine Procedures and THA

Study	Summary of Findings
Parilla et al., 2019[11]	• Risk factors of dislocation included sacral fusion and revision fusion
	• No difference in dislocation or revision rates based on order of THA or LSF
	• If THA is performed after LSF, may be protective to wait 1 year between procedures to minimize compensatory pelvic tilt that may affect component positioning
Bala et al., 2019[15]	• THA following LSF, compared with LSF following THA, had significantly increased rate of dislocation, PJI, cellulitis and revision THA, and lower rates of wound complications
	• THA with lumbar spine pathology without LSF had increased risk of dislocation, PJI, cellulitis, and revision THA compared with LSF after THA
Malkani et al., 2019[16]	• LSF before THA had increased risk of dislocation compared with LSF at least 5 years following their THA
	• LSF prior to THA had greater than 40% high risk of revision compared to THA prior to LSF with dislocation as most common indication for revision
Mohamed et al., 2024[17]	• LSF before THA had significantly greater risk of dislocation at 90 days and 1 year postoperatively compared with THA before LSF
Wu et al., 2023[18]	• THA before LSF had lower rates of subsequent spine surgery compared with those who had spine surgery first
	• Higher grade hip OA had lower odds of requiring spine surgery while progressive neurologic deficits/ claudication had increased risk of spine surgery
Welling et al., 2023[19]	• No increased risk of dislocation if LSF performed before or following THA within 1 year
Andah et al., 2021[20]	• Comparing THA before or following LSF, only patients with THA after LSF experienced dislocation with these patients having decreased standing lordosis and increased PI-LL mismatch
	• No difference in number of spinal levels fused, acetabular component positioning, head size, use of dual mobility or stem offset and no difference in spinopelvic parameters between cohorts
	• 75% of dislocations were in patients with posterior THA approach
Yang et al., 2020[21]	• THA prior to LSF had significantly higher risk of dislocation, infection, revision THA, and surgical complications compared with THA without LSF
	• THA following LSF had increased risk of revision with no increased rate of dislocation, PJI, or surgical site complications compared with THA without LSF
	• Patients undergoing THA and LSF, in any order, had increased rate of postop opioid consumption compared with THA without lumbar spine pathology
	• THA with LSF at least 2 years prior had no increased risk of 30-day complications or dislocation compared with THA without prior LSF but did have higher rates of revision and opioid consumption following THA

LSF = lumbar spinal fusion, OA = osteoarthritis, PI-LL = pelvic incidence to lumbar lordosis, PJI = periprosthetic joint infection, THA = total hip arthroplasty, and TKA = total knee arthroplasty.

ability to fully participate in rehabilitation exercises of adjacent joints, limitations of daily activities more affected by the involvement of a particular joint, severity of symptoms, presence of distorted proximal femoral anatomy which may affect adjacent joint surgical decision making and radiographic findings, including those suggestive of significant bony loss, or impending adverse events such as fracture. In addition, flexion contractures and severely limited ROM of the knee may dictate the ability to effectively position and maneuver the patient for THA depending on the approach used as some approaches require the patient to be supine while others necessitate the ability to flex the knee to approximately 90° for hip manipulation. Similarly, severely limited hip ROM may affect the ability to position the knee appropriately for TKA if there are limitations in flexion or internal rotation at the hip. These factors must be considered in patients with concomitant hip and knee symptoms as outcomes are likely similar, regardless of the sequence of procedures based on the available literature (Table II).

Optimal Timing Between Staged Arthroplasty Procedures

Despite multiple studies evaluating timing of staged THA and TKA procedures, a consensus regarding a single, "safe" time frame to perform the subsequent procedure has not yet been achieved. Independent risk factors for increased episode of care costs associated with bilateral, simultaneous TJA include increasing age, cardiac disease, and history of stroke and liver disease[8,27]. Patients undergoing bilateral, simultaneous TJA had decreased inpatient facility costs, increased post-acute care costs, and no difference in total episode of care costs compared with staged, bilateral procedures. Although there was no difference in readmission rates between the 2 groups, Phillips et al., observed simultaneous bTJA increased the risk of a thromboembolic event[27].

TABLE II Summary of References for Optimal Sequence of TKA vs THA

Study	Summary of Findings
Santana et al., 2020[6]	• Following TKA, cumulative incidence of contralateral TKA was 40% and incidence of any THA was 13% at 8 years
	• Following THA, cumulative incidence of contralateral THA was 32% and incidence of any TKA was 8% at 8 years
Wang et al., 2012[24]	• Patients undergoing hip reconstruction, resurfacing, or conversion THA had 90% improvement in postoperative ipsilateral knee pain without specific knee intervention
Liu et al., 2021[25]	• No difference in postoperative outcomes comparing THA or TKA first
	• No statistical difference in HHS, KSS, SF-12 score or radiographic findings preoperatively or at latest follow-up for THA vs TKA first

HHS = Harris Hip Score, KSS = Knee Society Score, SF-12 = Short Form-12, THA = total hip arthroplasty, and TKA = total knee arthroplasty.

When Richardson et al. compared patients undergoing simultaneous bTJA with staged bTJA performed (1) within 3 months, (2) between 3 and 6 months, and (3) between 6 and 12 months apart, all staged groups had decreased risk of blood transfusion and all-cause 90-day readmission compared with the simultaneous cohort[28]. However, all staged groups in this study had a significantly higher incidence of mechanical complications and infection. Those who underwent staged TKA within 3 months incurred an increased risk of requiring manipulation under anesthesia (MUA), but no difference in rates of venous thromboembolism (VTE) was observed[28].

For patients deemed more appropriate for staged bilateral procedures, another study found medical complications following pTKA were significantly higher following the staged replacement of the contralateral knee, including myocardial infarction (MI), ischemic stroke, other cardiac complications, respiratory complications, urinary complications, deep vein thrombosis (DVT), and pulmonary embolism (PE)[7]. This necessitates identifying these patients preoperatively in attempt to mitigate the risks and determine the optimal timing between the staged procedures.

A systematic review comparing outcomes of staged bTJA using various time intervals found a significant increase in the incidence of MI, other cardiac complications, DVT, pneumonia, and knee revision in patients undergoing staged bTJA with the second TKA within 30 days of index procedure[29]. By contrast, undergoing the second TKA within this 30 day time frame decreased the risk of PE, superficial surgical site infection, deep infection, and vascular complications. When evaluating outcomes between patients who underwent their staged procedures less than and greater than 90 days apart, they found similarly increased rates of MI, other cardiac complications, DVT, pneumonia, and revision in patients who had their second procedure within 90 days of index TKA. They found no differences in mortality rates, neurologic, gastrointestinal (GI), or urinary complications at either the 30-day or 90-day cutoffs[29]. This study suggests the earlier the second procedure is performed, the risk of medical complications is increased compared with delaying surgery for a longer period.

Villa et al. reviewed patients undergoing staged TKA or THA, comparing complications for different time intervals between procedures, including 90, 180, and 365 days[30]. When all arthroplasty patients were considered, patients with 365 days or less between procedures had significantly higher rates of adverse events, transfusion rates, and longer length of stay (LOS) at the time of their second procedure compared with patients with a 1-year delay. There were no significant differences in LOS or complications at 90 or 180 days. Unless patients are willing to wait 1 year between procedures, no increased risk of adverse events was found when their second procedure was performed before or after 90 or 180 days[30].

In summary, it is important to consider multiple factors when deciding if a patient is a candidate for simultaneous bTJA vs a staged procedure (Table III). In general, waiting over 1 year may mitigate the risk of adverse medical and surgical complications most effectively; however, many patients with bilateral symptoms are unwilling to wait that long. Patients undergoing bilateral staged procedures less than 30 days apart may be at the most increased risk of complications. If patients do experience an adverse event following their index procedure, they are at increased risk of recurrence and should be counseled on these risks before proceeding with the contralateral procedure.

Simultaneous bTJA Considerations

Some patients may be candidates for bilateral simultaneous THA or TKA. A proposed benefit of performing simultaneous bTJA is the theoretical reduction in cost due to a single anesthetic event and hospitalization. Patients undergoing bilateral simultaneous TJA have been shown to have decreased inpatient facility costs, increased post-acute care costs, and no difference in total episode of care costs compared with patients who underwent staged bilateral procedures[27]. However, there remains considerable concern regarding the risk of medical and surgical complications, particularly VTE, blood transfusion requirements, and infection.

When simultaneous bTJA has been compared with unilateral TKA, the bilateral cohorts have higher rates of

TABLE III Summary of References for Optimal Timing Between Staged Arthroplasty Procedures

Study	Summary of Findings
Grace et al., 2020[7]	• Medical complications following primary TKA were significantly higher following staged TKA of contralateral knee including MI, ischemic stroke, cardiac complications, respiratory complications, urinary complications, DVT, and PE
Phillips et al., 2018[26]	• Independent risk factors for increased episode of care costs associated with bilateral simultaneous TJA include increasing age, cardiac disease, history of stroke and liver disease
	• Bilateral simultaneous TJA had decreased inpatient facility costs, increased postacute care costs and no difference in total episode of care costs compared with staged procedures
	• Bilateral simultaneous TJA had increased risk of thromboembolic events but no difference in readmission rates compared with staged TJA
Richardson et al., 2019[28]	• All 3 cohorts of staged TKA had decreased risk of blood transfusion and all-cause 90-day readmission compared with simultaneous TKA but higher rates of mechanical complications and infection
	• Staged TKA within 3 months had increased risk of MUA but no difference in rates of VTE
Ghasemi et al., 2021[29]	• Second TKA within 30 days of primary TKA had increased incidence of MI, cardiac complications, DVT, pneumonia, and knee revision but had decreased risk of PE, superficial surgical site infection, deep infection, and vascular complications
	• Second TKA within 90 days of primary TKA had increased rates of MI, cardiac complications, DVT, pneumonia, and revision
	• No difference in mortality, neurologic, GI, or urinary complications at either 30 or 90 day cutoffs
Villa et al., 2020[30]	• For staged TJA, 365 days or less between procedures had significantly higher rates of adverse events, transfusion rates, and longer LOS at time of second procedures compared with 1 year delay
	• No significant differences in LOS or complications before or after 90 days or 180 days

DVT = deep vein thrombosis, GI = gastrointestinal, LOS = length of stay, MI = myocardial infarction, MUA = manipulation under anesthesia, PE = pulmonary embolism, and TKA = total knee arthroplasty.

medical and surgical complications with longer LOS and higher rates of discharge to a facility[31-33], but several studies have found no difference in outcomes or adverse events comparing bilateral with unilateral THA[34-36]. Bilateral TKA has been shown to have higher rates of VTE, cardiac, respiratory, and GI complications compared with matched unilateral TKA patients, with higher risk of hematoma/seroma, in-hospital mortality, longer LOS, and greater hospital costs[31]. Patients with increased medical comorbidities or age more than 75 years were at higher risk of complications[32]. Bilateral TKA patients were 3.6 times more likely to have any complication and 2.0 times more likely to have a major complication compared with unilateral[33]. One patient population routinely recommended for simultaneous bTJA are those with bilateral fixed knee flexion contractures, whom have been shown to have greater improvement in the fixed flexion deformity with lower residual deformity after their procedure[37]. While some studies report no difference in outcomes comparing unilateral vs simultaneous bTJA[34-36], others have found the bilateral cohort was less likely to be discharged home and had increased rate of deep wound infections and greater postoperative blood transfusions[38,39]. Proposed indications for simultaneous bTJA are bilateral hip osteonecrosis, rheumatoid arthritis, dysplasia, ankylosing spondylitis, and bilateral hip flexion contractures[38,40], as these systemic disease processes are more likely to cause bilateral end-stage hip disease for which THA is a proven and reliable treatment[36].

Similar results have been found comparing simultaneous vs staged bTJA outcomes. Specifically evaluating bilateral simultaneous TKA, the bilateral cohorts have been shown to have increased 90-day mortality, neurologic complications, PE, or DVT but lower rates of infection[41-43]. Comparing matched patients in the staged less than 90 days to simultaneous cohorts, staged patients had significantly lower rates of readmission, revision, and perioperative complications[44], but others have shown significantly increased risk of requiring a MUA[28].

Conversely, several studies report minimally increased risks of complications with simultaneous bTJA with similar patient-reported outcomes and potential cost savings compared with staged procedures. Simultaneous bTJA has been shown to increase the rate of nonhome discharge and 90-day readmission but with shorter LOS and no difference in reoperation[45,46], rates of aseptic or septic revision, deep infection, acute MI, stroke, death, VTE, or pooled complications compared with staged (within 90 days) bTJA[47]. A combined cost reduction of $643 has been shown for simultaneous TKA compared with staged with no difference in 1-year patient-reported outcome scores[45]. Some studies report no difference in episode of care costs of simultaneous TKA compared with staged[27], while others did observe significantly lower mean personnel costs and overall facility costs for the simultaneous cohort[9].

Patients undergoing simultaneous vs staged bTJA through a direct anterior approach found that the combined, total LOS of the simultaneous group was significantly shorter with no difference in blood transfusion rates following the incorporation of intraoperative tranexamic acid administration into the surgeon's practice[35]. Several studies comparing staged vs simultaneous THA have shown fewer major medical complications, surgical complications, DVT, pulmonary complications, and local complications with mixed findings in terms of transfusions rates, risk of PE, and periprosthetic fracture[40,48-50]. The simultaneous cohorts have been shown to have shorter LOS and operating costs but lower rates of home discharge[49]. When considering simultaneous bTJA, varying surgical approaches may be used with considerations for patient positioning, intraoperative fluoroscopy capabilities, and clinical assessment of stability and leg lengths. Comparing simultaneous bTJA through direct anterior or posterior approaches, no difference was found in the rates of mortality, early complications, early readmission or blood transfusions between cohorts with significantly longer

TABLE IV Summary of References for Simultaneous Bilateral THA Considerations

Study	Summary of Findings
Phillips et al., 2018[26]	• With all bilateral simultaneous TJA considered, there were decreased inpatient facility costs, increased postacute care costs and no difference in total episode of care costs compared with staged procedures
	• Bilateral simultaneous THA had decreased inpatient facility costs, increased postacute care costs and no difference in total episode of care costs compared with staged procedures
	• Staged THA patients had shorter average LOS per episode and more patients were discharged home with most simultaneous THA patients requiring inpatient rehab, but associated costs with postdischarge facilities home health aides and outpatients visits not significantly different
Goh et al., 2022[8]	• Simultaneous bilateral THA had lower personnel costs, supply costs, and overall facility costs compared with staged THA
Vanbiervliet et al., 2020[34]	• No significant rates of minor or major postoperative adverse events, 90-day readmission, or 1-year reoperation rates between bilateral vs unilateral THA
Inoue et al., 2021[35]	• Simultaneous bilateral DAA THA had significantly shorter combined total LOS compared with staged DAA THA with no difference in blood transfusion rates following incorporation of intraoperative TXA
Guo et al., 2020[48]	• Simultaneous bilateral THA patients had fewer major medical complications excluding VTE, fewer surgical complications, and shorter hospital stays but higher transfusion rates compared with staged THA
	• Within the staged cohort, procedures less than 30 days apart had higher rates of blood transfusion compared to 30-90 days and greater than 90 days between procedures
Ramezani et al., 2022[49]	• Simultaneous bilateral THA had lower rates of DVT, pulmonary complications, systemic complications and local complications with shorter LOS, operation cost, and blood loss compared with staged THA
	• Cumulative operative time for staged THA group was longer than simultaneous and rates of home discharge was higher for staged
Huang et al., 2019[50]	• Simultaneous bilateral THA had lower rates of DVT, PE, and respiratory complications with no difference in cardiovascular complications, digestive complications, dislocation, or infection
Shao et al., 2017[40]	• Simultaneous bilateral THA had fewer major postoperative complications and lower risk of DVT but greater risk of infection
	• Cumulative operative time was less in the simultaneous cohort with no difference in intraoperative blood loss or transfusion rates compared with staged THA
Morton et al., 2020[38]	• Bilateral simultaneous THA was less likely to be discharged home with increased rate of deep wound infection and greater postop blood transfusion rates compared to unilateral THA
Morcos et al., 2018[39]	• Bilateral simultaneous THA had higher rate of postoperative blood transfusion and higher discharge to rehab facility rates compared with unilateral THA with no difference in 30-day readmission rates or major complications
Flick et al., 2020[36]	• Simultaneous bilateral THA had significantly lower rates of PJI at 90 days and 1 year with no differences in other outcomes or complications and no difference in opioid use at multiple postoperative time points compared to unilateral THA
Micicoi et al., 2019[52]	• Performing bilateral simultaneous THA via posterior or DAA approach had no difference in rates of mortality, early complications, early readmission, or blood transfusion
	• Average LOS was longer in posterior approach group with longer operative time compared with DAA

DAA = direct anterior approach, DVT = deep vein thrombosis, LOS = length of stay, PE = pulmonary embolism, THA = total hip arthroplasty, TXA = tranexamic acid, and VTE = venous thromboembolism.

TABLE V Summary of References for Simultaneous Bilateral TKA Considerations

Study	Summary of Findings
Phillips et al., 2018[26]	• Bilateral simultaneous TKA patients had no difference in episode of care costs compared with staged TKA
Goh et al., 2022[8]	• No difference in 90-day complications or implant costs between simultaneous vs staged bilateral TKA
	• Simultaneous TKA had lower mean personnel costs and overall facility costs
Richardson et al., 2019[28]	• Staged bilateral TKA within 3 months were at significantly increased risk of requiring MUA compared with simultaneous group with no difference in the rates of VTE
Lee et al., 2016[37]	• Bilateral fixed flexion deformities of greater than 16° showed simultaneous TKA had greater improvement in the fixed flexion deformity and achieved significantly lower residual deformity but less improvement in the SF-36 physical component scores compared with staged TKA
Yakkanti et al., 2022[31]	• Same day bilateral procedures were found to have statistically higher rates of VTE, cardiac, respiratory and GI complications compared with matched patients with unilateral TKA
	• Bilateral TKA had higher risk of hematoma/seroma but decreased wound dehiscence and infection
	• Bilateral TKA group had significantly higher rate of in-hospital mortality with greater hospital costs, longer LOS and higher rate of discharge to a facility
Odum et al., 2014[32]	• Simultaneous bilateral TKA high significantly higher risk of in-hospital minor complications, in-hospital major complications, and in-hospital mortality compared with unilateral TKA
	• Patients with increased medical comorbidities and age greater than 75 had higher risk of complications
Warren et al., 2021[33]	• Bilateral TKA patients were 3.6 times more likely to have any complication and 2.0 times more likely to have a major complication compared with unilateral TKA
Makaram et al., 2021[42]	• Simultaneous bilateral TKA high higher 90-day mortality, neurologic complications, PE, and DVT compared with staged TKA
	• Superficial and deep infection rates were lower in the simultaneous bilateral TKA group compared with staged
Liu et al., 2019[25]	• Simultaneous bilateral TKA had increased rates of mortality, PE, and DVT with lower risk of deep infection and respiratory complications compared with staged TKA
Alshaikh et al., 2023[43]	• Simultaneous bilateral TKA had significantly increased mortality rates compared with staged TKA
Abdelaal et al., 2021[44]	• Significantly higher rates of intraop EBL with similar blood transfusion rates in the simultaneous TKA group compared with staged
	• Staged bilateral TKA performed less than 90 days had significantly lower rates of readmission, revision, and perioperative complications compared with simultaneous TKA
Pumo et al., 2022[45]	• Simultaneous bilateral TKA had significantly higher rates of nonhome discharge and 90-day readmission with shorter LOS and no difference in reoperation rates compared with staged TKA
	• Simultaneous cohort had cost reduction compared with combined costs of staged procedures
	• No significant difference in medial 1-year improvements in KOOS-pain, KOOS-PS, and KOOS-QOL scores in the simultaneous vs staged cohorts
Sobh et al., 2018[46]	• Simultaneous bilateral TKA had higher rate of discharge to inpatient rehab facility
	• Increased rates of VTE and blood transfusion was present in the simultaneous TKA cohort but no different in overall 90-day adverse events or revision rates was reported
	• Simultaneous vs staged procedure was only significant risk factor for VTE and was an additional risk factor for predicting blood transfusion
	• No difference in combined hospital costs for simultaneous vs staged TKA
Sheth et al., 2016[47]	• No difference in rates of aseptic revision, deep infection/septic revision, acute MI, stroke, death, VTE, or pooled complications between simultaneous and staged bilateral TKA groups within 90 days of index procedure
Kahlenberg et al., 2021[51]	• Employed patients with simultaneous bilateral TKA missed significantly fewer days of work compared with staged procedures
	• Simultaneous group missed an average of 16.9 fewer days of work compared to the staged TKA group

DVT = deep vein thrombosis, GI = gastrointestinal, KOOS = Knee Injury and Osteoarthritis Outcome Score, KOOS-PS = KOOS Physical Function Short Form, KOOS-QOL = KOOS Quality of Life, LOS = length of stay, MI = myocardial infarction, OKS = Oxford Knee Score, PE = pulmonary embolism, ROM = range of motion, SF-36 = Short Form-36, TKA = total knee arthroplasty, and VTE = venous thromboembolism.

TABLE VI Proposed Relative Indications for Simultaneous Bilateral THA and TKA

TKA	THA
• Bilateral fixed flexion contractures of the knee • Inflammatory arthropathies	• Bilateral osteonecrosis • Bilateral acetabular dysplasia • Bilateral fixed flexion contractures of the hips • Inflammatory arthropathies

THA = total hip arthroplasty, and TKA = total knee arthroplasty.

hospital LOS in the posterior group and increased operative time[51]. While some studies have shown simultaneous THA to have lower overall mean episode of care costs, more patients were discharged to inpatient rehab, but costs associated with skilled nursing facilities, home health aides, and outpatient visits were not significantly different[27]. Similarly, a retrospective review of bTJA found that simultaneous procedures had lower personnel costs, supply costs, and overall facility costs compared with staged procedures[9].

Arguably, a major advantage of undergoing bilateral procedures remains the potential for more expeditious recovery and return to work. Kahlenberg et al. found employed patients who had a simultaneous procedure missed significantly fewer days of work compared with staged procedures, with the simultaneous cohort missing an average of 16.9 fewer days of work[52], which is considerable and should be discussed with patients considering simultaneous procedures.

Patients who are older, have a higher burden of medical comorbidities, and higher body mass index (BMI) should be counseled about the potentially increased risk of early complication, particularly following bilateral simultaneous TJA. The presence of elevated complication risks, particularly VTE, infection and blood transfusions associated with undergoing bilateral simultaneous TJA remains controversial (Tables IV and V). Surgeons should discuss these risks with all patients. Costs associated with undergoing a simultaneous procedure do appear to be reduced or similar; however, patients are more likely to discharge to a rehabilitation facility.

Conclusions

In conclusion, many patients with OA have involvement of the lumbar spine and multiple involved LE joints requiring sequential arthroplasty procedures. Multiple studies demonstrate an increased risk of dislocation if LSF surgery is performed before THA, but waiting 2 years between procedures may be protective. Guidance on whether to perform hip or knee arthroplasty first remains variable. While gait mechanics is altered regardless of which procedure is performed first, it is helpful to consider the disability and positioning restrictions associated with the pathology in each individual joint and how these limitations may hinder the rehabilitation of the adjacent joint. Physical examination and the patient's symptoms should drive the surgeon's decision. If arthroplasty procedures are to occur in a staged fashion, adverse events in these patients may be mitigated by waiting more than 1 year between procedures; however, many patients are unwilling to wait this long and, thus, should be informed of the increased risk of complications, especially if the time between surgeries is less than 90 days. Finally, the literature is highly variable regarding the increased risks associated with simultaneous bTJA procedures. These procedures should likely be avoided in elderly patients, higher BMI, and those with a greater burden of medical comorbidities due to the increased risks of postoperative complications. Patients should be alerted of the potential for increased adverse events and the higher likelihood of requiring discharge to a facility. Performing bilateral procedures in a single setting has been shown to reduce costs and limit the cumulative, inpatient LOS. Simultaneous procedures may allow for quicker return to activities and work, but these procedures should be reserved for select patients (Table VI) who have undergone an appropriate preoperative screening and medical evaluation to limit the risk of complications and optimize outcomes.

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