

Comparison of Simultaneous Bilateral
and Staged Bilateral Total Knee
Arthroplasty in Terms of
Perioperative Complications

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<ABSTRACT>

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Purpose: We compared bilateral total knee arthroplasty (TKA) operations performed at a single session versus those performed at two separate sessions with respect to complications, the amount of blood loss, and the length of hospital stay. We hoped to determine whether simultaneous bilateral total knee arthroplasty is safe and beneficial.

Materials and Methods: Study participants included 119 consecutive patients undergoing simultaneous bilateral TKA and an additional 119 patients undergoing staged bilateral TKA. The two groups were compared with respect to perioperative complications, amount of blood loss, and length of hospital stay. These groups were further subdivided according to their ASA grade and age using a cutoff point of 70 years, and we compared the incidence of systemic complications.

Results: A total of 10 systemic complications occurred in the simultaneous bilateral group, as compared with three events in the staged bilateral group. In addition, the frequency of complications in the staged bilateral group was significantly higher statistically than that in the staged bilateral group ($P<0.05$).

Therefore, performing simultaneous bilateral TKA in elderly (> 70 years old) or high-risk patients results in a significantly higher rate of systemic complications ($P<0.05$). However, the length of hospital stay is significantly reduced in patients undergoing the simultaneous bilateral procedure ($P<0.05$).

Conclusion: Simultaneous bilateral TKA is a relatively safe and beneficial procedure for patients whose symptoms warrant TKA in both knees, with a minimal increase in the risk of systemic complications. However, this procedure should be conducted carefully particularly in elderly and high-risk patients.

Key words: total knee arthroplasty, simultaneous, staged, postoperative complication, length of hospital stay

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I. INTRODUCTION

Total knee arthroplasty (TKA) is a well-established procedure^{1,2} demonstrated to provide excellent long-term results in terms of reduced pain and increased mobility^{3,4}. However, in many patients osteoarthritis or rheumatoid arthritis affects the joints bilaterally, causing pain and deformity to both knee joints, and without bilateral total knee arthroplasty, functional recovery and pain relief is unlikely. Surgery for patients requiring bilateral knee arthroplasty can be accomplished in a staged bilateral fashion or as a simultaneous bilateral procedure under one anesthetic. It is not clear whether bilateral knee replacements are best performed in a simultaneous or staged procedure. For the last 20 years the increase in perioperative morbidity and mortality related to simultaneous bilateral TKA has been a critical issue of controversy. Several authors reported that postoperative cardiac events, postoperative confusion, intestinal ileus, gastrointestinal bleeding, thromboembolic diseases, and blood

loss occur in connection with simultaneous bilateral TKA⁵⁻¹². However, other authors reported perioperative morbidity and mortality are similar between simultaneous bilateral TKA and staged bilateral TKA, additionally, simultaneous bilateral TKA is advantageous over staged bilateral TKA in terms of hospital stay, medical cost and the speed of recovery^{13, 14}. To determine which approach is better, studies should compare the outcome of simultaneous and staged bilateral procedures. However, most previous studies have compared the outcome of unilateral TKA, rather than staged bilateral TKA^{5-9, 12, 14}. Thus the present study compared the perioperative complications, postoperative blood loss, and length of hospital stay of simultaneous bilateral and staged bilateral TKA utilizing the same prosthesis. We hoped to determine whether simultaneous bilateral total knee arthroplasty is safe and beneficial.

II. MATERIALS AND METHODS

After institutional review board approval was obtained, the surgical database of our institution was searched to identify retrospectively all patients who had undergone TKA between January 2003 and December 2006. There were 1538 consecutive procedure, performed in 1154 patients. Among the patients, one hundred and nineteen patients (10.3%) had undergone simultaneous bilateral TKA, and 265 patients (23.0%) had undergone staged bilateral TKA. Strict inclusion criteria included clinically significant osteoarthritis or rheumatoid arthritis in both knees and severe pain unrelieved by conventional medical therapy. Strict exclusion criteria included history of previous knee infection, trauma requiring surgery, or revision arthroplasty. All consecutive patients undergoing the simultaneous bilateral TKA met the criteria and were matched to 119 patients undergoing staged bilateral TKA who met the established criteria. They were carefully matched for gender,

age, diagnosis, comorbidities, anesthetic method, and the type of prosthesis. These patients elected to undergo separate procedures for the replacement of both knees because one knee was more painful at the time of the first surgery or they did not want have both knees replaced at once. However, comorbidities and age were not used as a selection criterion with regard to the performance of a simultaneous or staged bilateral procedure. The mean time between the first and second operations for the staged bilateral group was 12 months (range, 1 – 48 months). Table 1 shows the patients’ demographics and demonstrates that there was no statically significant difference between the two groups with respect to mean age, gender, diagnosis, or body mass index.

Table 1. Patient Demographics

Characteristic	Simultaneous	Staged
Patients (n)	119	119
Mean age (year, range)	70 (34-83)	70 (34-83)
Women (n, %)	112 (94.1%)	112 (94.1%)
Men (n,%)	7 (5.9%)	7 (5.9%)
Osteoarthritis (n, %)	115 (96.6%)	115 (96.6%)
Rheumatoid arthritis	4 (3.4%)	4 (3.4%)
Body mass index (range)	26.4 (19.1-34.2)	26.5 (18.3-35.6)

There were also no significant differences between groups with respect to the number and type of preoperative medical conditions (Table 2). No minimum follow-up period was used for this study because one of the purposes was to assess perioperative complications.

Table 2. Comparison of Preexisting Medical Conditions between the Simultaneous and Staged bilateral groups

Comorbidity	Simultaneous	Staged
Cardiovascular condition		
Hypertension	90	89
CAOD*	5	8
CHF†	1	3
Arrhythmia	6	4
Pulmonary disease‡	6	8
Diabetes mellitus	24	30
Hypothyroidism	6	4
CVA§	8	5

*: Coronary artery obstructive disease, †: Congestive heart failure, ‡: Asthma, pulmonary fibrosis, chronic obstructive, pulmonary disease, §: Cerebral vascular accident

Using the American Society of Anesthesiologists (ASA) classification system¹⁵, the anesthesiologist who supervised the administration of anesthetic agents to each patient, preoperatively determined the ASA grade. These groups were then further subdivided according to their ASA grade. The low-risk subgroup (ASA 1 & 2) contained patients who were fit at the time of operation or who had a mild illness not affecting daily life. The high-risk subgroup (ASA 3 & 4) contained patients with moderate or severe illness affecting daily life.

A controversial topic in the literature on TKA results is the definition of an

“old patient”. The age limit in literature for an elderly patient fluctuates between 70 and 90 years of age^{7,8,16}. In the current study, mean age was 70 years (range, 34-83 years), and thus we have considered 70 years as an acceptable cutoff point. Therefore, patients who underwent simultaneous bilateral TKA were subdivided into two groups, one aged 70 or under and the other aged above 70. We then compared the incidence of systemic complications between the two groups.

All patients received combined anesthesia. Spinal anesthesia was employed with 8 to 10mg of 0.5% isobaric tetracaine and the epidural infusion pump used 225mg of 0.225% ropivacaine, 0.1mg of sufentanyl, 0.005 mg/kg of naloxone, and 0.9% normal saline to make a 100mL solution. A tourniquet was used in all cases. In simultaneous bilateral TKA, the tourniquet was inflated on the second leg after release of the first tourniquet. We used an intra-medullary alignment system for the femur and an extra-medullary alignment system for the tibia. Patellar resurfacing was not conducted in any of the cases. During the simultaneous bilateral procedure, the second knee replacement was not have been undertaken if the patient was unstable at the end of the first TKA. However, none of the cases originally planned as a simultaneous bilateral procedure had to be performed as a staged bilateral procedure. Patients in each of the two operative groups were given cephalosporin antibiotics preoperatively, before surgery, and for forty-eight hours postoperatively. In order to prevent deep vein thrombosis, low-molecular-weight heparin (LMWH), anti-embolism stockings, and early mobilization were used in all patients. If deep venous thrombosis (DVT) or pulmonary embolism was suspected clinically, it was confirmed by venography or ventilation-perfusion scanning. However no routine screening for DVT was performed. Daily physical therapy for range of motion, walking, and strengthening began on post-operative day one.

The implants used throughout the study were the LCS prosthesis (DePuy Int, Leeds, UK) with mobile-bearing platform and the NexGen prosthesis (Zimmer, Warsaw, IN, USA) with fixed-bearing system. All implants were of a posterior cruciate sacrificing design and all of the components were cemented. The difference in prosthesis between simultaneous and staged bilateral groups was not statistically significant.

The following patient data were obtained and analyzed from the computerized total joint-replacement registry and medical records of our institute: (1) systemic and local complications, (2) total blood loss, (3) mortality, and (4) length of hospital stay. A comparison was made of preoperative factors and systemic complications between simultaneous and staged bilateral TKA, in addition the low risk (ASA 1 & 2) and high risk (ASA 3 & 4) subgroups. All the data were collected by one of the authors (HSY), who was not involved in any of the index operation.

Statistical analysis was performed using the SPSS 13.0 ps.exe statistical program (SPSS Inc, Chicago, IL, USA). The chi-square test was used to compare qualitative variables and student t-test was used to test the equality of means of quantitative variables between the two groups. The differences were considered significant if $P < 0.05$.

III. RESULTS

1. Systemic complications

A total of 10 systemic complications occurred in 10 patients (8.4 %) in the simultaneous bilateral TKA as compared with 3 systemic complications in 3 patients (2.5 %) in the staged bilateral TKA. The difference between the two groups in the total number of systemic complications was significant ($P<0.05$) (Table 3). The frequency of each complication was low, and no statistically significant difference was observed in each complications. Most systemic complications occurred during the immediate postoperative period, in fact complications arose less than 24 hours after surgery in 8 of 10 patients in the simultaneous bilateral group and all patients in the staged bilateral group.

Table 3. Overall Summary of Systemic complications in simultaneous and staged bilateral TKA

Complication	Simultaneous	Staged
Hypovolemic shock	0	1
Pneumonia	1	0
Confusion	2	0
Uremic encephalitis	1	0
Acute renal failure	1	0
Hypokalemia	4	2
ICU* care	1	0
Thromboembolic disease [†]	0	0
Mortality	0	0
Total	10 (8.4 %)	3 (2.5 %)

* : Intensive care unit, [†] : Deep vein thrombosis and Pulmonary embolism

The following data represents the number of patients that were found in either the simultaneous or staged bilateral TKA for each ASA grade: Grade 1 (21 vs 25), Grade 2 (68 vs 59), Grade 3 (27 vs 33), Grade 4 (2 vs 3). We found no significant difference in ASA grade ($P=0.6967$) between patients undergoing simultaneous or staged bilateral TKA. We further subdivided the patients into low risk (ASA 1 & 2) and high risk (ASA 3 & 4). In the simultaneous bilateral TKA, 89 patients (74.8 %) were low risk group and 29 patients (25.2 %) were high risk group. In the staged bilateral TKA, 84 patients (70.6 %) were low risk group and 36 patients (29.4 %) were high risk group. There were no significant differences ($P=0.3850$) in the proportion of low and high risk patients in the simultaneous and staged bilateral groups.

The systemic complications according to the ASA grading system are shown in Table 4. Significant differences were found in the complication rate for patients who were low risk versus those who were high risk in simultaneous bilateral TKA ($P<0.05$). However, there were no significant differences in the complication rate following ASA grade in staged bilateral TKA ($P=0.1643$). There was a significant difference in the overall number of systemic complications in ASA 3 & 4 simultaneous versus staged bilateral groups ($P<0.05$).

Table 4. Actual number of systemic complication following ASA grade

	Simultaneous		Staged	
	Low risk [*] (<i>n</i> =89)	High risk [†] (<i>n</i> =29)	Low risk [*] (<i>n</i> =84)	High risk [†] (<i>n</i> =36)
Systemic complication	4 (4.5%)	6 (20.7%)	2 (2.4%)	1 (2.8%)

*: ASA grade 1 and 2, †: ASA grade 3 and 4

In the simultaneous bilateral group, 52 patients (43.7 %) were 70 years old or younger and 67 patients (56.3 %) were 70 years of older. Systemic complications after a simultaneous bilateral procedure occurred in 8 patients (11.9 %) who were 70 years of older compared with 2 patients (3.8 %) who were 70 years or younger. The difference between the two groups in terms of total number of systemic complications was significant ($P<0.05$) (Table 5).

Table 5. Comparison of systemic complication between 70 years or younger patients and older patients in simultaneous bilateral group

	Patients (n, %)	Systemic complication (n, %)
≤ 70	52 (43.7 %)	2 (3.8 %)
> 70	67 (36.3 %)	8 (11.9 %)

2. Local complications

A superficial infection defined as any infection of the skin and subcutaneous tissue that responded appropriately to antibiotics with no residual problems¹⁷. Three patients (3 knees, 2.5 %) in each group experienced superficial wound infections. Prolonged discharge, defined as 4 or more days of discharge through the post-operative wound, was found in 3 simultaneous bilateral patients (3 knees, 2.5%) and 2 staged bilateral patients (2 knees, 1.7%). The difference was not statistically significant ($P=0.6527$). In all 5 cases the discharge was stopped with dressings by home-visiting nurse, and no further treatment was needed. A deep infection was defined as any infection that occurred inside the knee joint and required a washout or prosthesis removal. We did not experience a deep infection and a revision surgery in this study.

3. Postoperative bleeding and Length of hospital stay

There was a significant difference in postoperative bleeding loss between the simultaneous bilateral and staged bilateral groups when analyzed on a per-operation basis. Average blood loss was 1299 ml (range 480-2625 ml) in the simultaneous bilateral group compared with 650 ml (range 50-1970 ml) per operation in the staged bilateral group ($P<0.0001$).

The mean length of hospital stay in the staged bilateral group was calculated as the sum of two hospital stays and averaged 11.7 days. This was an average of 4.2 days longer than the 7.5 days averaged by the simultaneous bilateral group. The difference in the length of hospital stay was highly significant ($P<0.0001$).

IV. DISCUSSION

Total knee arthroplasty has shown remarkable results in resolving pain and recovering function in patients with advanced osteoarthritis or rheumatoid arthritis. However, many cases of osteoarthritis and rheumatoid arthritis become bilateral, resulting in the destructive change and severe deformation of the knee joints. Therefore, without total replacement of both knee joints, satisfactory results are difficult to attain. Patients with bilateral disease who wish to undergo surgery must decide on a single anesthesia and surgery, or separate surgeries and hospitalizations. This decision is affected by the patient's needs and expectations, in addition to their doctor's recommendation in consideration of patient comorbidities. Therefore, the surgeon must have a full understanding of the risks involved in the simultaneous bilateral procedure.

For the last 20 years, the increase in perioperative morbidity and mortality related to simultaneous bilateral TKA has been a critical issue of controversy. Gradillas and Volz¹⁴ reported that patients undergoing simultaneous bilateral TKA demonstrated a higher frequency of pulmonary embolism than those undergoing unilateral TKA. Conversely, there are studies demonstrating that patients undergoing unilateral TKA demonstrate a greater propensity for deep vein thrombosis and pulmonary embolism than the simultaneous bilateral group^{7, 18}. However, there was no deep vein thrombosis or pulmonary embolism in either of the two groups in our study. There is now solid evidence that Asians are less prone to thromboembolism¹⁹⁻²¹, and additionally there is a possible decrease in the rate of DVT or pulmonary embolism in patients who receive regional anesthesia²²⁻²⁴ and epidural analgesia^{25, 26}. Also,

LMWH²⁶ is known to have beneficial effects on the prevention of venous thromboembolism. We believe that we had a lower rate of DVT and pulmonary embolism compared with previous studies for several reasons. Our institute performed adequate anti-thrombotic therapy using LMWH, anti-embolism stocking, and early mobilization for all patients. Additionally, all patients received combined anesthesia (the spinal anesthesia and epidural analgesia). However, major bleeding remains a concern in using LMWH²⁸. We discontinued the use of LMWH in the patients who experienced major bleeding. This was defined as clinically overt bleeding associated with a 2g per deciliter or more decrease in hemoglobin or requiring the transfusion of two or more units of blood product²⁹.

Lane et al.⁵ reported that cardiopulmonary complications were approximately three times more frequent in patients who had simultaneous TKA. This is because simultaneous TKA is contraindicated in patients with existing cardiovascular diseases. There was one case of pneumonia in the ASA 3 & 4 simultaneous bilateral patients in our study. This patient had chronic obstructive pulmonary diseases listed in her medical history and therefore ran a high risk of pulmonary complications. Hypertension was observed in 90 simultaneous bilateral patients (75.6%) and 89 staged bilateral patients (74.8%). Among them, 5 simultaneous bilateral patients and 9 staged bilateral patients were high-risk patients with a history of CAOD (coronary artery obstructive disease). However, there were no cardiologic complications.

In the current study, there were two cases of documented postoperative confusion in the simultaneous bilateral group versus none in the staged bilateral group. A higher rate of postoperative confusion in the simultaneous

bilateral group could be explained by a number of factors, including increased postoperative blood loss, increased need for analgesics, increased hypoxemia and anemia, and increased fluid shifts and potential electrolyte imbalances. However, confusion could be attributed to increased systemic dissemination of fat during the surgical procedure. Lane et al.⁵ have shown that patients who received simultaneous bilateral TKA displayed postoperative confusion around 4 times more frequently than those who received unilateral TKA and that this was due to an increase in fat emboli.

The mean total blood loss was 1299 ml in the simultaneous bilateral group and 640 ml per operation in the staged bilateral group. Thus, blood loss was two times larger in the simultaneous bilateral patients. When simultaneous bilateral patients lose a large amount of blood during surgery, appropriate measures should be taken. This includes preparing a sufficient quantity of blood products, adequate fluid replacement, and frequent checks of postoperative vitals and laboratory tests. Gradillas and Volz¹⁴ reported that a mean total blood loss of 973 ml in their simultaneous bilateral group, and 606 ml in their unilateral group. Stubbs et al.³⁰ reported that postoperative bleeding was significantly higher in simultaneous bilateral groups (1701.8 ml) vs staged group (896 ml). In the both studies, all patient received LMWH or venous thrombosis prophylaxis based on a fixed hospital protocol (warfarin or LMWH). In our study, all patients received LMWH and mean of postoperative bleeding was acceptable compared with previous studies. Acute renal failure occurred in an ASA 3 & 4 simultaneous bilateral patient in our study. It was a prerenal-type renal failure, the patient had a medical history significant for hypertension and stable angina, and postoperative bleeding amount to was 1670 ml in one day. Additionally, a staged bilateral patient

temporarily lost consciousness secondary to her systolic blood pressure dropping under 80mmHg. However her vital signs stabilized, and she recovered after adequate fluid replacement. The patient drained 460ml of blood through a bulb-suction drain until the morning of post-operative day one, which was less than the mean blood loss in the staged bilateral patients. Because most patients who receive TKA are advanced in age and have one or more comorbidities, even a small amount of blood loss may result in a dangerous situation, such as a cardiac event or hypovolemic shock. Therefore, it is necessary to pay careful attention to all patients.

The American Society of Anesthesiologists score was the most common option for comprehensively patient assessment. Our study showed that high-risk patients (ASA 3 & 4) experienced more complications than the low-risk patients (ASA 1 & 2) in simultaneous bilateral TKA. Furthermore, the simultaneous bilateral group had a significantly higher rate of systemic complications than the staged bilateral group in high-risk patients. However, there was no difference in the rate of systemic complications between the simultaneous and staged bilateral groups in low-risk patients. Luscombe et al.³¹ reported that in the simultaneous bilateral group there were four mortalities and three of these patients were in ASA group 3. Using these scores, a clinician has the opportunity to calculate the need for perioperatively required adjuvant therapeutic measures before simultaneous or staged bilateral total knee arthroplasty, thus optimizing indications for the procedure.

The age of TKA patients is inconstantly considered as an influential factor in the final result. Comorbidity increases with age and consequently the patients ability to tolerate stress from operation is expected to decrease. Literature about the benefit of this process in elderly patients has produced

indefinite conclusion. Lynch et al.⁸, in a study of the results of unilateral and bilateral TKA in patients eighty years of age or older, found one-year mortality rates of 0% and 4.08%, respectively. Bullock et al.⁷ reported that patients older than seventy years old when they underwent a simultaneous bilateral procedure appeared to have an increased risk of cardiac complications compared with patients in the same age group who underwent unilateral procedures. In the current study, mean age was 70 years (range, 34-83 years). We considered two age groups, using a cutoff point of 70 years. Sixty-seven patients were older than 70, and 52 patients were 70 years or younger in the simultaneous bilateral group. Our series demonstrated that patients older than 70 had more comorbidities. Electrolyte imbalances occurred in 2 (3.8%) out of 52 patients aged 70 or younger, however, 8 (11.9%) out of 67 patients older than 70 had life-threatening complications. Therefore, although it is hard to set a age definite age, for patients older than 70, more careful attention is required for conducting simultaneous bilateral TKA.

We did not observe an increase in superficial infections for simultaneous bilateral TKA as compared to staged bilateral TKA. We also did not experience a deep infection in either group. Previously concern had been raised about the potential for both knees to become infected in a simultaneous bilateral procedure due to prolonged operating time and an increased number of assistants, not redraping, rescrubbing or changing instruments^{14, 31}. In our study, we believe that the absence of an increased postoperative infection rate in the simultaneous bilateral group can be attributed to precautions requested of the operating room staff and the use of two separate sets of instruments and materials.

One of the advantages of simultaneous bilateral TKA is the short length of hospital stay and the consequent reduction of financial burden. Hardker et al.¹³ compared patients who had staged bilateral TKA with patients who had simultaneous bilateral TKA and reported that the two groups were similar in knee joint score, pain relief and functional recovery, but that patients undergoing staged bilateral TKA tended to have increased in hospital stays and medical cost. Gradillas and Volz¹⁴ reported that the simultaneous bilateral group exhibited a 20% longer hospital stay than the unilateral group and maintained that it is more economical for patients who need to have bilateral TKA to do it simultaneously. In our study, the mean length of hospital stay for the simultaneous bilateral patients was 7.5 days (range, 5-15 days) which is only around 64% of the 11.7 days (range, 8-18 days) for the staged bilateral patients. Therefore, if total knee arthroplasty is required for both knees, simultaneous bilateral surgery is more advantageous financially because it reduces the length of hospital stay.

The limitations of this study include a retrospective design, the use of observable data, and a relatively small sample size. However, this study consisted of consecutive, nonselective patients. During this period, patients with bilateral osteoarthritis were given the option of proceeding with either simultaneous or staged total knee arthroplasty. In addition, we matched the control group with the simultaneous bilateral group carefully in terms of gender, age, comorbidities, body mass index, surgeon, and the year of surgical intervention. By minimizing the biases coming from these factors, these similarities lend statistical power to our results.

V. CONCLUSION

In conclusion, a simultaneous bilateral TKA is a relatively safe and reasonable option for patients whose are symptomatic warrant TKA in both knees, with a minimal increase in the risk of systemic complication. The length of hospital stay is significantly reduced in patients undergoing the simultaneous bilateral procedure. However, the frequency of systemic complications increases in elderly and high risk simultaneous bilateral patients. Therefore, we continue to perform simultaneous bilateral TKA at our institution, but we warn elderly patients (those more than seventy years old) and those with significant comorbidities about the risks.

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< ABSTRACT(IN KOREAN)>

양측 인공 슬관절 전치환술에 있어 동시 혹은 단계적 시술에
따른 합병증 비교

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연구 목적: 양측성 슬관절염에 대한 수술적 치료로 양측 슬관절 전치환술을 시행 함에 있어, 양측을 동시에 시행하는 방법과 일정한 기간을 두고 단계적으로 시행하는 방법간에 술 후 합병증 및 술 후 출혈량, 입원 기간의 차이를 비교하여, 양측 동시 슬관절 전치환술의 안전성과 유익성을 평가하고자 한다.

연구 대상 및 방법: 2003년 1월부터 2006년 12월까지 본원에서 동시에 양측 슬관절 전치환술을 시행 받은 119명의 환자를 대상으로 하였다. 대조군은 같은 기간 동안 단계적으로 양측 슬관절 전치환술을 시행 받은 환자 중 동시에 슬관절 전치환술을 시행 받은 환자와 나이, 성별, 질병의 기왕력, 체질량 지수 등이 일치하는 119명의 환자를 대상하였다. 양군간에 술 후 합병증 발생 및 술 후 출혈량, 입원 기간을 비교하였다. 환자군과 대조군을 American Society of Anesthesiologists(ASA) 분류와 나이에 따라 세분하여 합병증 발생을 비교하였다.

결과: 양측을 동시에 수술 받은 환자 중 10명 (10예)에서 전신 합병증이 발생하여, 3명 (3례)에서 발생한 단계적 양측 슬관절 전치환술을 시행 받은 환자군에 비하여 통계학적으로 유의한 차이를 보였다. 또한 동시에 수술을 시행 받은 환자군 중 고령과 고위험군 환자에서 다른 환자군에 비하여 전신 합병증이 더 높은 빈도로 발생하였다. 입원 기간은 단계적으로 수술을 시행 받은

군에서 통계적으로 유의하게 더 길었다.

결론: 양측성 슬관절염에 대한 수술적 치료로 동시에 양측 슬관절 전치환술을 시행하는 것은 비교적 안전하고 유익한 방법으로 사료되나 고령 및 고 위험군의 환자에 있어서 합병증 발생에 대한 주의가 필요하다.

핵심되는 말: 인공 슬관절 전치환술, 동시, 단계적, 술 후 합병증, 입
원 기간

