

What is the optimal interval between bilateral total knee or total hip arthroplasty when performed under separate anesthesia?

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Response/Recommendation: If a patient is considered for a staged bilateral total knee arthroplasty, the optimal interval between the two surgeries appears to be 90 days.

Level of evidence: Moderate

Rationale: There has been significant controversy and on-going debate on the safety of bilateral TKA (BTKA) either under a single anesthesia (same day) or staged within one year (replacement of the contralateral knee within maximum of one year following the first operation) (1). Recently, there are some reports on 1-surgeon single-anesthetic sequential BTKA (seq-BTKA) compared to 2-surgeon single-anesthetic simultaneous BTKA (sim-BTKA) [28]. Another approach is the so-called staggered Bilateral TKA which refers to replacement in a single hospitalization, but under different anesthesia sessions (2). Lately, there have been some proponents of 1-week staged bilateral procedure with planned interim transfer to a subacute rehabilitation facility (short-staged) [23]. There are advocates of all the afore-mentioned strategies.

Without doubt the TKA population is getting younger. In addition, approximately 30% of patients who undergo unilateral TKA present with bilateral knee symptoms -both in terms of pain and functional impairments- and therefore will require contralateral replacement within the following years (3). Consequently, it is of paramount importance to identify the ideal surgical approach for patients who present with bilateral knee osteoarthritis.

The spectrum of controversy of same day versus staged bilateral TKA can be further elucidated by addressing the following questions/concerns:

- 1- Complications, morbidity, and mortality rate: which approach is safer?
- 2- Which patient is the ideal candidate for same day BTKA?
- 3- Which approach has better functional outcome?
- 4- Which strategy is more financially advantageous, and cost-effective?
- 5- What is the optimal interval for staged BTKA?
- 6- What is the optimal interval for short-staged BTKA?

Complications, morbidity, and mortality rate: which approach is safer?

Same day BTKA has been described as a convenient procedure associated with higher patient satisfaction, faster recovery, and lower costs.[4–6] Studies, however, have shown higher complication rate including increased need for perioperative blood transfusion, cardiorespiratory and neurologic complication, increased rates of venous thromboembolism, wound breakdown, deep infection, and mortality.[7–10] A staged bilateral TKA may decrease the potential complication rate but has been shown to be associated with higher hospitalization costs.[6,11,12]

Fu et al [30] conducted a meta-analysis and concluded that same day versus staged BTKA is associated with higher rates of blood transfusion, pulmonary embolism (PE) and mortality, while decreasing the risk of revision rate and deep infection. However, the major studies included in this study were published before 2000, and therefore could not reflect the current situation of the perioperative safety of modern TKA surgery.

Liu et al, more recently, published a meta-analysis of 18 comparative studies published from 2001 to 2018, including 73,617 participants in the same day group and 61,838 in the staged BTKA group, respectively. Authors demonstrated that same day group showed a lower risk of respiratory complication and deep infection, but increased DVT, PE, and mortality compared with staged BTKA. There was no significant difference in revision, superficial infection, arthrofibrosis, neurological, and cardiac complication, and urinary complication between procedures [29]. Similarly, a qualitative synthesis of 29 articles published between 2001 and 2020 demonstrated that same day group was associated with decreased incidence of infection and LOS but increased incidence of 90-day mortality, VTE and neurological complication compared to staged, whereas revision rates were equivocal at 1 year. (11). It is noticeable that the use of navigation system seems to decrease the early mortality rate as stated by Kirvan, et.al. (10)

Because of the diversity of study settings and designs, it is difficult to draw definitive conclusions. Therefore, significant conclusions can be drawn from research originating from highly specialized or high-volume centers. A propensity- matched case-control study from nine fast-track centers found no significant differences in 30-day readmission rates and mortality between same day and staged BTKA, but the in-hospital complication rate and re-operation rate was higher after the same day procedure calling for further matched investigations in larger cohorts [31]. In a high-volume subspecialty setting in which patients undergoing same day BTKAs were carefully screened, and were generally much healthier and younger, same day bilateral TKAs appeared to be safe; there were no differences in 30-day mortality among groups. The same day group experienced more acute postoperative anemia, blood transfusions, and transfers to rehabilitation, but otherwise had complications comparable to those of the staged groups. In-hospital charges were lower in the same day group. Congestive heart failure and pulmonary hypertension were the most significant factors associated with morbidity and mortality in the same day group [32].

Which patient is the ideal candidate for same day BTKA?

With a growing body of literature determining risk factors and establishing the increased risks of same day BTKA, in 2013 a consensus statement was developed by 40 multidisciplinary experts [33]. It provided recommendations on the care of patients undergoing BTKA and elaborated on suggested exclusion criteria. According to this statement, same-day BTKA is excluded for patients ≥ 75 years of age and those categorized as ASA class III or higher. In addition, the criteria aimed to exclude patients with poor ventricular function (left ventricular ejection fraction $< 40\%$), active ischemic heart, and oxygen-dependent pulmonary disease. Patients with insulin-dependent diabetes, renal insufficiency, pulmonary hypertension, steroid-dependent asthma, morbid obesity (body mass index [BMI] > 40 kg/m²), chronic liver disease, and cerebral vascular disease were considered at higher risk and advised to undergo staged, unilateral TKAs instead [34]. Given the lack of evidence on the effect of selection criteria in reducing complication, a retrospective analysis

clearly showed that the adoption of these specific exclusion criteria can be associated with a reduction in adverse perioperative outcomes following same day BTKA. [35]

Which approach has better functional outcome?

The theoretical merits of doing BTKA under a single anesthetic time are cited as shorter hospital stay, faster rehabilitation, and shorter period away from work. A non-operated painful arthritic knee on one side may be a factor for poor rehabilitation and resultant stiffness of the contralateral knee which has recently underwent arthroplasty according to Mehan et al (6). Nationwide Inpatient Sample data sets from 2004 to 2007 were used to identify 24,574 same day and 382,496 unilateral procedures. The quality of life-years obtained were 9.31 for same day and 9.29 for staged BTKA (4). The rate of joint stiffness and need for manipulation under anesthesia has been reported to be less for same day BTKA compared with staged. Same day BTKA is associated with shorter length of stay (6, 12, 17, 18).

Comparable results in same day and staged BTKA have been reported when functional scorings of WOMAC, Oxford, Knee Society scores, and 10-year survival analysis criteria have been used (16, 17)

A recent single-institution study clearly showed that employed patients undergoing same day BTKA missed a mean of 17 fewer days of work because of their surgical treatment and rehabilitation compared with those undergoing staged BTKA. [36]

Which technique is more financially advantageous, and cost-effective?

Nationwide Inpatient Sample data sets from 2004 to 2007 were used to identify 24,574 same day and 382,496 unilateral procedures. A Markov model was designed to compare the cost-effectiveness of same day BTKA with that of staged. To minimize selection bias, propensity score matching was used to match the groups on socioeconomic variables, comorbid conditions, and hospital characteristics, which clearly showed that all complication rates were higher for the staged group. The estimated mean cost (in 2012 U.S. dollars) was \$43,401 for same day BTKA compared with \$72,233 for staged group. The quality of life-years obtained were 9.31 for same day and 9.29 for staged BTKA. Based on this analysis, same day BTKA is more cost-effective than staged, with lower costs and better outcomes for the average patient (4).

Likewise, a retrospective analysis of 2,372 BTKA patients demonstrated that same day patients had a shorter LOS and lower cost and comparable complication rates than staged ones. Therefore, authors concluded that same day strategy should be indicated in medically stable patients [19].

What is the optimal interval for staged BTKA?

The issue that has not been well documented or analyzed in literature is how long after the first TKA, one should wait to undergo TKA in the contralateral knee. There are infrequent occasions of significant improvement of function and pain symptoms on the contralateral, less arthritic knee after the first TKA that the patient does not want or need to undergo the second knee replacement.

Wang et al. in a systematic review in 2023 found that if staged TKA is planned, one should wait at least 3 months before embarking on the contralateral knee (7). Another systematic review showed that time interval of less than 30 or 90 days between two TKAs performed in patients with BTKA was associated with a higher risk of systematic complication. However, the shorter time intervals between the two TKAs may reduce the risk of other complication [20].

A retrospective study demonstrated that staging the second arthroplasty for more than a half year apart seems to offer a reduction in LOS and the rate of postoperative complication under enhanced recovery after surgery (ERAS) protocol. ERAS shortens the interval of staged bilateral TKA by at least 6 months for patients who might receive their second surgery without the need to wait for an extended period. [21]

Interestingly, an analysis of a large database of 67,956 BTKAs showed that staged procedures at an interval as short as 1-14 days appears safe in appropriately selected patients, with no increased risk of individual or any complication relative to unilateral TKA. [22]

What is the optimal interval for short-staged BTKA?

A retrospective review of 351 consecutive BTKA patients was conducted; patients underwent a 1-week staged bilateral procedure with planned interim transfer to a subacute rehabilitation facility (short-staged) or staged BTKA procedures within 1 year (long-staged). Regression analysis demonstrated that short-staged patients had a higher likelihood of requiring a blood transfusion but were less likely to return to the emergency department within 90 days. There was no difference in short-term complication, 90-day readmission, or 1-year complication between the groups, allowing however for a faster total recovery time [23].

Likewise, Courtney et al. evaluated 131 patients undergoing BTKA staged within 1 week and found no difference in readmission, complication, and reoperations at up to one year when compared to unilateral TKA. Proponents of this strategy argue that this short time interval provides the benefit of a single rehabilitation period without the increased medical risk of a same day bilateral procedure, while also allowing the patient and surgeon to delay the second procedure if any unexpected complications arise. [24]

On the other hand, an institutional analysis of a highly specialized arthroplasty center emphasized that patients who are not appropriate candidates for same-day BTKA due to increased overall comorbidity burden may be better managed by undergoing staged BTKA within 1 year rather than same-admission staged because of the associated higher perioperative morbidity observed in the same-admission BTKA group [25].

Utilizing the Nationwide Inpatient Sample data between 1998 and 2010 a total of 41,664 BTKA patients were identified, and categorized into three groups, same day, staging 1-3 days, and staging 4-7 days BTKA. Staging BTKA 1-3 days apart was associated with increased rates for complications compared to same day BTKA, while staging 4-7 days BTKA was associated with similar complication profiles compared to same day BTKA [26]. However, Sliva et al. reported that staggered BTKA with an interval of 4-7 days during a single admission resulted in significantly fewer complication compared to same day BTKA [27].

In conclusion same day BTKA appears to be a safe and cost-effective alternative to staged arthroplasty in carefully selected patients. Adoption of stringent exclusion criteria and modern arthroplasty surgery and perioperative care would mitigate perioperative risk. If patients are not medically suitable for same day surgery they can be staged with an interval of more than 3 months safely. If bilateral severe knee osteoarthritis patients are not cleared for same day surgery they can be staged within 4-7 days with relative safety.

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