

Higher Early Mortality with Simultaneous Rather than Staged Bilateral TKAs

Results From the Swedish Knee Arthroplasty Register

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Abstract Patients with knee osteoarthritis (OA) often present with symptoms that warrant bilateral TKAs. There are potential benefits to operating on both knees on the same day, but the safety of simultaneous bilateral TKAs has been questioned. To evaluate whether there were any differences in 30-day mortality between patients having simultaneous bilateral TKAs and those having staged bilateral TKAs, we analyzed data from the Swedish Knee Arthroplasty Register and the Swedish Cause of Death Register. We included 48,931 patients with OA having 60,062 primary TKAs during 1985 to 2004; 1139 had surgery on both knees on the same day (simultaneous bilateral) and 3432 had surgery on both knees on two different occasions with less than 1 year between operations (staged bilateral). The 30-day mortality after simultaneous bilateral TKAs was 7.53 (confidence interval, 2.62–21.69) times higher than after the second of staged TKA and 3.77 (confidence interval, 2.04–6.98) times higher than after a primary unilateral TKA. Assuming the total risk for a staged procedure is twice that of a unilateral procedure, the risk of mortality within 30 days is 1.94

(confidence interval, 1.05–3.59) times higher with simultaneous than staged TKA. It is safer to operate on one knee at a time.

Level of Evidence: Level II, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

Approximately 10% of patients having a primary TKA have the other knee operated on within 1 year [22], and 20% of patients with OA have severe symptoms from the other knee at the time of primary TKA [12]. It is debatable whether this group of patients should be offered the option of operating on both knees on the same day (simultaneous bilateral TKAs) or have one knee operated on at a time with an interval of weeks or months (staged bilateral TKAs) [14, 20].

The advantages reported with simultaneous bilateral TKAs are both knees can be treated during one hospital stay, and after one rehabilitation period, the patients can experience the benefits of TKA for both knees with less cost for the individual and society [5, 18]. The safety of simultaneous bilateral TKAs has been a concern, and in a recent meta-analysis, a higher risk of serious cardiac complications, pulmonary complications, and mortality was reported with simultaneous bilateral TKAs compared with staged bilateral or unilateral TKAs [17].

Death is the most devastating complication that can occur in conjunction with surgery, and as with other low-frequency complications, a large number of patients must be studied to conclusively assess the risks associated with different types of treatment. By using data from the Swedish Knee Arthroplasty Register, established in 1975, a

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large number of patients can be studied and the unique personal identification number makes it possible to match the data with that in the Swedish Cause of Death Register.

We asked whether there were any differences in early mortality between patients having simultaneous bilateral TKAs and those having staged bilateral TKAs. We then examined the causes of early death after TKA and asked whether there were any differences in causes of death and age at death between patients having simultaneous bilateral TKAs and those having staged bilateral TKAs.

Materials and Methods

This study is based on prospectively collected data stored in the Swedish Knee Arthroplasty Register that retrospectively was matched with the Swedish Cause of Death Register. Included were all patients having primary TKA attributable to OA from 1985 to 2004. Patients having one of two staged procedures performed either before 1985 or after 2004 were excluded. The study population consisted of 48,931 patients, of which 65.4% were female, who had 60,062 primary TKAs. The mean age at the first (or only) operation was 71.6 years (standard deviation [SD], 8.2 years; range, 28–96 years). Bone cement was used in 94% of the operations, whereas the mode of fixation was unknown in 3%.

Of the 48,931 patients, 11,131 (22.7%) had bilateral operations. Of those, 1139 had surgery on both knees on the same day (simultaneous bilateral), whereas 9992 had surgery on two different occasions (staged bilateral); 3432 had the second knee operated on within 1 year of the first operation, and this group was chosen as a comparison group, because it is likely these patients at the time of the first operation had symptoms warranting bilateral TKAs and might have been offered the option of simultaneous bilateral TKAs. In the simultaneous bilateral group, the mean age of the patients at surgery was 70.4 years (SD, 8.0 years; range, 41–92 years), and 59.2% were female, whereas in the staged bilateral within 1-year group, the age at the first operation was 71.2 years (SD, 7.9 years; range, 40–93 years), and 62.5% were female. The group of patients having simultaneous bilateral operations was younger ($p = 0.003$) and included more men ($p = 0.045$) than the group having staged bilateral TKAs with less than 1 year between operations. It is not known whether the patients in the simultaneous group had both knees operated on at the same time or one after the other during the same anesthetic session. Seventy percent of the orthopaedic units did simultaneous bilateral TKAs and the number of patients increased from three in 1985 to 185 in 2004.

Mortality within 30 days after surgery was chosen as a primary end point, because death occurring during that

time is likely to be causally associated with the operation. The unique personal identification number was matched with the Swedish Cause of Death Register and the number of deaths noted. There were 47,792 patients who had unilateral TKA as either the only operation or the first of two. The mortality after unilateral TKA was calculated as the number of deaths within this group, because all these patients were at risk of dying. A direct comparison of mortality after simultaneous and staged bilateral TKAs was not possible, because it was not known how many patients with planned staged bilateral TKAs died after the first operation or for some other reason had only one knee operated on.

We computed cumulative revision rate curves using the life-table method with monthly intervals. The confidence intervals (CIs) were calculated using the Wilson quadratic equation with Greenwood and Peto effective sample-size estimates [3]; we used 95% CIs. When presenting the results graphically, a cutoff was made when the sample size reached 40 as the confidence interval then has become large and the mortality estimate therefore uncertain.

For significance-level calculations, we used Cox regression adjusting for differences in age, gender, and year of operation. In the Cox model, age and year of operation were continuous variables whereas gender and type of operation (first or only TKA, simultaneous bilateral TKAs, or second TKA within a year) were categorical variables. The cofactors gender, age (at surgery), and year of operation were selected because gender and age are known to affect mortality and the year of surgery may be important owing to improvements in perioperative and postoperative care with time. The regression was repeated changing only the specification of the reference category for the type of operation. For the hypothetical scenario of two unilateral procedures being compared with simultaneous bilateral procedures, we used the results from the Cox regression comparing unilateral procedures with simultaneous bilateral but divided the B coefficient by two, which has the same effect as doubling the number of operations with the same risk.

The proportional hazard assumption was investigated by inspecting the log-minus-log survival function and no violation of the proportionality assumption was observed.

The cause of death, coded according to the International Classification of Diseases (9th and 10th Revisions) [6, 7], was available for patients who died between 1985 and 2002. We compared the causes of death after simultaneous bilateral TKAs with the causes of death after all operations on one knee (whether unilateral or the second of staged). We used the chi square test or Fisher's exact test to compare proportions in large and small samples, respectively, and the t test was used for comparison of means.

Table 1. Thirty-day mortality after primary TKA for osteoarthritis and mean age at death

Type of TKA	Number of patients	Number of deaths within 30 days	30-day mortality (%)	Age* (years)
Simultaneous bilateral	1139	11	0.97	74.3 (67.4–85.0)
Unilateral and first of staged bilateral	47,792	137	0.29	76.7 (54.4–90.1)
Second of staged bilateral within 1 year	3432	5	0.15	81.4 (74.3–86.3)
Second of staged bilateral after 1 year	6560	9	0.14	80.3 (70.5–89.0)

* Values are expressed as means with ranges in parentheses.

Results

One hundred sixty-two patients died within 30 days of surgery (Table 1). After adjusting for differences in age, gender, and year of operation, the 30-day mortality was 7.53 (CI, 2.62–21.69) times higher after simultaneous bilateral TKAs than after the second of staged TKA within 1 year. The 30-day mortality was 3.77 (CI, 2.04–6.98) times higher after simultaneous bilateral TKAs than after a unilateral procedure (first or only TKA). However, the risk ratio (RR) for the second TKA of staged procedures within 1 year was not different from that of a unilateral TKA (RR, 0.50; CI, 0.21–1.22) (Fig. 1). Assuming the risk for a staged procedure is twice that of a unilateral procedure, the risk of mortality within 30 days after simultaneous bilateral TKAs is 1.94 (CI, 1.05–3.59) times higher than that after staged bilateral TKAs.

The cause of death was available for 10 of 11 patients in the simultaneous bilateral group, 125 of 137 in the unilateral group, and 14 of 14 in the staged bilateral group.

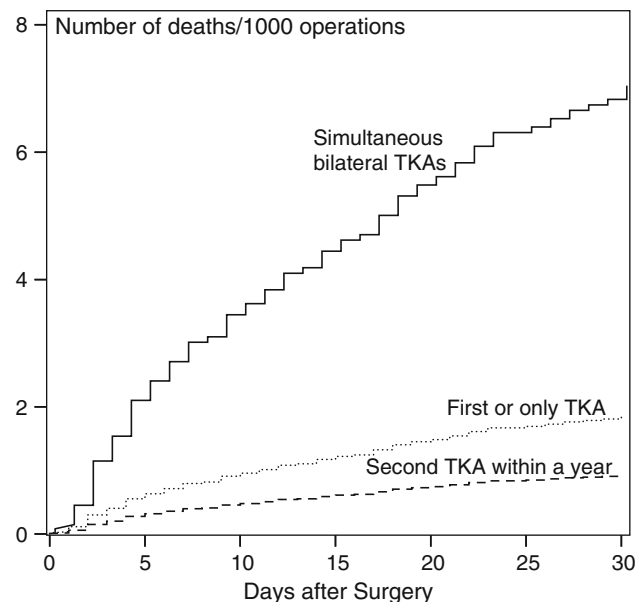


Fig. 1 Cox regression curves, adjusting for differences in age, gender, and year of operation, show the differences in 30-day mortality after simultaneous bilateral TKAs, after a unilateral procedure (first or only TKA), and after the second of staged bilateral TKAs within 1 year.

The predominant cause of death (77.8%) was a disease of the circulatory system (Table 2). The patients with simultaneous bilateral TKAs had a higher ($p = 0.048$) proportion of patients (40% versus 13.7%) with pulmonary embolism than the patients who had surgery on one knee at a time.

The mean age at death was similar for patients in the simultaneous bilateral group (76.7 years; SD 5.54 years) and the unilateral group (74.3 years; SD 6.64 years), whereas patients who died after the second staged operation within 1 year were somewhat older (81.4 years; SD 4.64 years) (Table 1).

For the entire group of patients, the 30-day mortality was higher for men than for women (RR, 2.43; CI, 1.78–3.32), increased with increasing age (RR, 1.11 for each year; CI, 1.08–1.13), and decreased during the study period (RR, 0.93; CI, 0.90–0.95).

Discussion

Simultaneous bilateral TKAs may be an attractive option for patients with bilateral knee arthritis, but there are concerns about safety. By combining data from the Swedish Knee Arthroplasty Register and the Swedish Cause of Death Register, a large number of patients can be studied for early mortality after TKA, revealing eventual differences in early mortality between patients having simultaneous bilateral TKAs and patients having staged bilateral TKAs.

Early mortality after simultaneous bilateral TKAs is easily calculated. However, estimating the mortality risk for patients after staged bilateral TKAs is problematic, because our study is not prospective with respect to the intent of performing staged surgery. Mortality after simultaneous bilateral TKAs cannot be compared with the mortality after the second staged TKA because patients have to survive the first operation to have the second one. Furthermore, patients having severe complications such as myocardial infarction or stroke are likely not to have a second operation. A consequence of this is the group of patients with only one knee operated on includes patients who originally were to have staged TKAs but they did not

Table 2. Causes of death within 30 days after primary TKA

Cause of death	Simultaneous bilateral	Unilateral and second staged bilateral	p Value*
Infectious diseases		1	
Neoplasms		3	
Diseases of the blood and blood-forming organs		1	
Diseases of the circulatory system			
Acute myocardial infarction	4	57	0.61
Pulmonary embolism	4	19	0.048
Cerebral infarction		3	
Other diseases of the circulatory system	2	27	0.62
Diseases of the respiratory system		11	
Diseases of the digestive system		9	
Diseases of the genitourinary system		1	
Other causes		7	
Total	10	139	

*Probability values comparing causes of death after simultaneous bilateral TKAs with causes of death after unilateral and the second of staged bilateral TKAs.

survive the first operation or were too sick to have a second one. Patients having simultaneous bilateral TKAs were younger than those having a staged procedure, which indicates a selection bias. A bias also might have existed for preexisting cardiovascular disease, which is a known risk factor [4, 16], but we had no information regarding comorbidities. Thromboprophylaxis was used with TKA in Sweden during the entire study period, but we have no information concerning which thromboprophylaxis was given to each patient or for how long. There could have been differences between hospitals regarding the quality of postoperative care, which might have affected the number of early deaths. We had no way of studying this and would presume the surgeons doing simultaneous bilateral TKAs are experienced and working at hospitals with good facilities.

The 30-day mortality after the second operation was lower than after the first or only operation. Owing to the selection problems described previously, we decided not to add the risk after a second procedure to the risk of unilateral TKA when estimating the total risk associated with staged TKAs. Instead we used the worse-case scenario of the second operation having as high 30-day mortality as the first operation. Still, we found substantially increased risk of death within 30 days when both knees were operated on the same day (RR, 1.94). Our findings are in agreement with those of a meta-analysis including 26,518 patients that reported the odds ratio for mortality after simultaneous bilateral TKAs to be 2.24 (CI, 1.21–4.16) that of staged TKA [17]. In a report from the Scottish Arthroplasty Project on 19,247 patients of whom 826 had simultaneous bilateral TKAs, the cumulative risk of staged TKA was calculated and no differences were seen in 90-day mortality

between simultaneous bilateral and staged bilateral TKAs (odds ratio, 0.69; CI, 0.31–1.55) [22]. The authors stated a larger patient series would have been needed to get enough power in the study.

When comparing early mortality after simultaneous bilateral TKAs with unilateral TKA, we found the RR to be 3.77. This result is in accordance with a meta-analysis including 35,475 patients, in which a 3.0 times higher risk of early death was seen in patients with simultaneous bilateral TKAs than with unilateral TKA [14]. In a study of 22,540 patients, the 2679 patients who had simultaneous bilateral TKAs had a higher 30-day mortality than those having a unilateral procedure with mortality rates of 0.17% and 0.49%, respectively [16]. Several other studies that included fewer patients have had divergent results [2, 4, 9, 11, 13, 19, 21].

The fact that pulmonary embolism was the dominating cause (40%) of death in the simultaneous bilateral group and a considerably less common cause of death in the unilateral group suggests the increased embolic load during simultaneous bilateral TKAs causes increased mortality. The use of a pneumatic tourniquet, intramedullary guides, and cement are factors that probably are of importance [1, 15, 16].

The lower mean age at death in the simultaneous bilateral group compared with the staged bilateral group can be explained by selection of healthier patients for the second operation. This finding is in contrast with earlier reports that suggested mortality after simultaneous bilateral TKAs is associated with advanced age [10, 20].

For the whole group of patients, early mortality increased with increasing age, as expected. Men had higher early mortality after TKA than women, which was

described previously [8], but the reason for this gender difference is not clear. Reduction in early death with time is probably the result of improvements in operative technique and perioperative and postoperative care, including earlier mobilization.

Death within 30 days after TKA is uncommon, but the risk increases with simultaneous bilateral surgery, and our data suggests it is safer to operate on one knee at a time.

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