



Comparison of Postoperative Morbidity Between Simultaneous Bilateral and Staged Bilateral Total Knee Arthroplasties: Serological Perspective and Clinical Consequences

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ARTICLE INFO

Article history:

Received 16 April 2013

Accepted 15 July 2013

Keywords:

total knee arthroplasty
bilateral
simultaneous
postoperative morbidity

ABSTRACT

The present study compared simultaneous and two-staged (stages 1 and 2 with 8-month interval on average) bilateral TKAs in terms of postoperative serological status and clinical consequences. The decrease in hemoglobin over 2 weeks postoperatively was similar between groups. C-reactive protein levels and creatine phosphokinase index peaking on day 2 were significantly higher in the simultaneous group than in either staged group ($P < 0.05$). Incidence of DVT on day 7 tended to be higher in the simultaneous group, but the difference was not significant. Considering the approximately 8-month interval and 2-month earlier functional recovery with stage 2 TKAs, 6 months were saved with the simultaneous bilateral TKA group. Collectively, simultaneous bilateral TKA is likely to offer a safe and effective procedure in appropriate clinical settings involving anti-bleeding and anti-venous thromboembolism prophylaxis.

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Recently, total knee arthroplasty (TKA) has achieved satisfactory results for severe end-stage degenerative joint disease, not only in terms of pain relief, but also for functional restoration. Despite significant improvements in surgeon- and physician-oriented evaluations, longer recovery time and cost-effectiveness remain issues of concern in patients with bilateral knee deformity showing severe malalignment and flexion contracture. Simultaneous bilateral TKA under a single session of anesthesia enables symmetrical rehabilitation of both knees, while staged bilateral TKA with one knee left untreated inevitably involves cumbersome rehabilitation [1]. One study reported that 98% of patients with bilateral knee involvement, when given a choice of either simultaneous bilateral TKA under a single anesthesia or two-staged bilateral TKA under separate anesthetics, expressed a preference for the simultaneous procedure [2]. Indeed, these patients may accept increased surgical risk in a simultaneous procedure in order to facilitate early functional recovery [3].

The benefits and risks of simultaneous bilateral TKA remain open to debate. Several meta-analyses have proposed potential risks of simultaneous bilateral TKA [4–7]. The incidence of pulmonary embolism (PE), cardiac complications, and even mortality have been reported as higher in simultaneous bilateral TKA [4,5,7–11], whereas major prosthetic infection and mechanical failure may be

less frequent with simultaneous bilateral TKA [7]. Actually, large differences in the rates of these complications exist among studies, and no consensus has yet been reached. Most recently, advancing age and preoperative comorbidity have been noted as critical factors for increased mortality and postoperative morbidity, rather than use of simultaneous or staged procedures [2,12]. Although abundant systematic reviews and meta-analyses have proposed overall clinical pictures for simultaneous and staged bilateral TKA, focus has not been placed on the detailed perioperative status of hospitalized patients following bilateral TKA, particularly from the perspectives of serological status and physical examination findings. This might be attributable to the shorter hospitalization even for simultaneous bilateral TKA in the United States and other Western countries, due to their different health care systems. Fortunately, the Japanese universal health insurance system permits >2 weeks of hospitalization even for unilateral TKA, allowing post-TKA patients to be followed postoperatively for laboratory parameters. In this study, clinical results of two different procedures for bilateral TKA were compared between simultaneous bilateral TKA during one session of anesthesia and two-staged bilateral TKA during two different sessions of anesthesia. Two-staged bilateral TKA was further divided into stage 1 TKA and stage 2 TKA. Comparison of these three groups was performed with particular emphasis on perioperative serological status and clinical consequences and the time to functional recovery. All TKAs were performed by a single surgeon in the same institution with use of the same prosthesis, providing good quality of information regarding perioperative risk and the benefits of simultaneous bilateral TKA.

The Conflict of Interest statement associated with this article can be found at <http://dx.doi.org/10.1016/j.arth.2013.07.019>.

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Materials and Methods

Patients who suffered from bilateral knee osteoarthritis (OA) underwent bilateral TKA using either simultaneous bilateral TKA or staged bilateral TKA, with allocation according to when the operation was performed (Fig. 1). We adopted the simultaneous procedure instead of the two-staged procedure from January 2010. The stage 1 TKA group comprised 60 patients who underwent the first TKA between January 2009 and December 2009, while the stage 2 TKA group comprised the same 60 patients who underwent the second TKA between May 2009 and November 2010. Mean interval between stage 1 and stage 2 TKA was 8.2 months (range, 3–14 months). The simultaneous bilateral TKA group comprised 60 patients who underwent bilateral TKAs under a single anesthesia between January 2010 and April 2011. All patients provided written informed consent, and an institutional review board approved the study. Demographic characteristics of the patients are shown in Table 1. The inclusion criterion was bilateral OA exceeding grade III based on the Kellgren and Lawrence classification [13], including primary OA and secondary OA resulting from osteonecrosis. Both knees were sufficiently symptomatic to warrant bilateral TKA. Exclusion criteria comprised revision TKA and inflammatory joint disease, such as rheumatoid arthritis, psoriatic arthritis, and ankylosing spondylitis. The reason for exclusion of these diseases was the effects of inherent inflammation on perioperative blood testing results and risk of complications. None of the patients primarily scheduled to undergo the simultaneous procedure was changed to a staged procedure due to severe comorbidity. However, during the study period, three patients canceled TKA based on preoperative cardiac risk assessment, with a high risk of myocardial infarction in two patients, and asymptomatic aortic valve stenosis in one patient. Two patients who suffered from cerebral infarction and lung cancer after stage 1 TKA canceled the second contralateral TKA.

All TKAs were performed by the first author (Y.N.) using minimally invasive techniques through a mini-midvastus approach under tourniquet control. All simultaneous bilateral TKAs were performed by one team, sequentially. The implant used was a posterior-stabilized prosthesis (LPS-FLEX; Zimmer, Warsaw, IN). Preoperatively, three-dimensional digital templating software (ATHENA®; Soft Cube, Osaka, Japan) was used to determine the proper size and rotational alignment of the femoral component, and all bone-cuts were performed according to the planning data. For simultaneous bilateral TKA, the same surgeon (Y.N.) operated on each knee in a sequential fashion, proceeding with the second TKA after wound closure and tourniquet deflation of the first TKA. Intra-articular injection of tranexamic acid using the drain clamping method was employed to reduce blood loss in all patients [14]. Briefly, 10 ml of tranexamic acid and 40 ml of saline were injected through a drain following wound closure, and the drain was completely clamped followed by the deflation of the tourniquet. After 2 h of clamping, the drain was released and kept open until 48 h postoperatively. All patients received thrombo-prophylaxis with 20 mg of enoxaparin (Sanofi, Paris, France) twice a day from postoperative day (POD) 2 to POD 8. Doppler ultrasonography (DUS) was routinely performed in all patients preoperatively and on POD 7 for diagnosing DVT. Warfarin was administered orally to patients with DUS-confirmed DVT, starting on day 8 postoperatively and continuing for 3 months.

Table 1

Demographic Characteristics of Patients.

	Simultaneous	Stage 1	Stage 2	P ^a
Number of patients	60	60	60	
Age (years)	73.0 ± 7.9 ^b	71.2 ± 7.1	72.3 ± 7.1	n.s.
Sex (male/female)	10/50	10/50	9/49	n.s.
BMI (kg/m ²)	26.4 ± 3.5	25.6 ± 4.2	25.5 ± 4.3	n.s.
FTA (degrees)	185.1 ± 7.2	187.5 ± 9.5	183.8 ± 11.8	n.s.
Knee score	47.5 ± 14.7	48.8 ± 16.3	44.8 ± 11.5	n.s.
Function score	46.3 ± 22.1	47.3 ± 23.8	58.4 ± 24.4	n.s.

^a P values are calculated using one-factor analysis of variance.

^b Values are given as mean ± standard deviation (SD).

Blood testing was performed and serum levels of hemoglobin, C-reactive protein (CRP), creatine phosphokinase (CPK), and D-dimer were measured at baseline and on PODs 1, 2, 4, 7, and 14. CPK index was expressed as a proportion of the preoperative value, as reported previously [15]. Total blood loss was determined as the intraoperative blood loss plus volume from drain until 48 h postoperatively. Knee Society Score (KSS), including Knee subscore and Function subscore, was routinely assessed preoperatively and postoperatively by an independent doctor (K.U.) who was not responsible for the patient's operation. At a mean of 38-month follow-up (range, 24–51 months), the incidence of postoperative complications was assessed. Serological parameters and clinical results were compared between the stage 1, stage 2, and simultaneous bilateral TKA groups.

Statistical analysis was performed using the Mann–Whitney test for continuous variables and the χ^2 or Fisher's exact test for categorical data. All statistical analyses were performed using StatView-J version 5.0 software (SAS Institute, Cary, NC, USA). Values of $P < 0.05$ were considered statistically significant.

Results

In three-group comparisons, mean operative time per knee was significantly shorter for simultaneous bilateral TKA than for either of the staged bilateral TKAs ($P < 0.05$, Table 2). Both actual blood loss and estimated blood loss per knee were similar among the three groups, with no significant differences. Temporal changes in serum hemoglobin level for 2 weeks postoperatively were similar among the three groups, with the lowest level universally found on day 4 or 7 (Fig. 2).

As a parameter for surgical invasiveness, serum CRP level peaked on day 2 and gradually decreased to almost baseline levels by day 14 in all three groups (Fig. 3). Peak CRP level on day 2 was significantly higher with simultaneous bilateral TKA than with either of the staged bilateral TKAs ($P < 0.05$). CPK index, reflecting the degree of muscle damage and early functional recovery [15], universally peaked on day 2, and this peak was significantly higher in simultaneous bilateral TKA than in either of the staged bilateral TKAs ($P < 0.05$).

As venous thromboembolism (VTE) represents one of the most serious complications after simultaneous bilateral TKA, we examined D-dimer levels at baseline and on PODs 1 and 7 (Fig. 4A). On both PODs 1 and 7, D-dimer level was significantly higher for simultaneous bilateral TKA than for either of the staged bilateral TKAs ($P < 0.05$). DUS-confirmed deep venous thrombosis (DVT) tended to occur more frequently after simultaneous bilateral TKA, but no significant

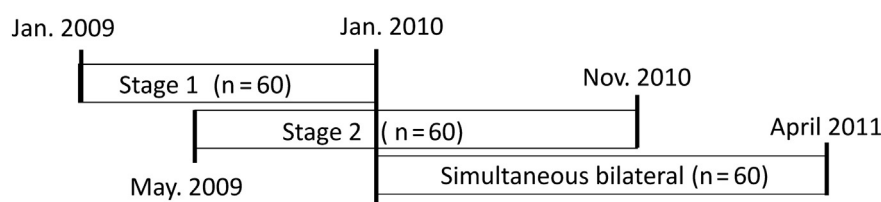


Fig. 1. Patient allocation for two bilateral TKA procedures based on when the operation was performed. Two-staged bilateral TKA was divided into stage 1 and stage 2 TKA groups.

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