



## Comparison of the effectiveness and safety of one-stage versus two-stage bilateral total knee arthroplasty

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This study aims to evaluate the effectiveness and safety of the patients receiving simultaneous bilateral TKA (BTKA). A total of 93 consecutive patients with bilateral knee degenerative osteoarthritis from January 2008 to November 2013 were divided into two groups – one-stage group (bilateral TKA under a single anesthetic,  $n = 54$ ) and two-stage group (bilateral TKA performed during two separate admissions,  $n = 39$ ). The patients in the both group have a similar incidence of postoperative complications ( $p = 0.544$ ). The one-stage BTKA can significantly ( $p < 0.05$ ) decrease the operative time, length of stay, and hospital charges, when compared to two-stage BTKA. The patients in one-stage group have a significantly ( $p < 0.05$ ) higher postoperative drainage, amount of hidden blood loss, amount of blood loss, allogeneic transfusion and rate of blood transfusion, compared with those in two-stage group. Patients in both groups had a similar KSS ( $p = 0.839$ ) and ROM ( $p = 0.383$ ). The findings suggests that one-stage BTKA may be safely performed with similar knee function to those of two-stage procedure, and has the added benefit of single anaesthetic, reduced costs and decreased hospital stay when compared to two-stage BTKA.

**Keywords :** total knee arthroplasty ; simultaneous ; staged ; complication ; safety.

### INTRODUCTION

Total knee arthroplasty (TKA) is an effective surgical procedure for the treatment for end-stage knee

joint arthritis, patients often can relieve pain and improve quality of life. Studies have shown that patients receiving TKA, 33% of the ones with degenerative osteoarthritis in both knees, and 20% of total patients required contralateral TKA during the first 2 years after the first TKA (11,15,16).

For patients suffering from end-stage osteoarthritis with bilateral knee, which need a TKA, generally, there are two surgical strategies – simultaneous bilateral TKA (one-stage BTKA) and staged bilateral TKA (two-stage BTKA). Controversy still exists to the extend of which surgical strategy is safe for patients with bilateral knee joint arthritis (20). Some authors believe that one-stage BTKA may have an increased mortality when compared to the two-stage BTKA (23) ; while others suggests that one-stage and two-stage BTKA have a similar incidence of postoperative complications (10). However, many studies are performed on European or American patients (10,11,15,16,20,23), limited information has been presented regarding the effectiveness and safety for Chinese patients exposed to one-stage or two-stage BTKA.

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Accordingly, this study retrospectively analyzed the clinical data of Chinese patients with degenerative osteoarthritis who underwent one-stage or two-stage BTKA, and aims to compare the effectiveness and safety of the two surgical procedures.

## MATERIALS AND METHODS

Institutional review board approval was obtained for this retrospective study. From January 2008 to November 2013, a total of 219 patients underwent TKA in our hospital, 93 consecutive patients with bilateral knee degenerative osteoarthritis. All of 93 patients were included in this study, and they were divided into two groups – one-stage group (bilateral TKA under a single anesthetic event) and two-stage group (bilateral TKA performed during two separate admissions), according to different surgical procedure.

### One-stage group

There were 54 patients (6 males and 48 females) aged 56-79 years, with mean  $67 \pm 7$  years. The average body mass index (BMI) was  $24.5 \pm 5.5$  kg/m<sup>2</sup> (range, 19.7-32.6 kg/m<sup>2</sup>). The average follow-up was 39 months (range, 12-60 months).

### Two-stage group

There were 39 patients (5 males and 34 females) aged 59-81 years, with mean  $67 \pm 8$  years. The average BMI was  $24 \pm 5$  kg/m<sup>2</sup> (range, 19.9-31.5 kg/m<sup>2</sup>). The mean time between the first and second surgeries for the two-stage group was 9 months (2 to 36 months). The average follow-up was 39 months (range, 12-60 months).

### Surgical technique

All the surgical procedures were performed by a single senior surgeon under general anesthesia using an anterior midline skin incision and medial parapatellar arthrotomy. The implant used was a cemented Genesis II posterior stabilized (Smith & Nephew, USA) prosthesis. During one-stage BTKA operation, the installation of the first knee prosthesis was completed and then while the assistants closed the incision, the contralateral tourniquet was inflated and surgery started on the second knee. The patella was not resurfaced in any of the patients. Drainage was utilized in all patients, and the tourniquet was

released when the incision had been sutured and compression bandaging applied.

### Post-operative management

The drainage system was left in situ for 48 h after operation. Blood was transfused on the basis of the clinical symptoms of patients and laboratory test results. Transfusion was provided for patients with symptomatic anemia or hemoglobin (Hgb) at  $< 100$  g/L. Low-molecular-weight heparin was used for thromboembolic prophylaxis for 4 to 6 weeks after surgery. The first day after operation, the patients were encouraged to start with exercises on the continuous passive motion (CPM) machine, and perform an active range of motion on their knees, quadriceps, and hamstrings for strengthening. The second day, patients started walking with the help of a walker. All patients were discharged directly to their homes and suggested for a regular outpatient follow-up.

### Clinical evaluation

These data were recorded prospectively, including operative time, postoperative drainage, amount of hidden blood loss which was calculated according to Sehat designed mathematical methods (21), amount of blood loss, allogeneic transfusion, the rate of blood transfusion, length of stay, hospital charges, peri-operative complications (hematoma, wound healing problems, pulmonary emboli, deep-vein thrombosis (DVT) which was assessed at seven days after surgery by Doppler ultrasound scan, peri-operative mortality, peri-prosthetic infection), Knee Society clinical scoring system (KSS) (6), and range of motion (ROM). The KSS and ROM was assessed at three and six months, and one year thereafter.

### Statistical analysis

SPSS software 18.0 (SPSS, Chicago, Illinois, USA) was used. The continuous variables of the both groups of patients were compared by a Student's t-test, but if the data are non-normal, the Mann-Whitney U-test was used. Chi-square test or Fischer's exact test was used for categorical data. Two-sided  $p < 0.05$  was considered significant.

## RESULTS

The mean follow-up was similar in the one-stage group and two-stage groups. Details of these data

Table I. — Baseline characteristics of both groups

	One-stage group (n = 54)	Two-stage group (n = 39)	P-value
Average age (yrs)	66.9 ± 7.1	67.2 ± 7.8	0.850
Gender (Male:Female)	6:48	5:34	0.801
Mean BMI (kg/m <sup>2</sup> )	24.5 ± 5.3	23.9 ± 4.9	0.584
Mean Comorbidity (n, %)	29 (53.7%)	23 (58.9%)	0.613
Hypertension	19	21	
Coronary heart disease	3	4	
Diabetes mellitus	8	9	
Cerebrovascular	1	2	
ASA Grade (n, %)			
1	22 (40.7%)	12 (30.8%)	0.324
2	26 (48.1%)	20 (51.3%)	0.765
3	5 (9.3%)	4 (10.3%)	1.000
4	1 (1.9%)	3 (7.8%)	0.306
Mean RBC (10 <sup>12</sup> )	4.7 ± 0.8	4.6 ± 0.6	0.512
Mean Hgb (g/L)	137.4 ± 11.9	136.9 ± 12.7	0.846
Mean KSS (points)	81.2 ± 9.6	79.9 ± 10.2	0.532
Mean ROM (°)	96.6 ± 8.5	95.7 ± 7.3	0.595

are given in Table I. There was no significant difference in the baseline demographics of both groups ( $p > 0.05$ ).

Details of clinical outcomes and peri-operative complications are shown in Table II. There was significant ( $p < 0.05$ ) difference between two groups in term of operative time, postoperative drainage, amount of hidden blood loss, amount of blood loss, allogeneic transfusion, the rate of blood transfusion, length of stay, and hospital charges. None of patients had undergone revision surgery, cardiac complications, acute infection, peri-prosthetic infections, and death. There was no significant difference between two groups in term of the incidence of postoperative complications ( $p = 0.544$ ), KSS ( $p = 0.839$ ), and ROM ( $p = 0.383$ ).

## DISCUSSION

The most important finding of the present study was that (1) the patients in both groups had a similar incidence of postoperative complications ; (2) the one-stage BTKA can significantly decrease the operative time, length of stay, and hospital charges,

when compared to two-stage BTKA ; (3) the patients in the one-stage group have a higher post-operative drainage, amount of hidden blood loss, and amount of blood loss, allogeneic transfusion, rate of blood transfusion, when compared with those in two-stage group ; (4) patients in both group have a similar KSS and ROM.

In the present study, the patients with one-stage BTKA had a similar incidence of every postoperative complications (hematoma, wound healing problems, DVT) compared with two-stage BTKA, and no cases of pulmonary emboli, peri-operative mortality, and peri-prosthetic infection were observed, which also suggests that the simultaneous TKA is safe. In contrast, several authors believe that the one-stage BTKA may lead to an increased risk of serious cardiac complications, pulmonary complications, and mortality (4,19). It may be attributed to the following reasons. In our study, the senior surgeon has a high surgical volume of TKA, and blood transfusions were given to all patients when these patients presented an hemoglobin level less than 10 g/L, rather than less than 8 g/L as suggested by other authors (17). Some authors (7,8,13,18) have

Table II. — The postoperative data in the two groups

	One-stage group (n = 54)	Two-stage group (n = 39)	P-value
Mean operative time (min)	154.7 ± 14.3	171.8 ± 13.4	0.000
Mean postoperative drainage (mL)	456.3 ± 78.9	313.6 ± 58.1	0.000
Mean amount of hidden blood loss (mL)	1656.8 ± 389.1	1476.3 ± 298.7	0.000
Mean amount of blood loss (mL)	2448.9 ± 636.3	1798.4 ± 567.2	0.000
The total allogenic transfusion (u)	9.6 ± 2.3	3.2 ± 1.6	0.000
Number of transfusions (n, %)	54 (100%)	19 (51.3%)	0.000
Average length of stay (days)	11.7 ± 3.6	21.6 ± 6.7	0.000
Average hospital charges (\$)	12223.4 ± 938.5	14733.2 ± 1268.7	0.000
Average KSS (points)	176.5 ± 14.2	177.1 ± 13.8	0.839
Average ROM (°)	114.6 ± 11.2	112.7 ± 8.9	0.383
Postoperative complications (n, %)	14 (25.9%)	8 (20.5%)	0.544
DVT (n, %)	5 (9.3%)	3 (7.7%)	1.000
Pulmonary emboli (n, %)	0	1 (2.5%)	0.419
Hematoma (n, %)	6 (11.1%)	4 (10.3%)	1.000
Wound healing problems (n, %)	3 (5.6%)	1 (2.5%)	0.673
Peri-prosthetic infections (n, %)	0	0	1.000
Peri-operative mortality (n, %)	0	0	1.000

reported that there exists a relationship of surgeon procedure volume and outcomes of total joint arthroplasty (TJA), and a surgeon with high surgical volume (performing 35 cases or more a year) of TJA can minimize the risk for complications and has a trend towards better outcomes. We chose the patients with hemoglobin less than 10 g/L as the standard for blood transfusion, with consideration for the elderly patients who may not tolerate a high change in circulating blood volume. So, all patients did not undergo blood pressure fluctuations in this study. In addition, a lower risk of severe complications was observed in this study, which may be related to the fact that fewer patients were ASA class 3 or 4. Several authors have reported that ASA class 3 or 4 patients have a higher risk of severe complications following TKA (12,25).

In the present study, patients with one-stage BTKA were associated with shorter operative time, shorter length of hospital stay, and lesser hospital charges when compared to those with two-stage BTKA. Some authors (2,3,12) had reported that one-stage BTKA has the advantage of decreasing length of stay and reducing the financial burden of patients. Yoon *et al* (25) have compared the mean length of

hospital stay between one-stage and two-stage BTKA, with respectively 7.5 days versus 11.7 days.

In the present study, patients with one-stage BTKA have a higher postoperative amount of drainage, amount of hidden blood loss, and amount of blood loss, allogenic transfusion, and the rate of blood transfusion when compared to those with the two-stage BTKA. Patients with one-stage BTKA result in massive blood loss, can reduce clotting factors which may lead to increased postoperative amounts of drainage and transfusion. Patients with two-stage BTKA have a lower rate of blood transfusion, which may be attributed to the patients with two-stage BTKA, a mean time between the first and second surgeries was 9 months that would be enough for hematopoiesis to replenish the blood loss following the first operation. In support of our results, Bould *et al* (1) reported an increase of 3.9 units requirement for patients with one-stage BTKA. Stubbs *et al* (24) have compared the mean amount of blood loss between one-stage and two-stage BTKA, with respectively 1702 mL versus 896 mL. Given the level of blood loss and transfusion in one-stage BTKA is high, patients requires adequate preoperative preparation of blood and

must be closely observed pulse blood pressure changes.

In this study, we did not observe an increase in KSS and ROM for the one-stage BTKA as compared with two-stage BTKA. However, some authors suggest that patients with bilateral knee arthritis, only underwent bilateral TKA, to get the best rehabilitation (9,22). Though the one-stage BTKA were a shorter rehabilitation time compared with two-stage BTKA, the clinical function was similar in both group at one year after surgery (5,14).

### CONCLUSIONS

In summary, one-stage BTKA may be a safe procedure with similar knee function to those of two-stage procedure, and has the added benefit of single anaesthetic, reduced costs and decreased hospital stay when compared to two-stage BTKA. We support the one-stage BTKA for treatment of patient with bilateral degenerative osteoarthritis of the knee.

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