

Perioperative Risk Assessment in Patients Aged 75 Years or Older: Comparison between Bilateral and Unilateral Total Knee Arthroplasty

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Purpose: The purpose of this study is to evaluate the risk of sequential bilateral total knee arthroplasty (TKA) under 1 anesthesia in patients 75 years or older.

Materials and Methods: Patients aged 75 years or older who underwent sequential bilateral TKA (bilateral group, n=159) and unilateral TKA (unilateral group, n=159) between 2002 and 2012 were selected. All patients were evaluated for underlying medical diseases, such as cardiac, pulmonary, and renal problems, and high-risk patients were recommended to postpone the surgery. We compared the underlying diseases, major postoperative complications, and the length of hospital stay between bilateral and unilateral groups.

Results: The prevalence of underlying diseases of the bilateral group was 74.8% and major complications occurred in 6 patients (3.8%). The prevalence of underlying diseases of the unilateral group was 52.4% and complications were observed in 4 patients (2.4%). Although the complication rate of the bilateral group was slightly higher than that of the unilateral group, the difference was not statistically meaningful ($p=0.204$). The length of hospital stay was 21.9 days for the bilateral group and 24.9 days for the unilateral group.

Conclusions: There was no significant difference in postoperative complications between groups. The result shows that bilateral TKA can be relatively safe compared with unilateral TKA in patients 75 years or older. However, careful selection of low-risk patients is advised.

Keywords: Knee, Arthroplasty, Postoperative complications, Aged patients

Introduction

Bilateral knee osteoarthritis can be treated by two arthroplasties performed either with a certain period of interval (staged total knee arthroplasty [TKA]) or on the same day in one anesthetic session (sequential TKA under one anesthesia, or simultaneous

bilateral TKA). The same-day bilateral TKA requires only one anesthetic and reduces the length of hospital stay and rehabilitation period, resulting in lower medical costs and enabling early return to normal activities. However, it has been associated with high medical complication rates compared to unilateral TKA¹⁻⁵. Thus, extra caution has been advised with the use of simultaneous bilateral TKA among elderly patients who are predisposed to medical complications^{6,7}.

The prevalence of TKA has been increasing among patients aged 75 years or older due to the longer life expectancy and higher expectation of quality of life. The incidence of complications following TKA was found to be higher in the elderly patients than young patients in some studies⁸⁻¹⁰; however, the safety of the same-day bilateral TKA has not been sufficiently investigated, and the interpretation of published results remains controversial. Adili et al.¹¹ reported that bilateral TKA resulted in higher complication rates than did unilateral TKA in patients ≥ 75 years of age. In contrast, Severson et al.¹² reported that simultaneous

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bilateral TKA and unilateral TKA did not result in significant difference in perioperative morbidity and mortality, and simultaneous bilateral TKA was more effective in cost reduction and postoperative recovery than staged bilateral TKA.

The purpose of this study was to compare the perioperative risk and complications of simultaneous bilateral TKA and unilateral TKA in patients aged 75 years or older.

Materials and Methods

1. Patients and Methods

The total study population consisted of 159 patients who underwent simultaneous bilateral TKA (bilateral group) and 159 patients who underwent unilateral TKA (unilateral group) under the diagnosis of primary knee osteoarthritis at our institution between 2002 and 2012. All the patients were ≥ 75 years of age and TKA was considered necessary due to persistent pain refractory to more than 1-year conservative treatment. None of the patients had a history of trauma that necessitated knee surgery. Previous history of knee joint infection was noted in 5 patients in the bilateral group and in 8 patients in the unilateral group. Each patient's history of cardiovascular disease, pulmonary and renal disease, and thromboembolism was reviewed. For patients with a history of cardiovascular disease and abnormal findings on basic preoperative tests, such as electrocardiogram, additional tests, including thallium SPECT imaging, were performed in consultation with cardiologists to assess the risk of surgery (Fig. 1). For patients with pulmonary, renal, or cerebrovascular disease, the risk of surgery was determined based on the consultation with pulmonologists, nephrologists, and cerebrovascular specialists.

If the overall risk of surgery was considered high, the planned TKA was cancelled and medicinal treatment was applied. For patients with a low or moderate risk, the surgery was performed after informed consent of patients and families was obtained. If the risk of surgery was determined high in patients with bilateral osteoarthritis, conservative treatment was prescribed instead of proceeding with staged TKA with an interval of 1–2 weeks or 1–2 months. For patient with a history of stroke or myocardial infarction within 1 year prior to surgery, TKA was performed based on the medical assessment after 1 year had passed. In 6 patients in the unilateral group, additional TKA was necessitated due to the development of osteoarthritis in the contralateral knee during follow-up, all of which were carried out at least 2 years after the initial TKA. In these patients, only the data related to the initial TKA were used for analysis.

For thromboembolism prophylaxis, intermittent pneumatic compression was used during the 1st postoperative week in all patients. For patients who had been on the anticoagulant therapy, it was resumed on the 2nd postoperative day. Among patients who underwent TKA after 2009, those who had a history of thromboembolism, congestive heart disease, respiratory disease, or prolonged restriction of ambulation, factor Xa inhibitor was administered during the 1st postoperative week for venous thrombosis prophylaxis. Blood transfusion was performed if the hemoglobin level was ≤ 8.0 mg/dL or for patients with a hemoglobin level of 8–9 mg/dL if the blood pressure was ≤ 100 mmHg even after 500 mL saline infusion or tachycardia (less than 100 beats per minute), ≤ 30 mL/hr urine output, or anemia symptoms (fatigue, dyspnea, or mental confusion) were observed¹³.

All the operations were performed by the same surgeon using a

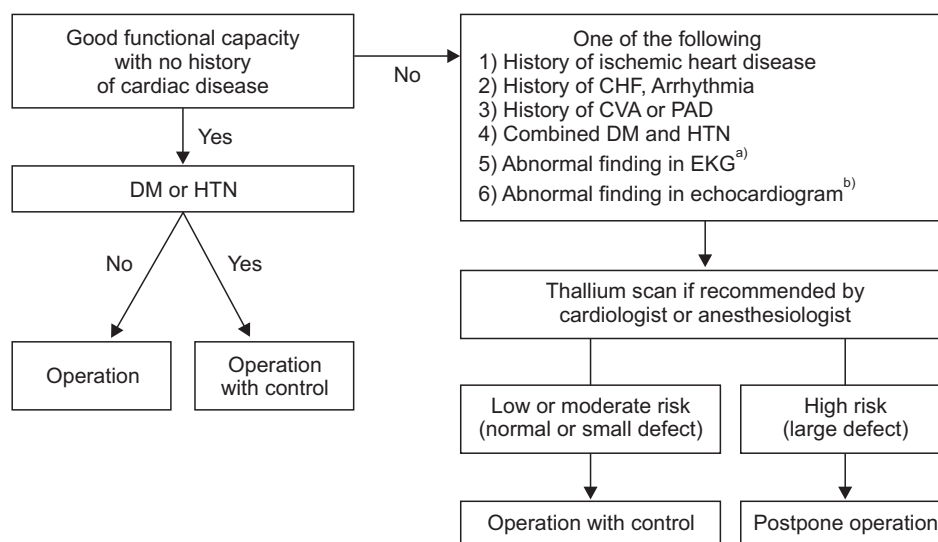


Fig. 1. Flow chart for cardiac evaluation. DM: diabetes mellitus, HTN: hypertension, CHF: congestive heart failure, CVA: cerebrovascular disease, PAD: peripheral arterial disease, EKG: electrocardiography. ^{a)}Includes left ventricular hypertrophy, left bundle branch block, and ST-T abnormality. ^{b)}Includes significantly decreased wall motion.

standard medial para-patellar approach with a tourniquet placed around the proximal femur. The prosthesis of choice was Nexgen LPS (Zimmer Inc., Warsaw, IN, USA), Genesis II Posterior Stabilized type (Smith & Nephew Inc., Memphis, TN, USA), or Vanguard Posterior Stabilized type (Biomet, Warsaw, IN, USA). The patella was resurfaced in all knees and cement was used for prosthesis fixation. After implant insertion, the tourniquet was released, and bleeding vessels were cauterized. In the bilateral group, the procedure for the second knee was initiated upon skin closure of the other knee.

Retrospective review of the patient demographics, including gender, age, preoperative diagnosis, and body mass index, was conducted using data retrieved from the electronic medical record. The presence of preoperative comorbidities, such as diabetes mellitus, hypertension and major heart diseases (angina and myocardial infarction), thromboembolism/pulmonary thromboembolism, and cerebrovascular disorders, were investigated. The American Society of Anesthesiologist (ASA) score was assessed. The mean length of hospital stay, intraarticular drainage volume, and postoperative blood transfusion volume were compared between the groups. Complications in major organs, such as cerebral infarction, deep venous thrombosis, pulmonary thromboembolism, pneumonia, acute renal failure, angina, and myocardial infarction, were examined by reviewing medical records. Only complications observed during hospitalization were included in the analysis. The rate of early mortality during hospital stay, which was defined as death before discharge, was assessed. Surgical wound complications and wound infections that were not critical to patient survival were not investigated.

2. Statistical Analysis

Statistical analysis was performed using SPSS ver. 14.0 (SPSS Inc., Chicago, IL, USA). The Mann-Whitney test or t-test was used for intergroup comparison of continuous demographic variables, and the Fisher's exact test was used for comparison of categorical demographic variables. The frequency of preoperative comorbidities was compared using the Fisher's exact test, and the ASA score was compared using the Mann-Whitney test. Postoperative complication rates were compared between the groups using chi-square test, and the difference in the length of hospital stay was assessed using the Mann-Whitney. A p-value of <0.05 was considered statistically significant.

Results

In the bilateral group where TKAs for both knees were performed on the same day, the mean age of the patients was 77.5 years (range, 75 to 87 years) and the percentage of females was 91.3%. In the unilateral group where TKA was performed on one knee, the mean age of the patients was 78.2 years (range, 75 to 86 years) and the percentage of females was 86.8%. There was no notable intergroup difference in patient demographics, such as height, weight, and body mass index (Table 1). The most common indication for surgery was primary osteoarthritis in both groups, but spontaneous osteonecrosis was more significantly prevalent in the unilateral group than in the bilateral group ($p < 0.001$).

The prevalence of pre-existing comorbidities (presence of ≥ 1 underlying disease) was higher in the bilateral group than in the unilateral group (74.8% vs. 52.4%, $p < 0.001$). Hypertension was

Table 1. Demographic Data

| Variable | Bilateral group (n=159) | Unilateral group (n=159) | p-value |
|--------------------------------------|----------------------------|-----------------------------|---------|
| Sex (n) | | | 0.203 |
| Male | 13 | 21 | |
| Female | 146 | 138 | |
| Age (yr) | 77.5 | 78.2 | 0.099 |
| Height (cm) | 153.1 | 152.3 | 0.295 |
| Weight (kg) | 61.3 | 60.1 | 0.265 |
| Body mass index (kg/m ²) | 26.2 | 25.9 | 0.077 |
| Preoperative diagnosis (%) | | | <0.001 |
| Osteoarthritis | 98.7 | 85.5 | |
| Osteonecrosis | 0.6 | 13.8 | |
| Rheumatoid arthritis | 0.6 | 0.6 | |

Table 2. Preoperative Comorbidity and ASA Score

| Variable | Bilateral group (%) | Unilateral group (%) | p-value |
|-------------------|---------------------|----------------------|---------|
| Hypertension | 117 (73.6) | 83 (51.2) | <0.001 |
| Diabetes mellitus | 27 (17.0) | 30 (17.6) | 0.215 |
| Cardiac | 4 (2.5) | 4 (2.4) | 1.000 |
| Cerebrovascular | 3 (1.9) | 1 (0.6) | 0.357 |
| Thromboembolism | 0 | 0 | - |
| Mean ASA score | 2.2 | 2.1 | 0.062 |
| Class I | 5 (3) | 15 (9) | - |
| Class II | 125 (79) | 119 (75) | - |
| Class III | 29 (18) | 25 (16) | - |

ASA: American Society of Anesthesiologists.

Number of patients (%) was denoted except in case of mean ASA score.

Table 3. Intraoperative Characteristics

| Variable | Bilateral group | Unilateral group |
|---|-----------------|------------------|
| Implant | | |
| LPS | 138 | 123 |
| Vanguard | 10 | 18 |
| Genesis | 11 | 18 |
| Anesthesia | | |
| Spinal (%) | 3 (1.9) | 107 (67.3) |
| General (%) | 156 (98.1) | 52 (32.7) |
| Operation time (min) | 181 | 90 |
| Duration of antibiotics treatment (day) | 7 | 7 |

Table 4. Postoperative Complications

| Variable | Bilateral group (%) | Unilateral group (%) |
|-----------------|---------------------|----------------------|
| Cardiac | 0 (0) | 0 (0) |
| Pulmonary | 0 (0) | 1 (0.6) |
| Renal | 0 (0) | 0 (0) |
| Cerebrovascular | 3 (1.9) | 1 (0.6) |
| Thromboembolism | 3 (1.9) | 1 (0.6) |
| Others | 0 (0) | 1 (0.6) |
| Mortality | 0 (0) | 2 (1.2) |

Values are presented as number (%).

more common in the bilateral group, but there was no significant intergroup difference with regard to the other comorbidities, such as diabetes mellitus, cardiac disease, cerebrovascular disease, and thromboembolism (Table 2). Except for the relatively prevalent hypertension and diabetes mellitus, the total incidence of cardiac disease, cerebrovascular disease, and thromboembolism was relatively low in the bilateral group and unilateral group (4.4% and 3.0%, respectively). The mean ASA score in the bilateral group was 2.2, which was not significantly different from that in the unilateral group ($p=0.062$, Table 2).

The prosthesis of choice was not significantly different between the groups. In the bilateral group, most of the surgery was performed under general anesthesia. The surgery took an average of 181 minutes in the bilateral group and 90 minutes in the unilateral group. Antibiotics were administered until the 7th postoperative day in both groups (Table 3).

Postoperative complications occurred in 6 patients (3.8%; cerebral infarction in 3, pulmonary embolism in 2, and deep venous thrombosis in 1) in the bilateral group and in 4 patients (2.4%; cerebral infarction in 1, pulmonary embolism in 1, pneumonia

Table 5. Blood Loss and Transfusion Requirement

| Variable | Bilateral group | Unilateral group | p-value |
|--|-------------------------------|------------------|---------|
| Amount of drainage (mL) | Right: 864.35 Left: 891.26 | 882 | |
| Hematocrit | | | |
| At admission | 36.5 | 35.9 | 0.129 |
| Postoperative day 4 | 28.8 | 29.8 | 0.018 |
| Postoperative RBC transfusion (no. of packs) | 6.1 | 3.1 | <0.001 |

RBC: red blood cells.

Table 6. Pre- and Postoperative Range of Motion

| Variable | Bilateral group | | Unilateral group Involved |
|---|-----------------|------|---------------------------|
| | Right | Left | |
| Preoperative flexion contracture (°) | 11 | 11 | 13 |
| Preoperative further flexion (°) | 114 | 116 | 116 |
| Postoperative flexion contracture ^{a)} (°) | 3 | 3 | 2 |
| Postoperative further flexion (°) | 130 | 132 | 134 |

^{a)}Postoperative range of motion was measured at 1 year after surgery.

in 1, and intestinal infarction in 1) in the unilateral group. Although the incidence of complications was higher in the bilateral group than in the unilateral group (3.8% vs. 2.4%), the difference was not statistically significant ($p=0.438$). During the less than 30 days of hospital stay, no death occurred in the bilateral group whereas 2 patients (1.2%) in the unilateral group died of pneumonia accompanied by septic shock and pulmonary embolism each (Table 4).

The total drain output was not significantly different between the groups, but the hematocrit level on the 4th postoperative day was slightly more decreased in the bilateral group (Table 5). The mean blood transfusion requirement was higher in the bilateral group than in the unilateral group (6.1 units of packed red blood cells [packed RBC] vs. 3.1 units of packed RBC) (Table 5). The mean hospitalization period was 21.9 days in the bilateral group and 24.4 in the unilateral group, showing no significant difference between the groups ($p=0.921$). The range of motion (ROM) was improved postoperatively in both groups and there was no notable difference in the mean postoperative ROM between the groups (Table 6).

Discussion

Compared to unilateral TKA, simultaneous bilateral TKA

has been associated with high risk of morbidity and mortality, especially in patients aged 75 years or over^{1,3,5}. However, recent studies have demonstrated that improvement in patient selection, prophylaxis, and perioperative care has led to reduction in complication rates¹⁴, indicating the need for re-evaluation of the risk of the same-day bilateral procedure in patients aged 75 years or older. In the present study, we compared postoperative complications of bilateral TKA and unilateral TKA in 75 years or older patients without any high risk features. The results of the study showed there was no significant intergroup difference in complications during hospital stay. No patient death was observed after bilateral TKA and major complications developed in 3.8% of the 159 patients.

The association between simultaneous bilateral TKA and the incidence of morbidity and mortality has not been clearly elucidated not only in advanced age patients (≥ 75 years) but also in young patients. The available studies provide conflicting results. Stefansdottir et al.⁵ reported that the 30-day mortality rate was twice higher in the simultaneous bilateral TKA group ($n=1,139$) than in the staged TKA group where the two procedures were performed less than 1 year apart ($n=3,432$). In contrast, Meehan et al.¹⁵ showed that the incidence of mortality was not significantly different between the simultaneous bilateral TKA group ($n=11,445$) and the staged TKA group ($n=23,715$). Bini et al.¹⁶ also reported there was no significant difference in the 90-day mortality rate between the simultaneous bilateral TKA group ($n=2,441$) and the staged TKA group ($n=4,231$). Therefore, we believe the safety of simultaneous bilateral TKA should be thoroughly investigated through systematic literature reviews and meta-analyses. Although we did not observe any patient death in the bilateral group, we acknowledge that the sample size ($n=159$) was too small to yield reliable results, considering the reported mortality rate of 0.3%–1% after bilateral TKA^{5,17}.

Cardiovascular diseases are the most common complications of bilateral TKA^{5,18,19}. Yoon et al.⁷ noted systemic complications in 6 of the 119 patients (5%) who underwent simultaneous bilateral TKA and in 1 of the 119 patients (0.8%) who underwent unilateral TKA. Among various complications, cardiac diseases were the most common in the study. Meehan et al.¹⁵ compared 11,445 simultaneous bilateral TKAs and 23,715 staged TKAs in terms of complications and found that the incidence of adverse coronary events, such as myocardial infarction, was significantly higher in the simultaneous bilateral TKA group. The high incidence of cardiovascular complications after simultaneous bilateral TKA has been demonstrated in various studies^{18,20,21}. However, in a recent study by Spicer et al.²² involving 373 bilateral TKAs and 966

unilateral TKAs, bilateral TKA was not associated with increased cardiovascular complications. Still, bilateral TKA has been frequently associated with cardiovascular complications in high risk groups consisting of patients aged 75 years or over. Adili et al.¹¹ reported that simultaneous bilateral TKA resulted in increased cardiovascular complications compared to unilateral TKA, especially among patients with a previous history of cardiovascular disease. The risk was found greater among patients who were 80 years of age or older after bilateral TKA²³. In the current study, there was no occurrence of cardiovascular complication in both groups, and the incidence of cerebrovascular diseases was low in the bilateral group and the unilateral group (1.6% and 0.9%, respectively). It is our understanding that rigorous preoperative assessment and proper patient selection are essential to prevention of cardiovascular complications following bilateral TKA.

Among our patients who were 75 years or older, the mean transfusion requirement was 6.1 units of packed RBC in the bilateral group and 3.1 units in the unilateral group, which was relatively high when compared to 3.9 units in the bilateral group and 1.4 units in the unilateral group in the study by Bould et al.²⁴. However, it should be taken into consideration that 1) the mean age of the patients in their study was relatively low (68 years) and 2) we opted for a more aggressive transfusion strategy than we did for young patients to prevent drastic hemodynamic changes and transient ischemic attack that had been suggested as triggers of cardiovascular events²³. We think that hemodynamic support by sufficient blood transfusion at the early stage of surgery could have an influence on the low incidence of cardiovascular complications; however, this should be investigated in further studies to determine whether aggressive transfusion can be justified despite the risk of transfusion-related complications in advanced age patients.

In the absence of consensus on the safety of simultaneous bilateral TKA, it is difficult to expect that results introduced by few available studies based on findings obtained exclusively from patients aged 75 or older would be accepted without controversy. Based on a review of 200,000 bilateral TKAs performed during the same hospitalization, Memtsoudis et al.²⁵ concluded that age was a risk factor for mortality and major complications: compared to patients aged 45–65, ≥ 75 years of age patients were 2.7 times more likely to suffer a major adverse outcome. In contrast, Severson et al.¹² reported no significant difference was observed with respect to morbidity and mortality during the 1-year follow-up after staged bilateral TKA (140 knees) and unilateral TKA (312 knees). Although there are no sufficient data to draw a definitive conclusion, we believe that pre-existing comorbidity a more

important factor than biological age in patient selection. In our study, high-risk patients were excluded from the study population in the first place: in the bilateral group, 25% had no pre-existing comorbidities and 95% had minor underlying diseases, such as hypertension and diabetes mellitus; and in the unilateral group, 48% had no pre-existing conditions and 97% had no major comorbidities, suggesting that none of the enrollees was a high-risk patient. Therefore, we would like to emphasize the fact that this study was conducted on relatively healthy patients aged 75 years or older and simultaneous bilateral TKA was found to be a safe surgical procedure for osteoarthritis of the knee in these patients.

It has been widely recognized that rigorous preoperative assessment and proper patient selection are key to successful simultaneous bilateral TKA^{14,26,27}. In the latest decade, the trend toward selection of younger and healthier patients has become evident, which has contributed to reduced postoperative morbidity²⁷. On the other hand, comorbidities, such as congestive heart failure and pulmonary hypertension, increase the risk of complications by 5.5 times and 4.1 times, respectively²⁵. In our study, the non-high-risk patients did not exhibit significant difference in the morbidity and mortality rates after either bilateral TKA or unilateral TKA in spite of their advanced age (≥ 75 years). Therefore, we believe that the severity of comorbidities, general health condition, and daily living abilities should also be taken into account in determining candidates for bilateral TKA. Moreover, age and comorbidities may act as confounding variables due to the higher prevalence and severity of comorbidities in advanced age patients, which should be elucidated in further studies involving large study populations and multivariate analyses.

Memtsoudis et al.³ suggested that the same-day bilateral TKA would shorten the total length of hospitalization by 7 days, resulting in 18%–36% of medical cost reduction. In our study, the length of hospital stay of the bilateral group was not significantly different from that of the unilateral group, which is more notable considering the need for future hospitalization for another TKA of the contralateral knee in the unilateral group. Although it is not entirely appropriate to make a direct comparison with data from a country employing a different medical system, the mean length of hospitalization after the same-day TKA in the US was reported as 5.7 days between 2000 and 2005²⁸. Recently, we have recommended discharge within 14 days after bilateral TKA. Among patients aged 75 years or over, the mean hospitalization period exceeded 20 days due to late discharge caused by pain, rehabilitation, or medical complications in some patients. For patients who were ≤ 65 years of age, the mean hospital stay was 19.1 days after bilateral TKA during the same period.

The same-day bilateral TKA provides further benefits other than the reduced hospitalization. One of the disadvantages of staged bilateral TKA in patients with severe bilateral knee osteoarthritis is that the remaining flexion contracture/varus deformity in the contralateral knee after unilateral TKA results in leg length discrepancy, which disrupts effective ambulation and rehabilitation exercises. In addition, the patient is more likely to apply excessive pressure on the operated side due to pain in the contralateral knee¹⁸. Ritter et al.⁴ reported that the 10-year survivorship of TKA was 6.2% higher in the simultaneous bilateral group than in the unilateral group (78.6% vs. 72.0%, $p=0.006$). Some studies showed that the same-day bilateral TKA caused less prosthetic knee infection than did unilateral or staged TKA^{15,29}. Therefore, simultaneous bilateral TKA is expected to result in improved survivorship of the prosthesis if the incidence of complications can be reduced.

There are some limitations of this study that restrict generalization of the results. First, the study population was relatively small. Although the incidences of postoperative mortality and major complications were found to be relatively low, such findings cannot necessarily be extrapolated to all populations. This is because statistical significance may not be ascertained due to the small sample size. Continuous data collection and multicenter studies involving large study populations should be conducted to improve the statistical power of the analysis. In spite of this, the statistical significance of our findings can be found in the fact that all the operations were performed by the same surgeon using the same surgical approach at the same institution. Thus, it is reasonable to assume that intervening variables were properly controlled to preclude influence of any variables other than the independent variables on the dependent variables, enhancing the internal validity of the study. Indeed, there are few studies on simultaneous bilateral TKAs performed by a single surgeon on more than 150 high-risk patients aged 75 years or over. Second, it is a non-randomized study including only patients without severe medical comorbidities among all ≥ 75 -year-old TKA candidates; therefore, it is difficult to extrapolate the findings to all patients aged 75 years or over. The results should be interpreted with caution in that high-risk groups were not included in the study. Third, there were differences in the prevalence of pre-existing comorbidities and anesthetic methods between the groups. However, considering that the prevalence of hypertension was most distinctively different between the groups and the postoperative complication rate was not higher in the bilateral group where hypertension was predominant, we believe hypertension has no significant influence on the appearance of postoperative compli-

cations. Regarding the anesthetic methods, bilateral TKAs have been performed under general anesthesia and unilateral TKAs under spinal anesthesia according to the surgeons' preference at our institution. Although it is difficult to entirely rule out its influence on complications, some authors suggested regional and general anesthesia did not exhibit obvious difference in mortality rate³⁰.

Conclusions

There was no significant difference between unilateral TKA and simultaneous bilateral TKA with regard to the incidence of complications among patients aged 75 years or over with low-risk of cardiovascular disease selected through rigorous medical assessment. However, we believe the results should be further carefully examined in future studies including proper control groups and designed to minimize patient selection bias.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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