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EDITORIAL

Simultaneous Bilateral Total Knee Arthroplasty: For Whom, By Whom, and Where?

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For decades, the debate over bilateral total knee arthroplasty (BTKA) has been framed around a seemingly straightforward question: should both knees be replaced during the same operative episode, or should the procedures be staged? Proponents of simultaneous BTKA point to a single anesthetic and hospitalization, one rehabilitation period, reduced cumulative operative time, and lower overall cost. Proponents of staged BTKA, by contrast, emphasize the lower immediate physiological burden of addressing one knee at a time.

Before addressing outcomes, the terminology warrants clarification, because part of the apparent disagreement in the literature is definitional rather than clinical. *Simultaneous* BTKA refers to replacement of both knees under a single anesthetic, whether the procedures are performed concurrently by two surgical teams or sequentially by one team. *Staged* BTKA refers to two separate anesthetics, with the second procedure performed either during the same admission or after an interval of weeks to months. These scenarios are physiologically different, and combining them—as many comparative analyses do—can obscure rather than clarify the clinical question.

After almost two decades of accumulating evidence, however, the central question may no longer be whether simultaneous BTKA is preferable to staged surgery. A more clinically useful question is: for which patients, performed by whom, and in which setting can simultaneous BTKA be undertaken safely?

The concern over simultaneous BTKA is longstanding. In 2007, Restrepo et al. reported higher odds of pulmonary embolism, cardiac complications, and mortality with simultaneous than with staged bilateral TKA.[1] That analysis, however, was based on literature published through 2005 and included only 458 staged procedures versus more than 16,000 simultaneous procedures—a period preceding routine tranexamic acid use, contemporary thromboprophylaxis, and enhanced recovery pathways. Its limitations are therefore relevant to the broader argument: the risk associated with simultaneous surgery has never been a fixed quantity but has depended on the patient, surgical team, era, and perioperative environment. Subsequent registry and large database studies continued to show a signal of increased early systemic complications, indicating that, despite major advances in anesthesia, blood management, thromboprophylaxis, and enhanced recovery, the excess risk has not been eliminated.

Recent meta-analyses further illustrate this trade-off. Boutros et al., in an analysis of 42 studies involving more than 560,000 patients, found that simultaneous BTKA was associated with lower cumulative operative time, inpatient cost, and reoperation rates, but with higher transfusion risk (OR 3.99) and first-year mortality (OR 2.43).[2] Bensa et al. (2025) likewise reported higher mortality and thromboembolic complications after simultaneous surgery, despite advantages in selected other surgical outcomes.[3] The apparent reoperation benefit warrants caution: in many included cohorts, the second-stage procedure is counted as an additional operation, which inherently favors the simultaneous group. A matched analysis of 231,119 patients published in this journal reached a similar conclusion, with simultaneous BTKA independently associated with venous thromboembolism (OR 1.28), acute kidney injury (OR 1.47), transfusion (OR 6.81), and any complication (OR 1.63) compared with unilateral TKA.[4]

These relative estimates should also be considered in absolute terms, because relative measures presented in isolation can exaggerate the perceived magnitude of harm. In pooled data comprising 86,333 simultaneous and 115,146 staged procedures, mortality was approximately 0.66% after simultaneous surgery versus 0.43% after staged surgery (OR 1.55; 95% CI, 1.16–2.08).[5] The difference is clinically meaningful and should not be dismissed, but it represents a difference between two relatively uncommon outcomes. When the absolute risk

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remains below 1%, findings of this kind support careful patient selection rather than either routine abandonment of simultaneous surgery or uncritical adoption of it.

One additional point deserves emphasis because it runs counter to a common interpretation of the evidence. In nearly every observational dataset, patients selected for simultaneous BTKA are younger, fitter, and less comorbid than those selected for staged surgery; in the series cited above, simultaneous patients were, on average, three years younger and had a lower comorbidity burden.[4] This selection pattern should favor the simultaneous group. The persistence of a mortality signal despite that advantage suggests that the true attributable risk may be underestimated rather than overstated, and that residual confounding alone is unlikely to account for the observed difference.

Taken together, these findings do not establish that simultaneous BTKA is intrinsically unsafe, nor do favorable single-center series demonstrate that its additional risk has disappeared. Rather, the apparently conflicting literature may be highlighting a more important principle: the safety of simultaneous BTKA is conditional.

The Right Patient

Patient selection remains the most established component of this equation. The risk of simultaneous BTKA cannot be adequately characterized by age or body mass index alone. Frailty, cardiopulmonary reserve, anemia, renal dysfunction, cardiovascular disease, pulmonary hypertension, coagulation disorders, and the overall burden of comorbidity all shape a patient's capacity to tolerate the concentrated physiological stress of two arthroplasties.[6] The 2013 Consensus Conference on Bilateral Total Knee Arthroplasty reached a similar conclusion, supporting simultaneous surgery only in patients who meet stringent criteria and recommending staged procedures for those who do not.[7]

Available evidence also suggests that more stringent selection can translate into better outcomes. Gerner et al. (2022) reported a substantial reduction in major and cardiac complications after institutional selection criteria for simultaneous BTKA were implemented.[8] Although observational before-and-after data cannot prove that selection alone caused the improvement, they provide persuasive real-world evidence that patient selection should be viewed as a safety intervention rather than merely as an administrative step in preoperative assessment.

Obesity illustrates why selection is better viewed as graded than binary. Reported outcomes among obese patients undergoing same-day bilateral surgery are not consistently worse, and avoiding a second anesthetic and hospital admission may, in some patients, offset part of the burden associated with a larger single procedure.[9] Conversely, the clinically important risk is likely to arise from the interaction between very high body mass index and cardiopulmonary comorbidity rather than from body weight alone. Obesity is therefore better regarded as a risk modifier that raises the threshold for simultaneous surgery rather than as an absolute contraindication. The same principle applies to age, which is an imperfect surrogate for physiological reserve.

Selection should extend beyond medical fitness. Simultaneous BTKA also creates a more demanding early rehabilitation period, during which both lower extremities are affected at once. Home support, access to rehabilitation services, socioeconomic circumstances, and the patient's ability to manage a period of temporary bilateral disability should therefore be incorporated into the assessment. An appropriate candidate needs not only sufficient physiological reserve but also the practical capacity to recover.

The Right Surgeon

Much less attention has been paid to the second selection criterion: the surgeon. Patient suitability for simultaneous BTKA is routinely discussed, yet the procedure is often treated as though its risk were independent of who performs it. That assumption is difficult to defend.

In a randomized study, Uzer et al.[10] found that one-stage bilateral TKA performed concurrently by two experienced surgeons reduced operative duration and was associated with fewer major complications than one-stage bilateral TKA performed sequentially by a single surgeon under the same anesthetic. Both groups underwent a single-anesthetic procedure; the variable being examined was team structure rather than staging. Kirschbaum et al.[11] subsequently reported favorable outcomes in selected patients treated by a high-volume arthroplasty surgeon who performed 1,924 primary TKAs during the study period.

These studies do not establish a minimum annual case volume for simultaneous BTKA, and such a threshold should not be inferred from the available evidence. Surgeon volume is more appropriately viewed as a proxy for several potentially relevant characteristics, including technical reproducibility, operative efficiency, team familiarity, predictable blood loss, and consistently low complication rates.

The goal, however, should not be speed for its own sake. Efficient surgery is not synonymous with hurried surgery. Operative efficiency must be achieved without compromising component positioning, soft-tissue balancing, hemostasis, sterility, or closure. This concern is not merely theoretical: the second knee of a simultaneous procedure has been reported to have more than twice the odds of falling outside neutral mechanical alignment compared with the second knee of a staged procedure.[12] Fatigue, time pressure, and declining team vigilance during the latter part of a prolonged bilateral case are plausible contributors, and each is potentially modifiable.

Moreover, planning a bilateral procedure should never make completion of the second knee automatic. Unexpected blood loss, hemodynamic instability, prolonged operative time, or unanticipated complexity during the first knee should prompt a fresh assessment of whether proceeding is appropriate. Consent may cover both knees, but completion of the second procedure should remain conditional on the patient's intraoperative status.

The Right System

The third selection criterion is the institution itself. High-volume arthroplasty centers have reported outcomes after

simultaneous BTKA that are, in some series, substantially more favorable than those reported in national databases.[11] This does not demonstrate that institutional volume eliminates the additional physiological risk. Rather, it suggests that the hospital and its perioperative pathway are themselves components of the intervention. Kulshrestha et al. (2018) illustrate this point directly: using a defined risk-screening and optimization protocol with a two-team fast-track pathway, they reported 90-day morbidity and mortality comparable to those of unilateral TKA. The intervention studied was therefore not simply the surgeon, but the system.[13]

Experienced anesthesia personnel, standardized tranexamic acid and blood-management protocols, early mobilization, appropriate postoperative monitoring, and immediate access to medical and critical-care support may all determine how well a patient tolerates the greater acute physiological burden of simultaneous surgery. Although arbitrary institutional thresholds would be difficult to justify, several capabilities are difficult to regard as optional: standardized tranexamic acid and transfusion protocols, an anesthesia team experienced in the hemodynamic management of bilateral arthroplasty, immediate access to higher-acuity care, and an audited institutional complication rate. A center unable to provide these elements should probably not offer simultaneous BTKA, regardless of the individual surgeon's technical expertise.

This distinction may help explain why the literature appears contradictory. Large administrative databases essentially ask, "What happens when simultaneous BTKA is performed across an entire healthcare system?" In contrast, high-volume specialist-center studies ask, "What happens when carefully selected patients undergo simultaneous BTKA in an optimized environment?" Both observations can be valid because they describe different clinical contexts.

The Case Against Reflexive Staging

Any balanced assessment must acknowledge that staged surgery is not risk-free and that the rationale for it may be less straightforward than it first appears. Staged surgery exposes the patient to a second anesthetic, a second admission, and another perioperative recovery. Patients who experience a complication after the first procedure are at substantially greater risk of experiencing a complication after the second, [14] so the risk of staged surgery is cumulative rather than simply divided by two. In addition, a painful or deformed contralateral knee can limit rehabilitation after the first replacement, and the functional plateau between procedures is not necessarily a neutral period for the patient.

These considerations become even more relevant in resource-constrained health systems, which account for a substantial proportion of this journal's readership. Patients may present with advanced and symmetrical bilateral disease, travel considerable distances for care, and face substantial financial, occupational, and logistical burdens if a second admission is required. When the likelihood of returning for the second knee is genuinely uncertain, the relevant comparison is not necessarily between simultaneous and staged surgery, but between simultaneous surgery and treatment of only one knee. That is a different clinical and health-system calculation from the one implied by studies conducted in settings with reliable access to follow-up care, and it deserves explicit consideration rather than being assumed away.

Staged Does Not Mean "Anytime Later"

When staged surgery is selected, the timing of the second procedure also warrants deliberate consideration. Recent comparative evidence suggests that intervals longer than six weeks—and particularly intervals of approximately three to six months—may be favorable.[14] The 2024 World Expert Meeting in Arthroplasty similarly concluded that an interval of approximately 90 days appears appropriate when BTKA is performed under separate anesthetics.[15] A systematic review of 23 studies involving 117,090 staged procedures, published in this journal, reached a more specific conclusion: performing the second knee within 30 or 90 days of the first was associated with substantially higher odds of myocardial infarction, other cardiac complications, deep vein thrombosis, pneumonia, and subsequent knee revision, although it was associated with lower risks of pulmonary embolism and infection.[16]

The optimal interval remains unsettled, however, and the evidence is not uniformly directional. Staging at intervals as short as 1 to 14 days has been reported without an increase in 90-day complications compared with unilateral TKA,[4] suggesting that physiological recovery may matter more than the calendar alone. The most prudent conclusion, therefore, is not a single prescribed interval but a functional criterion: staging should not simply mean postponing simultaneous surgery. The second procedure should ideally be undertaken only after restoration of hemoglobin, physiological reserve, mobility, and medical stability.

Moving Beyond "Simultaneous Versus Staged"

The available evidence supports several broadly consistent conclusions. Simultaneous BTKA is more efficient, whereas staged BTKA distributes the physiological burden and appears safer for patients with limited physiological reserve. Mid-term pain and functional outcomes do not differ meaningfully between the two strategies,[2,3] and registry data suggest comparable implant survival, although these comparisons arise from populations selected differently for each strategy.[17]

What the evidence does not support is routine use of simultaneous BTKA in every patient with bilateral disease, or the assumption that results achieved by experienced arthroplasty teams can be reproduced automatically by every surgeon and every institution.

The research agenda should therefore move beyond yet another comparison of simultaneous versus staged surgery. Prospective studies are needed to determine how patient characteristics and frailty interact with surgeon performance and volume, operative duration, institutional experience, anesthesia pathways, blood-management practices, rehabilitation resources, and social support to shape risk.

This is also an opportunity for our own professional

community. Bilateral disease is common in clinical practice, simultaneous surgery is performed frequently, yet outcomes remain incompletely documented. A prospective national registry capturing laterality, staging interval, team structure, and institutional context—developed under the auspices of the Iranian Society for Knee Surgery, Arthroscopy and Sports Traumatology and its partner societies—could allow the region to generate context-specific evidence rather than continue to rely predominantly on evidence imported from elsewhere.

Conclusion

Until such evidence becomes available, simultaneous BTKA should neither be abandoned nor normalized. It should be selected deliberately. The question is no longer simply whether surgery should be simultaneous or staged; it is for whom, by whom, and where?

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