Many patients in need of total knee arthroplasty (TKA) have bilateral symptoms and require surgery to both extremities. Performance of a bilateral procedure under a single anesthetic provides a reduced hospitalization time, an isolated anesthesia risk, a single rehabilitation, and substantial cost savings. While most current research examines postoperative complication rates, the primary purpose of TKA is the alleviation of pain and improved quality of life. The purpose of this study was to assess pain and functional outcomes associated with simultaneous bilateral TKA. The authors believe that patients with advanced destructive arthritis to numerous joints cannot achieve complete restoration of their functional status until comprehensive treatment of their disease process occurs. A retrospective review of 697 TKAs in 511 consecutive patients with bilateral knee arthritis was performed. Patients underwent either simultaneous bilateral TKA (n=186), performed sequentially under the same anesthetic, or unilateral TKA (n=325). The same intra- and postoperative protocols were followed in each group. There was no statistically significant difference in postoperative pain, represented by Knee Society Score ($P = .161$). However, there was a significantly higher postoperative functional outcomes—including increased total range of motion ($P = .001$), flexion ($P = .003$), and function score ($P < .001$)—associated with bilateral TKA. Simultaneous bilateral TKA is an effective treatment option and may be worth possible added risk in appropriate patients because it produces a better functional outcome. [Orthopedics. 2015; 38(1):e43-e47.]
Total knee arthroplasty (TKA) can provide reliable pain relief in patients with moderate to severe degenerative joint disease. Many patients with osteoarthritis have bilateral symptoms. A 17-year-long consecutive patient study by Ritter et al reported a greater number of patients requiring bilateral procedures (2202) than unilateral procedures (1796). When both knees warrant surgery, the patient is often faced with the need for multiple hospital admissions, 2 operations, repeated medical risks of anesthesia, and 2 separate periods of rehabilitation. Simultaneous bilateral TKA is thought to be beneficial because a symptomatic arthritic knee can significantly affect the patient’s rehabilitation potential. In addition, the bilateral procedure is associated with a higher degree of patient satisfaction while showing excellent prosthesis survival. When given the option, the majority of patients elect to undergo a simultaneous bilateral TKA (both procedures performed under 1 anesthesia) vs staged bilateral TKA (procedures performed different anesthesias and on different days with varying amounts of time between). An orthopedic surgeon attempting to extract information from the literature regarding the safety of simultaneous bilateral TKA is faced with conflicting findings. Previous reports in the literature vary from unilateral TKA producing better outcomes than simultaneous bilateral TKA,1-3,13-27 the 2 procedures producing no significant difference,1,4,5,11,13,28 and simultaneous bilateral TKA producing a better outcome than unilateral TKA.1,4,5,9,13,14,16,28-31 Not only are there conflicting results in the literature as a whole, but several studies present conflicting results within themselves. 1,3,5,9,13,14-15 The potential of comorbidity factors such as age, sex, surgical technique, and body mass index (BMI) complicate matters further.4,7,11,32-36 The possibility for these elements has been thought to create an inadvertent selection bias that questions the integrity of previous studies.15

This is all representative of the complexity and conflicting ideas present in the literature regarding postoperative complications associated with bilateral TKA. To the current authors’ knowledge, no study in the literature examines the functional outcomes of bilateral TKA. Because the primary purpose of TKA is the alleviation of pain and improved quality of life, the possibility of complications should be investigated only after proof of the effectiveness of bilateral TKA at achieving the major goals of the procedure. The purpose of this study was to assess whether bilateral TKA provides equivalent reduction in pain (as measured by the Knee Society Score [KSS]) and functional outcome (as measured by the function score and range of motion [ROM]) as comparable unilateral surgeries.

**Materials and Methods**

A retrospective review of 697 TKAs in 511 consecutive patients was performed for a diagnosis of bilateral knee osteoarthritis. Patients were extracted from a surgical database encompassing surgeries that were performed over a 5-year period. Patients were excluded if any additional procedure had been performed under the same anesthesia. Patients who had revision TKA were also excluded to limit the number of intra- and postoperative variables. A posterior cruciate ligament-substituting prosthesis (NexGen Legacy; Zimmer, Warsaw, Indiana) of a traditional design was used in all cases. The same surgeon (J.L.P.) performed all surgeries using a medial parapatellar approach. All 3 components were cemented and the patella was resurfaced in all knees. Touriquets were used for all patients. In all cases, thromboembolic prophylaxis consisted of low-dose warfarin with a targeted international normalized ration of 1.8 to 2.2 for 4 weeks postoperatively beginning on the day of surgery. Patients were started on a supervised physical therapy program on postoperative day 1. The same standardized postoperative clinical pathway was used for all patients. Active and passive flexion, KSS, and knee function scores were obtained preoperatively and 2 or more years postoperatively during routine office visits. Active and passive flexion were measured by the operating surgeon with the patient in the supine position. Because passive and active flexion were strongly correlated (Pearson r=0.99; P<.00001), the latter measurement was used in the statistical analysis.

Patients were split into 2 groups: those who underwent unilateral TKA (n=325) and those who underwent simultaneous bilateral TKA (n=186). Too few patients underwent a staged bilateral TKA for it to be statistically applicable and were thus excluded from the study. The simultaneous bilateral TKAs were performed sequentially, with the surgeries performed under the same anesthetic, and both knees were prepared and draped together. In the simultaneous bilateral TKAs, the procedure was started on the second knee after the first prosthesis was implanted and the knee was closed. Each side was considered separately at follow-up. The same intra- and postoperative protocols were followed in each group.

Analysis of covariance was used to eliminate the covariables of preoperative flexion and postoperative flexion, KSS, and function score. For this test, comparison of equations for these outcome variables (tcalc=1.2619, 1.5735, and 1.1506, respectively) was not significantly different (tcalc=1.6470; P>.05), satisfying its assumptions. The majority of statistical analysis was conducted using SPSS version 20.0 statistical software (SPSS, Inc, Chicago, Illinois), whereas analysis of covariance was conducted with NCSS version 8 statistical software (NCSS, Kaysville, Utah). For all analyses, a P value of .05 or less (alpha=.05) was considered significant. Standard deviations are given with means.
RESULTS

The study cohort comprised 342 (66.9%) women and 169 (33.1%) men. Mean±SD age was 67.3±0.36 years (range, 33.9-100.2 years), and mean±SD BMI was 33.26±0.38 kg/m² (range, 17.9-57.4 kg/m²) at the time of surgery. All patients had a minimum of 2 years of follow-up (mean±SD, 3.56±0.05 years [range, 2.0-8.0 years]). There was no significant difference (P>0.05) between the groups in regard to age, length of follow-up, and BMI (Table), nor regarding preoperative range of motion, KSS, or function score. There was an unequal distribution of sex among the groups, with a predominance of women in both.

Mean±SD flexion was 120.12°±10.432° (range, 90°-140°) for patients in the bilateral group and 118.05°±10.463° (range, 70°-140°) for patients in the unilateral group. Analysis of covariance found flexion to be significantly different (F ratio=10.73; P=.001). This represented a gain of 6.71° (range, 4.4-100) in the bilateral group and 84.39±878 (range, 20-100) in the unilateral group. These values were determined to be significantly different (F ratio=13.93; P<0.001).

DISCUSSION

Today, TKA revolves around 3 principles: cost, complications, and outcome. Simultaneous bilateral TKA is a highly debated topic among the orthopedic surgical community because of inconstancies and disputes associated with these main considerations. There is an increasing emphasis on cost containment. Based on the mounting external pressures of Medicare and insurance companies for more proficient uses of time and money, reduction of expenditures has become a main priority in many hospitals. With the single anesthesia administration and single hospital stay of simultaneous bilateral TKA, reduced cost compared with unilateral TKA has been reported.6,13,16,18 Such a surgery gives the potential for savings of $6678 for the hospital, $7449 for the extended care facility, and $3155 for home health care.13 This is in part due to the 2-fold need for physical therapy in unilateral TKA. A second factor that affects cost is length of stay, which is found to be significantly shorter in patients undergoing bilateral TKA.4,5,13,16,18 However, increased risk of intensive care unit stay has a greater association with simultaneous bilateral TKA.4,12

In addition to increased incidence of intensive care unit admission due to cardiac or respiratory complications, other serious complications such as deep venous thrombosis (DVT) and pulmonary embolism can occur following bilateral TKA. These complications form the second important aspect of TKA: the desire to diminish increased and unnecessary risks to patients. Deep venous thrombosis is a known risk of TKA, but its true risk is difficult to gauge with respect to bilateral TKA. Deep venous thrombosis has been shown to have a greater incidence in simultaneous bilateral TKA; in a meta-analysis of 27,807 patients (44,684 knees) from 18 studies over 39 years, Restrepo et al15 demonstrated the probability of DVT to be 2-fold higher for bilateral patient. On the other hand, Kim and Kim19 reported no significant difference between patients undergoing bilateral and unilateral TKA in regard to DVT, and studies conducted by Soudry et al26 and Bullock et al37 demonstrated a lower incidence of DVT in patients undergoing bilateral TKA. Pulmonary embolism is another dangerous—and debated—topic when it

Table

Patient Characteristics and Functional and Pain Outcomes Following Simultaneous Bilateral and Unilateral TKA

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Unilateral TKA (n=325)</th>
<th>Bilateral TKA (n=186)</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>67.98±0.575 (33.88-100.19)</td>
<td>66.7±0.441 (45.13-88.15)</td>
<td>3.233</td>
<td>.073</td>
</tr>
<tr>
<td>Length of follow-up, y</td>
<td>3.5±0.07 (2-8)</td>
<td>3.64±0.073 (2-8)</td>
<td>1.688</td>
<td>.194</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>32.46±0.388 (13.3-57.4)</td>
<td>33.94±0.39 (11.2-53.9)</td>
<td>0.465</td>
<td>.496</td>
</tr>
<tr>
<td>Range of motion°</td>
<td>118.05°±0.463° (70°-140°)</td>
<td>120.12°±0.432° (90°-140°)</td>
<td>10.73</td>
<td>.001</td>
</tr>
<tr>
<td>Knee Society Score°</td>
<td>93.96±0.436 (49-100)</td>
<td>94.8±0.407 (51-100)</td>
<td>1.97</td>
<td>.161</td>
</tr>
<tr>
<td>Function score°</td>
<td>84.39±0.878 (20-100)</td>
<td>88.88±0.82 (44-100)</td>
<td>13.93</td>
<td>.001</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index; TKA, total knee arthroplasty.
*Analysis of variance performed.
**Analysis of covariance performed.
comes to the question of bilateral TKA. Multiple studies have shown that patients who undergo bilateral procedures have a significantly higher incidence of pulmonary embolism.\textsuperscript{5,6,11,15} However, similar to DVT, there are studies that contradict these findings.\textsuperscript{26,32}

As with any surgery, TKA carries with it an inherent risk of mortality, the most serious of all complications. When examining this risk in the context of bilateral procedures, significant and nonsignificant differences have been found at various postoperative intervals.\textsuperscript{1,11,15} However, in all studies, the occurrence of patient mortality following this surgery was still extremely low. The only consistent negative finding was the increased intraoperative blood loss associated with simultaneous bilateral TKA.\textsuperscript{9,13,14} This more significant blood loss raises the need for homologous blood transfusions, increasing the possibility for ABO hemolytic reactions or contraction of blood-borne diseases such as HIV, hepatitis B/C, and cytomegalovirus. However, more stringent donor selection and screening techniques have greatly reduced the risk of contracting blood-borne diseases in this manner.\textsuperscript{18} Increased blood loss during bilateral TKA is surprising because the bilateral surgery presents shorter total anesthesia and operative times compared with the unilateral surgery.\textsuperscript{33}

With such a complex set of issues surrounding the potential for increased risks associated with simultaneous bilateral TKA, perioperative health status should be assessed carefully, and decisions about whether to attempt a simultaneous or staged bilateral TKA should be made on an individual basis. However, the purpose of this study was to determine whether, regardless of the possibility of risk, there were equivalent pain and function outcomes between unilateral and bilateral TKA. The authors’ results demonstrate no statistically significant difference in pain, as represented by KSS ($P=1.161$), between bilateral and unilateral TKAs. However, it was also demonstrated that there is a significantly higher postoperative functional outcome associated with simultaneous bilateral TKA, as represented by range of motion ($P=.001$), improvement in motion ($P=.003$), and function score ($P<.001$). The authors hypothesize this to be related to the absence of contralateral arthritis producing painful and restricted rehabilitation. In patients with advanced destructive arthritis to numerous joints, restoration to increased functional status cannot be achieved until complete treatment of their disease process.

This study has some limitations. The study is retrospective by design; however, the authors feel that the retrospective study design is enhanced by the large number of patients in the study cohort. Also, the cohort consisted of consecutively, nonselective patients who were not significantly different in respect to their baseline demographic information. In addition, the study is limited to the diagnosis of osteoarthritis. This was done in an effort to minimize variables within the study population and thereby enhance the isolation of knee outcome parameters as a function of the type of procedure performed, rather than introducing diagnosis as a possible confounding variable.

The primary weakness of this study is that the control group (unilateral TKA) may be more appropriately represented by patients who underwent staged bilateral procedures. However, based on the goals of this study, the authors do not believe its significance was lessened by using the unilateral TKA group because of the small number of patients who undergo bilateral TKA under separate, staged anesthetics. The control group of 325 patients who underwent unilateral TKA in the same period was more statically comparable, producing more significant conclusions. This study design is also seen throughout the majority of the preexisting studies examining bilateral TKA, including those previously mentioned.

**CONCLUSION**

This study demonstrates that performing simultaneous bilateral TKA not only provides equivalent results as measured by the KSS, but it provides better outcomes as measured by postoperative range of motion and function score. Given the current inconsistent results and uncertain dangers of bilateral TKA, preoperative health status should be assessed carefully, and patients must be informed of possible risks. However, this study shows that not only is simultaneous bilateral TKA an effective option, but it may be worth possible added risk in appropriate patients because it produces a better functional outcome.

**REFERENCES**


