# Simultaneous Bilateral Total Knee Replacement – Current Evidence Based Management Strategy

Abhishek Patil[1], Nandan Rao[2]

## Abstract

With an ever-increasing geriatric population and associated knee arthritis; the number of patients requiring total knee arthroplasty continues to rise. In India 94% of patients with Kellegren-Lawrence grade 3 or 4 arthritis have bilateral arthritis. As such bilateral knee arthroplasty offers the convenience of single surgery, concomitant recovery and rehab of both knees and significant cost savings. However traditionally simultaneous bilateral knee replacement has been associated with higher mortality- both in hospital and after discharge extending up to 1 year and higher morbidity due to cardio-pulmonary complications, deep vein thrombosis, pulmonary embolism and higher rates of readmissions. With modern day surgical refinements and improved anesthetic practices; recent studies have reported results and complications at par with unilateral and staged bilateral total knee arthroplasty. However controversies do remain over the applicability of doing simultaneous bilateral knee arthroplasty. Ethical considerations and rarity of complications have made it difficult to conduct adequately powered randomized trials to justify or refute the practice of simultaneous bilateral knee arthroplasty. This review tries to amalgamate the views of recent literature to give the present status and best practices in simultaneous bilateral total knee arthroplasty.

**Keywords:** Total knee arthroplasty, bilateral total knee arthroplasty, bilateral knee replacement, knee arthritis, knee arthroplasty, knee replacement.

## Introduction

The number of TKAs (total knee arthroplasty) continues to rise. As per estimates , in the United States the number of total knee arthroplasties is expected to reach 3 million by 2030 (1) . Estimated prevalence of knee OA was found to be 28.7% in India (2) . As compared to the western population , the incidence of osteoarthritis in India is higher. Seventeen percent of these were Kellegren Lawrence grade 3 or 4 and 94% of them were BL (bilateral) (3) . Whereas 23% of patients with unilateral symptoms report disability, 74% of the patients with bilateral symptoms report disability in daily activities of living (3) and hence bilateral disease assumes added significance in the Indian scenario. Total knee arthroplasty is an established treatment option for end stage arthritis. In view of high prevelance of bilateral disease in India, the debate of simultaneous bilateral TKA versus staged BL TKA becomes relevant.

[1]Department of Joint Replacement and Orthopaedics, Sahyadri Superspeciality Hospital Hadapsar, Pune, Maharashtra, India
[2]Department of Orthopaedics Reliance Hospital, Navi Mumbai, Maharashtra, India.

**Address of Correspondence**
Dr Abhishek Patil, Sahyadri Superspeciality Hospital, Survey number 163, Bhosale nagar, Pune-Solapur road, Hadapsar, Pune. 411028
Email- abhipatortho@gmail.com

## Simultaneous versus staged bilateral TKA

There is a general lack of consensus regarding the choice of simultaneous versus staged BL TKA. A further discrepancy exists as most studies fail to mention whether in a simultaneous BL TKA, both knees were operated simultaneously by two independent surgical teams or they were operated sequentially by the same team. Advantages of simultaneous BL TKA include decreased overall length of hospitalisation, decreased anaesthesia time, decreased total duration of rehab and decreased overall cost of treatment which is in line with the current efforts of decreasing overall cost of health care (4-7). At the same time concerns regarding morbidity and mortality associated with simultaneous BL TKA have been expressed in many studies (8-10) . In a consensus meeting in 2013 on simultaneous BL TKA , 81% participants agreed that simultaneous BL TKA was more invasive in nature and carried a higher risk of peri operative adverse events especially in an unselected group of patients (11). On the contrary, other authors suggest that there is no difference in mortality, morbidity and outcomes of simultaneous BL TKA versus staged TKA in properly selected patients (12-16).

## Patient selection

While it is difficult to assign any inclusion criteria for selction of patients

for simultaneous BL TKA, the medical condition of the patient should dictate the inclusion rather than the orthopaedic concerns and commercial benefits. The consensus group 2013 (11) has suggested the criteria for patient exclusion (Table 1). The overall agreement amongst the participants was around 63%. The exclusion factors that were agreed upon by more than 90% of the participants were ASA class 3 and above, and patients with history of significant ischemic heart disease. In a multivariate analysis of complications in over 2 lakh patients over 10 years it was demonstrated that congestive heart failure and pulmonary hypertension were the most significant comorbidities associated with adverse outcomes. Others were age>75 years, chronic lung disease, coagulopathy, renal disease, cardiac valvular disease, neurological disorders, electrolyte/fluid abnormalities and white males. Hence patients with these comorbidities are poor candidates for simultaneous BL BTKA (17).

## Pre-operative work-up (11)

Every hospital and surgical team should have a protocol for risk assessment and investigations based on the patient and associated co-morbidities.

1. All patients should undergo routine blood investigations including blood chemistry; electrolytes, HbA1c, albumin, liver function tests, blood counts, coagulation tests, a chest radiograph and a 12 lead ECG [2]. The rest of the tests are based on history and clinical assessment of risks. An echocardiography is advised if there is evidence of right heart strain and pulmonary hypertension. Exercise testing may be used for occult cardiac compromise.
3. If there is history of pulmonary disease then spirometry, exercise testing and diffusion capacity of lung for carbon monoxide (DLCO) may be used.

## Intra-operative management

### Anaesthesia in simultaneous BL TKA

Simultaneous BL TKA can be performed under neuraxial blockade (Spinal, epidural or combination), general anaesthesia or combination of neuraxial and general anesthesia. In a large retrospective study it was observed that neuraxial block was preferred in only 6.8% patients (18). The study demonstrated that neuraxial techniques were associated with a statistically significant shorter stay, lesser blood loss and hence lesser need for blood transfusion. Other complications like cardiac events, thrombo-embolic complications, wound and systemic infections, acute renal failure and 30-day mortality were less common with neuraxial methods than with other methods (18). Other studies have corroborated the advantages of neuraxial anaesthesia compared to general anaesthesia (19,20). General anesthesia although the most preferred method resulted in more complications (18). Therefore in absence of a strong consensus the approach in a given patient should be individualized.

## Intra operative monitoring

Besides the standard monitoring, use of intra-arterial BP monitoring is helpful. In patients who are deemed to be high cardio-pulmonary risk, pulmonary artery catheter placement or trans-esophageal echocardiography should be contemplated (18). Normally the mean pulmonary resistance has been found to be 98+/-39.8 dyne/second/cm5 that rises not more than 10% after each side of knee replacement. An empiric value of 200 dyne/second/cm5 has been suggested as a cut-off to postpone surgery for second knee in a sequential simultaneous BL TKA (77) . Another variable to monitor is the systemic to pulmonary vascular resistance ratio. This ratio can be maintained with judicious use of ephedrine/ systemic vasopressors. Whenever there is elevation in pulmonary vascular resistance ,other parameter like pH, pO2, pCO2, ventilation pressure should be checked. Pulmonary arterial catheterization helps in monitoring cardio-pulmonary hemostasis and can help to identify patients with increased pulmonary arterial resistance after the first knee arthroplasty. Hence sequential BTKA may be preferable as compared to true simultaneous BTKA as it helps in early identification of patients at risk (77).

## Use of tourniquet

Most studies on the use of tourniquet in TKA are focussed on unilateral TKA and literature on use of tourniquet in BL TKA is lacking. In a prospective study on use of tourniquet in simultaneous BL TKA, the authors observed that tourniquet use was associated with a decreased surgical time, however the risk of wound complications and knee swelling were higher causing a delay in rehab [21]. The incidence of DVT and long term functional results were not affected. In a meta-analysis on tourniquet use in BL TKA similar findings were observed, except that a higher incidence of thrombotic complications in the tourniquet group was documented [22]. In a recent study no difference was found in cement

**Table1. Guidelines for patient exclusion**

| |
|---|
| 1. Patients older than 75 years |
| 2. All patients with an American Society of Anesthesiologists Class III condition |
| 3. Active ischemic heart disease (positive stress test or a history of anginal equivalents) |
| 4. Decreased left ventricular function (left ventricular ejection fraction<50%) |
| 5. Patients with symptoms of dyspnea on exertion, shortness of breath, or poor functional capacity, ideally should have a preoperative echocardiogram |
| 6. Pulmonary disease (moderate to severe pulmonary hypertension, oxygen-dependent pulmonary disease, oral steroid-dependent asthma, exercise-limiting chronic obstructive pulmonary disease) |
| 7. Morbid obesity (body mass index>40 kg/m2) |
| 8. Renal insufficiency (creatinine>1.6 mg/dL) |
| 9. Chronic liver disease (functional impairment in liver function and/or ascites, Child's Class B or greater) |
| 10. Poorly controlled diabetes mellitus |
| 11.Cerebrovascular disease with a history of a previous stroke |
| 12. Major peripheral vascular disease involving the lower extremities with stents or vascular bypass. |

penetration with or without tourniquet thereby suggesting that the use of tourniquet is not an absolute must to obtain a good cement mantle (23). Regarding the time of tourniquet closure, the consensus group suggested that the tourniquet deflation should be timed optimally to achieve adequate hemostasis (11). It has been recommended that deflating the tourniquet after closure helps to reduce operative time significantly without any effect on blood loss or functional results (24). Thus there is at present no consensus on the use of tourniquet in simultaneous BL TKA.

## Blood loss and use of tranexamic acid

Blood loss and resultant need of blood transfusion is a problem in simultaneous BL TKA. Multiple studies have shown a higher amount of blood loss and need for blood transfusion in simultaneous BL TKA (25-26). Use of tranexamic acid (TXA) has effectively reduced blood loss due to TKA. Use of IV TXA has been shown to reduce the blood loss significantly, and the need for blood transfusions reduced from 96.7% to 60 %. The risk of thrombotic events did not increase (27, 28, 29). Controversy exists on the use of topical versus IV TXA. Recent studies though suggest that use of topical/intra articular TXA may be more effective as compared to IV TXA (30-31). Another strategy suggested to reduce blood loss and decrease the need of allogenic blood transfusions is pre operative donation of autologous blood along with use of blood salvage systems intra operatively (11,78). Their role however is not conclusively proven. In a recent study on safety and complications of simultaneous BL TKA, the authors concluded that with use of modern anaesthetic techniques including hypotensive anaesthesia, use of tranexemic acid, and use of and pre-operative iron infusions, the need for blood transfusions has decreased to less than 5% (32).

## Post operative management

All patients after simultaneous BL TKA should be monitored closely given the chances of haemodynamic instability, electrolyte and fluid imbalances, cardio pulmonary and neurologic complications. Step down units are ideal in this setting (18,33,34).

## Post operative pain management

Pain management is an important aspect of achieving the early rehab goals in the post op period. Multiple studies have suggested the use of peri articular injections for pain management in first 24 hours (35, 36). In a prospective study comparing the use of epidural anaesthesia with peri articular injection (containing morphine, ropivacaine, ketorolac, epinephrine, methyl prednisolone and normal saline) the authors found that the pain relief and use of rescue analgesia were significantly better in the injection group especially in the first 24 hours. The incidence of post op nausea and vomitting was significantly lower. Knee flexion at day 5 was significantly better in the injection group (37). Other authors have found similar findings in addition to reduced blood loss (38). Pre emptive analgesia, peri articular injections and multimodal approach to post operative pain relief helps in aggressive pain management and expedites early rehab which in turn culminates into good post op recovery.

## Thromboprophylaxis

The role of peri operative thromboprophylaxis is now proven beyond doubt. Multiple authors have raised concerns about the risk of thrombo embolic complications after simultaneous BL TKA (4,40,41). In this setting the role of thromboprophylaxis becomes even more important. Needless to say that the role of early mobilization and mechanical methods of thromboprophylaxis cannot be over emphasised. Controversy exists in choosing the ideal chemoprophylaxis agent. AAOS guidelines 2011 could not recommend a single agent as an ideal thromboprophylactic agent in joint replacement surgery (39). While potent anticoagulants decrease the risk of thrombosis, they increase the risk of wound complications, haematoma formation and infections ( 42,43). Multiple studies therefore advocate classification of patients into high and low risk groups. Aspirin along with mechanical compressive devices is effective in reducing the thromotic events especially in low risk group, while the stronger anticoagulants could be reserved for high risk patients only (44,45). NICE guidelines published in 2010 and revised in 2015, have suggested certain risk factors which may indicate a higher risk of developing post op venous thrombo embolism (Table 2). The duration of anticoagulation is debatable (45). Though from available literature it seems that in most patients a duration of 2 weeks is sufficient, in high risk and less mobile patients, an extended regimen may be advocated (45,46,47).

## Complications after simultaneous BL TKA

Complications after BL TKA have been classified as minor or major. While

**Table 2 : NICE criteria for patients with high risk for DVT**

| Sr. no. | Condition |
|---|---|
| 1 | Active cancer or cancer treatment |
| 2 | Age over 60 years |
| 3 | Critical care admission |
| 4 | Dehydration |
| 5 | Known thrombophilias |
| 6 | Obesity (body mass index [BMI] over 30 kg/m2) |
| 7 | One or more significant medical comorbidities (for example: heart disease; metabolic, endocrine or respiratory pathologies; acute infectious diseases; inflammatory conditions) |
| 8 | Personal history or first-degree relative with a history of VTE |
| 9 | Use of hormone replacement therapy |
| 10 | Use of oestrogen-containing contraceptive therapy |
| 11 | Varicose veins with phlebitis |

minor complications have found less importance in literature, the major complications like DVT, pulmonary embolism, cardiac complications and death have been found to affect long-term outcomes. There is considerable divergence in the opinion regarding increased risk with simultaneous BL TKA as compared to staged BL TKA. While each study has its merits and demerits; meta-analyses help in reaching a consensus. Hence in this review we have attempted to mirror the findings of these meta-analyses and other smaller studies on this subject. There are 3 meta-analyses published on this topic in 2007, 2011 and the latest one in 2013. The difficulty is in carrying out a truly controlled randomized trial due to ethical issues and to carry out a study of adequate power with adequate number of subjects (52). In the consensus meeting 2013, 81% participants agreed that simultaneous TKA was a more invasive procedure and associated with more complications as compared to staged BL TKA (11). All participants agreed that strict screening criteria should be applied before assigning patients for simultaneous BL TKA. In the current scenario, where medico-legal aspects of medical care have drawn a lot of attention, it is imperative to note that the current evidence is not strongly in favor of simultaneous BL TKA. The major and life-threatening complications of simultaneous BL TKA are mainly cardio pulmonary, neurologic and thrombo-embolic in nature.

## Mortality

Mortality as a complication for a surgery meant to improve quality of life such as TKA is unacceptable. Almost all metanalysis on this topic comparing simultaneous BL TKA with staged TKA found that the mortality rate for simultaneous BL TKA was significantly higher as compared to staged TKA (6, 41,49,52,54). This despite the fact that in most studies patients in the simultaneous BL group were younger and medically more fit as compared to the patients in the staged group. The older metanalysis reported that the odds ratio of mortality in simultaneous BL TKA was 2.24 (52). A recent metanalysis found that simultaneous BL TKA did not influence the in-hospital mortality. However the 30-day, 3 months and 1 year mortality were significantly higher with simultaneous BL BTKA. The in-hospital mortality was 0.31% for simultaneous BLTKA as compared to 0.27% for staged BL TKA and ranged from 3.42% for simultaneous BTKA to 2.02% for staged BL TKA at 1 year (54). It must be stated that patients may die between 2 procedures in staged BTKA and many other patient related factors might affect mortality of patients at 3 months and 1 year. Additionally surgeons may decide not to operate on patients if there have significant complications after the first procedure and subsequently these patients may not be included in the cohort for the study (54).

## Cardiac complications

The major and life-threatening complications of simultaneous BL TKA are mainly cardio pulmonary, neurologic and thrombo-embolic in nature. In a meta-analysis the authors concluded that the odds ratio for cardiac complications in simultaneous BL TKA was 2.49 as compared to staged BL TKA (52). In another study it was found that the chances of having an adverse coronary event was 60 % higher in patients undergoing simultaneous BL TKA (6). However other studies do not corroborate the same finding (41,49,54) . It is interesting that most of the recent studies suggest that with improvement in anesthetic techniques, surgical expertise, and more effective post op management, the rate of cardiac complications have become comparable to those with staged BL TKA (41,48,49,50,54).

## Thrombo-embolism

Thrombo-embolic complications; mainly deep vein thrombosis (DVT) and pulmonary embolism (PE) after TKA have always attracted a lot of discussion in literature. The earlier reviews found the risk of pulmonary embolism to be 40% higher in patients undergoing simultaneous BL TKR as compared to staged BL TKA with a pooled odds ratio of 1.8 (6,49,52). However recent studies observed no difference (41,48,50,54). The improvement in regional anesthetic techniques and surgical expertise, aggressive rehabilitation protocols, and application of optimum thrombo-prophylaxis regimens based on risk stratification may have contributed to this decline.

## Joint infections

It is interesting to note that whereas most complications are found to be higher in patients of simultaneous BL TKA, most studies have observed that the rate of superficial or deep infections are either lesser or comparable to staged TKA. In a meta-analysis the authors observed that the rate of major infection was almost two folds lower in patients of simultaneous BL TKA as compared to staged TKA (6). Other authors have found similar findings (48-50,54). In a comparative study the rate of in hospital infection (deep infection) has been found to be lowest in the simultaneous BL TKA group (0.28%) and highest in the staged BL TKA group (0.96%). The rate of late infections was as comparable between the groups. The rate of superficial infections was also lowest in the simultaneous BL group (0.28%) and highest in the staged group (1.04%). Interestingly in the staged groups, the second side was more commonly infected, whereas in the simultaneous group the incidence was higher on the first side (55). The increased risk of

infection in staged BL TKA, suggests that infection rate was proportional to the number of times the patient was exposed to the operating room. The fact that patients selected for simultaneous BL TKA are relatively younger and fitter could confound the results. Last but not the least simultaneous BL TKA are generally undertaken in high volume centers by experienced surgeons and this could explain the lower incidence of infection in simultaneous BL group.

## Disparity between results of first and second side in simultaneous BL TKA

A lot of studies comparing simultaneous BL TKA and staged or unilateral TKA do not mention whether the simultaneous BL TKA was done by the same team one after the other (sequential) under one anaesthesia or by two independent teams at the same time. In the setting where both knees are being operated by one team, limited space to work while operating the second side (while the first side is being closed simultaneously), longer duration of surgery and fatigue of the operating team may induce intra operative surgical errors and influence the post op clinical and radiological outcome. In one such study when the post op X-rays were compared, the number of outliers with respect to the coronal alignment of the limb, were significantly higher in the second operated side. There was no difference however when the alignment of individual components were compared. The mean operative time of the second knee was significantly longer the mean total blood loss was significantly more for the second knee as compared to the first knee. The post op Knee society knee score (KSKS) was significantly better for the first knee. The knee society function score (KSFS) and the WOMAC score however were not different. The occurrence of complications between the two groups was not significantly different (70). Though the significance of these findings cannot be inferred based on results of one single study, yet it draws attention to the possible shortcomings of a true simultaneous BL TKA.

## Role of navigation

Use of intra medullary guides on the femoral side during TKA increases the pressures and can result in fat and air emboli. These not only affect the cardio vascular and pulmonary system but also result in neurologic dysfunction in form of post op confusion to even seizures, encephalopathy, neurological deficits and coma in 0.17% cases undergoing simultaneous BL TKA (60). Theoretically therefore use of navigation should prevent the emboli by avoiding intra medullary reference guides and thereby reduce the incidence of neurologic and cardio pulmonary syndromes associated with these. In a prospective randomized study the maximum occurrence of embolization occurred during insertion of femoral rods and the embolic load was significantly reduced in the navigated group as compared to the conventional group (61). Clinical studies on this subject by other authors have found similar findings, however this could not translate into a better clinical outcome (58,59). A prospective study using trans esophageal echocardiography and pulmonary artery catheterization found that, the mean embolic scores were significantly higher at 6.21 points in the conventional total knee arthroplasty group as compared to 5.48 points in the computer assisted surgery group ($p = 0.0161$). Maximum embolic load was observed at tourniquet deflation. There was however no significant difference in the pulmonary vascular pressures and pulmonary vascular resistance or systemic vascular resistance between the two groups (58). Even in studies where the use of navigation has reduced the blood loss and embolic load significantly there has been no corresponding benefit in post-operative outcome (57,59). Thus current literature lacks strong evidence to show clinical benefit of navigation in patients undergoing simultaneous BL TKA.

## Advantages of simultaneous BL TKA

Simultaneous BL TKA has some obvious advantages. Single stage surgery, reduced risks of repeated anesthesia, reduced length of hospital stay, early recovery and reduced overall cost of healthcare to name a few (41,50,52,54).

## Functional recovery after simultaneous BL TKA in BL deformities

One of the postulated advantages of simultaneous BL TKA is that in BL disease, the functional recovery after simultaneous BL TKA is better as both sides undergo rehab together and this ultimately culminates into a better outcome. A retrospective study on this issue reported no difference in pain, but the range of motion (ROM), flexion and function scores were significantly better in the simultaneous BL TKA group as compared to unilateral TKA group (51). In another study on simultaneous versus staged BL TKA in patients with severe fixed flexion deformity (>16 degrees) it was observed that though the residual deformity at 2 years was significantly better in patients in the bilateral group, the knee society scores, function scores and SF 36 scores were comparable between simultaneous and staged BL TKA (62). Hence simultaneous TKA did not offer significant clinical advantage even in severe BL deformities. It seems that at this point there is not enough evidence to say that simultaneous surgery offers better functional results in bilateral deformities. Besides, the consensus group has already highlighted the fact that the medical concern for the patient safety should prevail over the orthopaedic need (11).

## Cost effectivity

Multiple studies have highlighted the cost effectiveness of simultaneous BL TKA (4, 51, 63, 64, 65, 66). Studies have shown savings of 350 USD to up to 10000 USD in the simultaneous setting as compared to staged BL TKA. However they have not accounted for readmissions for complications (65, 66,69). Two recent studies observed that most patients of the simultaneous group had to be discharged to an inpatient rehab center (IPR) (4, 51, 63, 64, 65, 66).Additionally the mean length of stay in the simultaneous group was significantly higher as compared to the staged group. When the combined costs of in hospital stay and rehab were added, there was no difference between the two groups. Complications like venous thrombo-embolism and need of blood transfusions were also significantly higher in the simultaneous group, which further negated its cost-effectivity. The long-term functional outcomes were similar between the groups. The authors mentioned that need of IPR in the simultaneous group could have contributed to increased costs (67,68). Overall from the evidence thus far, especially considering the risk of complications, cost-effectivity of simultaneous BL TKA is debatable.

## Simultaneous BL TKA in a fast track setting

The concept of fast track surgery basically involves interdisciplinary team effort and, multimodal approach to accelerate postoperative convalescence and reduce general morbidity. Fast-track rehabilitation which is a part of the fast track surgery concept involves preoperative patient education, minimal-invasive access to the operative field, optimized anesthesia with optimum fluid management and prevention of intraoperative hypoxia and hypothermia, multimodal analgesia for pain control, aggressive post op rehab and mobilisation, and avoidance of tubes and drains (73,74). The importance of fast track setting in decreasing length of stay, improving patient outcomes and satisfaction has already been emphasized (72,75,76). In a study comparing simultaneous BL TKA and unilateral TKA in a fast track setting it was observed that the outcomes in both groups were comparable or slightly better in the BL group. The important fast track elements in this study included detailed pre operative counseling, specialized joint replacement ward with trained staff, intraoperatively, use of regional anaesthesia and peri articular blocks, absence of drains and use of compressive dressings, post operatively multimodal pain management and aggresive rehab, optimum risk stratified DVT prophylaxis ,and functional discharge criteria. Thus it seems that though the fast track surgery holds promise, a prospective randomized control and adequately powered study would be needed to consolidate this fact.

## Various biases inherent to studies

One of the drawbacks of the study by Restrepo et al is that it reported on the studies published till 2003 (52). It also suffered from the biases of reporting outcomes of the constituent studies. It did not distinguish between simultaneous and sequential BTKA under single anaesthesia and some relevant studies were excluded because of the strict inclusion criteria of the meta-analysis. Another drawback pointed out was that the above study included studies which compared simultaneous BL TKA with unilateral TKA which my not be a true control for simultaneous BL TKA (41). The meta-analysis by Hussain et al was based on retrospective studies with 3 studies of registry data forming bulk of patient population (54). These large studies may lead to skewing of the data. Majority of the studies comparing simultaneous BL TKA with either unilateral or staged BTKA are retrospective studies. With the reported incidence of major complications it is very difficult to establish adequately powered prospective studies with adequate number of participants to establish meaningful outcomes.

**Misclassification Bias:** This occurs when the patients included in the staged BTKA are the patients who actually underwent surgery and excludes patients who underwent first side TKA and who failed to undergo scheduled second side surgery because of complications encountered during first surgery. According to Meehan et al this bias may potentially explain the disparity in mortality outcomes in various studies (71).

**Selection Bias:** This happens when younger, healthier and patients with a lower BMI patients are chosen to undergo simultaneous BTKA as compared to those undergoing staged BTKA. Similarly comparing patients undergoing simultaneous BTKA with those undergoing unilateral TKA is inappropriate.

**Follow up time bias:** This happens when patients are followed up for a fixed time after a surgery. This creates a disparity in actual follow up time between knees operated simultaneously and those operated in a staged fashion , which again can positively as well as negatively affect the outcomes in various studies (71).

## Conclusions:

It can be concluded from the above evidence that simultaneous BL TKA is not a panacea for all patients with bilateral knee arthritis who are candidates for knee arthroplasty. However careful patient selection, meticulous risk stratification, appropriate peri-operative (medical, surgical and anaesthetic) management

will help in gaining a favourable outcome. Sequential BTKA has the theoretical advantage of allowing reassessment of patient after the first procedure and helps in risk mitigation.

## References


1. Kurtz S, Ong K, Lau E, et al. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg[Am] 2007;89(4):780-5.
2. Pal CP, Singh P, Chaturvedi S, Pruthi KK, Vij A. Epidemiology of knee osteoarthritis in India and related factors. Indian J Orthop 2016;50:518-22
3. Shadab M, Zulkifle M, Ansari A.H, Itrat M. Prevalence of knee osteoarthritis in patients visiting NIUM hospital Bangalore. International Journal of Herbal Medicine 2014; 2 (2): 61-64
4. Ritter MA, Meding JB. Bilateral simultaneous total knee arthroplasty. J Arthroplasty 1987;2(3):185-9
5. Hu J, Liu Y, Lv Z. Mortality and morbidity associated with simultaneous bilateral or staged bilateral total knee arthroplasty: a meta-analysis. Arch Orthop Trauma Surg 2011;131:1291-8
6. Meehan JP, Danielsen B, Tancredi DJ, et al. A population-based comparison of the incidence of adverse outcomes after simultaneous-bilateral and staged-bilateral total knee arthroplasty. J Bone Joint Surg Am 2011;93:2203-13
7. Kim YH, Choi YW, Kim JS (2009) Simultaneous bilateral sequential total knee replacement is as safe as unilateral total knee replacement. J Bone Joint Surg Br;91:64-68
8. Lane GJ, Hozack WJ, Shah S, et al. Simultaneous bilateral versus unilateral total kneearthroplasty. Outcomes analysis. ClinOrthopRelat Res 1997;345:106-12.
9. Oakes DA, Hanssen AD. Bilateral total knee replacement using the same anesthetic is not justified by assessment of the risks. ClinOrthopRelat Res 2004;428:87-91.
10. Parvizi J, Sullivan TA, Trousdale RT, et al. Thirty-day mortality after total knee arthroplastyJ Bone Joint Surg [Am] 2001;83-A:1157-61
11. Stavros G. Memtsoudis et al. Consensus Statement from the Consensus Conference on Bilateral Total Knee Arthroplasty Group.ClinOrthopRelat Res (2013) 471:2649-57
12. 5. Vince KG. Bilateral total knee arthroplasty under one anesthesia: a safe protocol.MayoClinProc 1997;72:883-5.
13. Adili A, Bhandari M, Petruccelli D, DeBeer J. Sequential bilateral total kneearthroplasty under 1 anesthetic in patients > or =75 years old: complications and functional outcomes. J Arthroplasty 2001;16:271-8.
14. Bullock DP, Sporer SM, Shirreffs TG Jr. Comparison of simultaneous bilateral with unilateral total knee arthroplasty in terms of perioperative complications. J Bone Joint Surg [Am] 2003;85-A:1981-6.
15. Gill GS, Mills D, Joshi AB. Mortality following primary total knee arthroplasty. J Bone Joint Surg [Am] 2003;85-A:432-5.
16. Kim YH, Choi YW, Kim JS. J Bone Joint Surg Br. 2009 Jan;91(1):64-8
17. Memtsoudis SG, Ma Y et al. Bilateral total knee arthroplasty: risk factors for major morbidity and mortality. AnesthAnalg. 2011 Oct;113(4):784-90.
18. Studner o, Chiu Y L et al. Comparative perioperative outcomes associated with neuraxial versus general anesthesia for simultaneous bilateral total knee arthroplasty.RegAnesth Pain Med. 2012 Nov-Dec;37(6):638-44.
19. Rodgers A, Walker N, Schug S, et al. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. BMJ. 2000;321:1493.
20. Wijeysundera DN, Beattie WS et al. Epidural anaesthesia and survival after intermediate-to-high risk non-cardiac surgery: a population-based cohort study. Lancet.2008;372:562-69.\
21. Liu PL, Li DQ et al. Effects of Unilateral Tourniquet Used in Patients Undergoing Simultaneous Bilateral Total Knee Arthroplasty Orthop Surg. 2017 May;9(2):180-5.
22. Zhang W, Li N et al. The effects of a tourniquet used in total knee arthroplasty: a meta-analysis.JOrthopSurg Res. 2014 Mar 6;9(1):13.
23. Ozkunt O, Sariyilmaz K. The effect of tourniquet usage on cement penetration in total knee arthroplasty: A prospective randomized study of 3 methods.Medicine (Baltimore). 2018 Jan;97(4):e9668.
24. Thorey F, Stukenborg-Colsman C, Windhagen H, Wirth CJ. The effect of tourniquet release timing on perioperative blood loss in simultaneous bilateral cemented total knee arthroplasty: a prospective randomized study. Technol Health Care. 2008;16:85-92.
25. Hutchinson JR, Parish EN, Cross MJ. A comparison of bilateral uncemented total knee arthroplasty: simultaneous or staged? J Bone Joint Surg Br 2006;88(1):40-3.
26. Bullock DP, Sporer SM, ShirreffsJr TG. Comparison of simultaneous bilateral with unilateral total knee arthroplasty in terms of perioperative complications. J Bone Joint Surg Am 2003;85-A(10):1981-6.
27. Chen X, Cao X et al. Effectiveness and Safety of Fixed-Dose Tranexamic Acid in Simultaneous Bilateral Total Knee Arthroplasty: A Randomized Double-Blind Controlled Trial.J Arthroplasty. 2016 Nov;31(11):2471-5 .
28. MacGillivray RG, Tarabichi SB, Hawari MF, et al. Tranexamic acid to reduce blood loss after bilateral total knee arthroplasty: a prospective, randomized d double blind study. J Arthroplasty 2011;26(1):24-8
29. Kim TK, Chang CB, Kang YG, et al. Clinical value of tranexamic acid in unilateral and simultaneous bilateral TKAs under a contemporary blood-saving protocol: a randomized controlled trial. Knee Surg Sports TraumatolArthrosc 2014;22(8):1870-8.
30. Seo JG, Moon YW, Park SH, et al. The comparative efficacies of intra- articular and IV tranexamic acid for reducing blood loss during total knee arthroplasty. Knee Surg Sports TraumatolArthrosc 2013;21:1869-74
31. Aggarwal AK, Singh N, Sudesh P. Topical vs Intravenous Tranexamic Acid in Reducing Blood Loss After Bilateral Total Knee Arthroplasty: A Prospective Study.J Arthroplasty. 2016 Jul;31(7):1442-8.
32. Wong E, Nguyen CL et al. Simultaneous, same-anaesthetic bilateral total knee arthroplasty has low mortality and complication rates.KneeSurg Sports TraumatolArthrosc. 2018 Nov;26(11):3395-3402
33. Peskun C, Mayne I et al Backstein D. Cardiovascular disease predicts complications following bilateral total knee arthroplasty under a single anesthetic.Knee. 2012;19:580-4.
34. Reidy CM, Beach Mlet al hemodynamic instability after simultaneous bilateral total knee arthroplasty. J Patient Saf. 2010;6:233-7.
35. Chaumeron A, AudyDet al. Periarticular injection in knee arthroplasty improves quadriceps function. ClinOrthopRelat Res. 2013 Jul;471(7):2284-95.
36. TsukadaS,Wakui M, Hoshino A. Postoperative epidural analgesia compared with intraoperativeperiarticular injection for pain control following total knee arthroplasty under spinal

anesthesia: a randomized controlled trial. J Bone Joint Surg Am. 2014 Sep 3;96(17):1433-8.

37. Tsukada S, Wakui M et al. Pain control after simultaneous bilateral total knee arthroplasty: a randomized controlled trial comparing periarticular injection and epidural analgesia.J Bone Joint Surg Am. 2015 Mar 4;97(5):367-73.
38. Lombardi AV Jr, Berend KR, Mallory TH, Dodds KL, Adams JB. Soft tissue and intra-articular injection of bupivacaine, epinephrine, and morphine has a beneficial effect after total knee arthroplasty. ClinOrthopRelat Res. 2004 Nov;(428):125-30.
39. Mont MA, Jacobs JJ. AAOS clinical practice guideline: preventing venous thromboembolic disease in patients undergoing elective hip and knee arthroplasty. J Am AcadOrthop Surg. 2011 Dec;19(12):777-8
40. Barrett J, Baron JA, Losina E, Wright J, Mahomed NN, Katz JN (2006) Bilateral total knee replacement: staging and pulmonary embolism. J Bone Joint Surg Am 88:2146-51
41. Hu J, Liu Y et al. Mortality and morbidity associated with simultaneous bilateral or staged bilateral total knee arthroplasty: a meta-analysis.ArchOrthop Trauma Surg. 2011 Sep;131(9):1291-8.
42. Bottner F, Sculco TP. Nonpharmacologic thromboembolic prophylaxis in total knee arthroplasty. ClinOrthopRelat Res 2001 Nov;(392):249-56.
43. Colwell Jr CW, Berkowitz SD, Lieberman JR, et al. Oral direct thrombin inhibitor ximelagatran compared with warfarin for the prevention of venous thromboembolism after total knee arthroplasty. J Bone Joint Surg Am 2005 Oct;87(10):2169-77.
44. Nam D, Nunley RM et al. Mobile compression devices and aspirin for VTE prophylaxis following simultaneous bilateral total knee arthroplasty.J Arthroplasty. 2015 Mar;30(3):447-50 .
45. Azboy I, Barrack R et al. Aspirin and the prevention of venous thromboembolism following total joint arthroplasty: commonly asked questions.Bone Joint J. 2017 Nov;99-B(11):1420-30.
46. Parvizi J, Huang R, Raphael IJ, et al. Timing of Symptomatic Pulmonary Embolism with Warfarin Following Arthroplasty. J Arthroplasty 2015;30:1050-53.
47. Brighton TA, Eikelboom JW, Mann K, et al. Low-dose aspirin for preventing recurrent venous thromboembolism. N Engl J Med 2012;367:1979-87.
48. Sheth DS, CafriG et al . Bilateral Simultaneous vs Staged Total Knee Arthroplasty: A Comparison of Complications and Mortality. J Arthroplasty 2016 Sep;31(9 Suppl):212-6.
49. Fu D, Li G et al. Comparison of clinical outcome between simultaneous-bilateral and staged-bilateral total knee arthroplasty: a systematic review of retrospective studies.J Arthroplasty. 2013 Aug;28(7):1141-7.
50. Seol JH, Seon JK, Song EK. Comparison of postoperative complications and clinical outcomes between simultaneous and staged bilateral total knee arthroplasty.JOrthop Sci. 2016 Nov;21(6):766-69
51. Bagsby D, Pierson JL. Functional outcomes of simultaneous bilateral versus unilateral total knee arthroplasty.Orthopedics. 2015 Jan;38(1):e43-7
52. Restrepo C1, Parvizi J et al. Safety of simultaneous bilateral total knee arthroplasty. A meta-analysis.J Bone Joint Surg Am. 2007 Jun;89(6):1220-6.
53. Chua HS, Whitehouse SL et al. Mortality and Implant Survival With Simultaneous and Staged Bilateral Total Knee Arthroplasty Experience From the Australian Orthopaedic Association National Joint Replacement Registry.J Arthroplasty. 2018 Oct;33(10):3167-73.
54. Hussain N, Chien T . Simultaneous versus staged bilateral total knee arthroplasty: a meta-analysis evaluating mortality, peri-operative complications and infection rates.HSS J. 2013 Feb;9(1):50-9.
55. Poultsides LA, Memtsoudis SG et al. Infection following simultaneous bilateral total knee arthroplasty.J Arthroplasty. 2013 Sep;28(8 Suppl):92-5.
56. Pulido L, Ghanem E, Joshi A, et al. Periprosthetic joint infection: the incidence, timing, and predisposing factors. ClinOrthopRelat Res 2008;466:1710.
57. MuralidharanVenkatesan, DevendraMahadevan, Robert U. Ashford. Computer-Assisted Navigation in Knee Arthroplasty: A Critical Appraisal. J Knee Surg 2013;26:357-62.
58. Rajesh Malhotra, AmitSingla et al. A Prospective Randomized Study to Compare Systemic Emboli Using the Computer-Assisted and Conventional Techniques of Total Knee Arthroplasty. J Bone Joint Surg Am. 2015;97:889-94.
59. Mary O Connor, Mark Brodersen et al. Fat embolism in total knee arthroplasty, A prospective control study of navigation VS standard surgical techniques. JOA 2010;25:1034-40.
60. Su Chan Lee et al. Cerebral fat embolism after simultaneous bilateral total knee arthroplasty a case series. JOA 2012;27:409-14.
61. Y. Kalairajah, A. J. Cossey et al. Are systemic emboli reduced in computerassisted knee surgery? A Prospective Randomised clinical trial. J Bone Joint Surg [Br] 2006;88-B:198-202.
62. Lee WC, Kwan YH, Yeo SJ.Severe Bilateral Fixed Flexion Deformity-Simultaneous or Staged Total Knee Arthroplasty?J Arthroplasty. 2016 Jan;31(1):128-31.
63. Jankiewicz JJ, Sculco TP, Ranawat CS, Behr C, Tarrentino S. One-stage versus 2-stage bilateral total knee arthroplasty. ClinOrthopRelat Res. 1994; (309):94-101.
64. Reuben JD, Meyers SJ, et al. Cost comparison between bilateral simultaneous, staged, and unilateral total joint arthroplasty. J Arthroplasty. 1998; 13(2):172-9.
65. Aaron Chih-Chang Lin, En Chao, et al. Costs of staged versus simultaneous bilateral total knee arthroplasty: a population-based study of the Taiwanese National Health Insurance Database.JOrthopSurg Res. 2014; 9: 59.
66. Odum SM, Troyer JL, Kelly MP, Dedini RD, Bozic KJ. A cost-utility analysis comparing the cost-effectiveness of simultaneous and staged bilateral total knee arthroplasty. The Journal of bone and joint surgery American 2013;95(16):1441-9.
67. Sobh AH, Siljander MP et al.Cost Analysis, Complications, and Discharge Disposition Associated With Simultaneous vs Staged Bilateral Total Knee Arthroplasty.J Arthroplasty. 2018 Feb;33(2):320-323.
68. Buhagiar MA, Naylor JM, et al. Effect of Inpatient Rehabilitation vs a Monitored Home-Based Program on Mobility in Patients With Total Knee Arthroplasty: The HIHO Randomized Clinical Trial. The Journal of the American Medical Association. 2017;317(10):1037-46.
69. Reuben JD, Meyers SJ. Et al. Cost comparison between bilateral simultaneous, staged, and unilateral total joint arthroplasty.J Arthroplasty. 1998 Feb;13(2):172-9.
70. Seo JG, Lee BH et al. Disparate postoperative results in the first and second knees on simultaneous bilateral total knee arthroplasty.J Arthroplasty. 2014 Dec;29(12):2331-6.
71. Meehan JP, Blumenfeld TJ. Risks and Benefits of Simultaneous Bilateral Total Knee Arthroplasty: A Critical Analysis Review.JBJS Rev. 2015 Feb 17;3(2).
72. Husted H, Troelsen A et al.Fast-track surgery for bilateral total knee replacement.J Bone Joint Surg Br. 2011 Mar;93(3):351-6.
73. Huotari K, LyytikΣinen O, Seitsalo S. Hospital Infection Surveillance Team. Patient outcomes after simultaneous bilateral total hip and knee joint replacements.JHosp Infect 2007;65:219-25.
74. Schwenk W, Mler JM. What is "Fast-track"-surgery?.Dtsch Med Wochenschr. 2005 Mar 11;130(10):536-40
75.Kehlet H, Wilmore D W. Multimodal strategies to improve surgical outcome. Am J Surg 2002; 183: 630-41
76. Husted H, Holm G, Jacobsen S .Predictors of length of stay and patient satisfaction after hip and knee replacement surgery: fast-track experience in 712 patients.ActaOrthop. 2008 Apr;79(2):168-73.
77. Dorr LD, Udomkiat P et al. Intraoperative monitoring for safety of bilateral total knee replacement.ClinOrthopRelat Res. 2002 Mar;(396):142-51.
78. Bottner F, Pavone V et al. Blood management after bilateral total knee arthroplasty. ClinOrthopRelat Res. 2003;410:254-61.

Conflict of Interest: NIL
Source of Support: NIL

How to Cite this Article

Patil A, Rao N. Simultaneous Bilateral Total Knee Replacement – Current Evidence Based Management Strategy. Journal of Clinical Orthopaedics July-Dec 2018; 3(2):22-29