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Functional outcome of simultaneous bilateral total knee replacement (SBTKR): Prospective clinical study

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Abstract

The functional outcomes and patient satisfaction scores are comparable, or higher, in persons undergoing bilateral TKA, and this occurs without a subsequent increase in out-of-pocket or insurance-covered medical expenses. Opponents of simultaneous bilateral TKA contend the procedure carries a higher mortality rate than staged bilateral TKA. Other opponents of simultaneous bilateral TKA cite an increase in postoperative complications and higher rehabilitation costs. Detailed history of all patients was taken. All patients were assessed clinically and functionally using the Knee Society Score and oxford knee score. The preoperative medical evaluation of all patients were done to prevent potential complications that can be life-threatening or limb-threatening. One way ANOVA was performed to assess the improvement in KSS score in left knee it was observed that the increase in score was statistically significant with F value of 65.6 and $p < 0.05$. Further post Hoc analysis was done to assess the level of significance by multiple comparison it was observed that KSS score of left knee was significantly more at 3 months, 6 months, 12 months compared to preop levels $p < 0.05$. The KSS score of left knee was significantly more at 6 months, 12 months compared to 3 months $p < 0.05$ and The KSS score of left knee was significantly more at 12 months compared to 6 months $p < 0.05$.

Keywords: Functional outcome, simultaneous bilateral total knee replacement, SBTKR

Introduction

Currently, the lifetime risk of developing symptomatic knee osteoarthritis (OA) is approximately 50%. Knee OA is a leading cause of disability in persons in the United States, and this is only projected to increase with an aging and overweight population. Although most total knee arthroplasties (TKAs) are unilateral, there is a high incidence of bilateral knee disease. Ten years after a primary TKA, the incidence of the cognate knee joint requiring surgical intervention for end-stage OA is 37%^[1]. Although unilateral TKA has been shown to be an effective surgical intervention for management of knee OA symptoms, the short-term and long-term outcome for bilateral TKA has been debated. There is currently not a clear consensus on the benefits of performing simultaneous bilateral TKA^[2].

Proponents of simultaneous bilateral TKA argue that performing the surgery decreases rehabilitation time when compared to unilateral TKAs performed at separate times. Furthermore, proponents of simultaneous bilateral TKA will argue the surgery carries no more risk for postoperative complications than unilateral TKA^[3].

The functional outcomes and patient satisfaction scores are comparable, or higher, in persons undergoing bilateral TKA, and this occurs without a subsequent increase in out-of-pocket or insurance-covered medical expenses. Opponents of simultaneous bilateral TKA contend the procedure carries a higher mortality rate than staged bilateral TKA. Other opponents of simultaneous bilateral TKA cite an increase in postoperative complications and higher rehabilitation costs^[4].

The risks in TKR are greatly influenced by the patient's general health and, even if simultaneous bilateral and unilateral TKR is safe overall, this may not apply to high-risk patients. The general health of patients has been classified by the American Society of Anesthesiologists (ASA) and most clinical studies have confirmed the safety of simultaneous bilateral TKR in the low - risk subgroups (ASA 1 and ASA 2)^[5].

ASA grading is described in detail later. In severely deformed bilateral knees, unilateral TKR can significantly affect rehabilitation and result in poorer outcome.

The principal determinant of functional ability 3 years after a primary TKA is the strength of the non-operated knee. This suggests that the disease progression in the non-operated limb affects a person's long-term functional outcome after a unilateral TKA. It can be supposed that functional outcomes after a simultaneous bilateral TKA would not decrease due to weakening or disease progression of a single side because the diseased joint was replaced bilaterally. This may lead to better long-term functional ability in persons receiving bilateral TKA [6].

The purpose of the study is to evaluate longitudinal functional outcome in patients undergoing simultaneous bilateral total knee replacements (SBTKR).

Methodology

Detailed history, clinical examination, and radiological examination were carried out in all patients.

Detailed history of all patients was taken. All patients were assessed clinically and functionally using the Knee Society Score and Oxford knee score. The preoperative medical evaluation of all patients were done to prevent potential complications that can be life-threatening or limb-threatening. Any limb length discrepancies were noted. Presence of any hip and foot deformities was assessed. The extensor mechanism was assessed for any quadriceps contractures. The knee deformities were examined for any fixed varus or valgus deformities or presence of any fixed flexion contracture

Standard guidelines were utilized to get knee radiographs - standing anteroposterior view and a lateral view and a skyline view of the patella.

Any collateral ligament laxity, subluxation of tibia, presence of osteophytes, any bone defects in the tibia and femur and the quality of bone is assessed. Sizing of the femoral and tibial components can also be done.

Operative Procedure

All patients after thorough pre-op evaluation were taken up for surgery by the same surgical team under combined spinal and epidural anaesthesia, patient in supine position with both knees flexed to 90 degree. Tourniquet was applied at the thigh region bilaterally and sterile preparation done from thighs to toes and draped.

The upper part of the replacement knee joint consists of a contoured metal shield that fits around the lower end of the femur.

The inner surface can be fixed to the cut bone surfaces by the surgeon's choice of bone in growth or bone cement.

The outer surface of the contoured metal shield is shaped to allow the knee cap (patella) to slide up and down in its groove.

The surgeon may choose to retain the natural knee cap or resurface it. In this case a polyethylene button will be cemented in place.

Surgical Technique

With the knee in 90 degree of flexion an anterior midline incision was made. Begin the incision 3cm to 5 cm above the superior pole of patella. Extend it distally to below the level of the tibial tubercle. The retinacular incision was a medial parapatellar retinacular approach, so as to gain easy access to the diseased medial compartment and prevent fibrosis over the lateral side of patella that will predispose to patella

dislocation post operatively.

The patella was retracted laterally. The patella was not everted as it will cause risk of patellar tendon rupture. The degenerated femoral condyle was exposed. The retro patellar fat pad was excised to prevent post operative arthrofibrosis.

With the knee extended, elevate a subperiosteal sleeve of soft tissue from the proximal medial tibia, including the deep medial collateral ligament, superficial medial collateral ligament, and insertion of the pesanserinus tendons. Continue the elevation with a periosteal elevator to free the posterior fibers. To improve exposure during the release, retract this subperiosteal sleeve using a Homan retractor. Release the insertion of the semi-membranosus muscle from the posteromedial tibia. Continue the release distally on the anteromedial surface of the tibia and strip the periosteum medially from the tibia.

For more severe deformities, continue subperiosteal stripping posteriorly and distally. If flexion contracture is present, release or transversely divide the posterior capsule. The Whiteside line and the Trans-epicondylar line were made over the femoral condyles after exposing the condyles. Whiteside line is the vertical line cutting through the middle of distal femoral sulcus. Trans-epicondylar line is the horizontal line linking the medial and lateral epicondyle.

The starter whole was created at the intersection between the vertical Whiteside Line and the horizontal Epicondylar Line. The hole was placed medial and anterior to the anteromedial corner of the intercondylar notch. Initiate an opening in the femoral canal with the 9.5mm diameter drill bit.

Distal femur was resected with either the standard resection slot, which provides a 9mm resection from the prominent distal condyle, or the +4mm resection slot which provides a 13mm resection. If headless pins are used, the resection block can be adjusted 2mm proximally or distally. Assemble the Distal Resection Guide and Valgus Alignment Guide onto the intramedullary alignment rod. The 5 to 7 degree valgus cut was made in order to get a distal cut that is perpendicular to the mechanical axis. Ensure that the resection block is seated flush against the anterior rough cut and lock the assembly with the thumbscrew. Fix the distal femoral resection block to the anterior cortex with two headless pins. Resect the distal femur using the standard resection slot which provides a 9mm resection from the prominent distal condyle.

The extramedullary tibial guide was assembled composing of the cross head with pin, resection guide and ankle yoke. Use the adjustment screw at the ankle to align the resection guide. The long axis of the tibial resection guide should be parallel to the tibia.

Raise the bar holding the resection guide and pin the bar to the upper tibia when the guide is centered on the proximal tibia. The resection slot should be located a few millimeters below the lowest articular surface (usually medial). Use the stylus to check the amount of tibial cut. 2 mm for medial referencing, 10 mm for lateral referencing. The final tibial cut was completed with an osteotome to prevent over penetration of saw blade posteriorly which risked popliteal artery cut.

Extension gap was checked with Trial Tibial Base. The extension gap should be able to accept a minimum of 10 mm base. A symmetrical and rectangular extension gap must be obtained. Do not accept a trapezoidal gap. If this is the case, release more soft tissue to get a rectangle. The extension gap must be the same as flexion gap.

Place the A-P femoral sizer flush against the resected distal femur and adjust the sizer so the feet contact the posterior condyles and the stylus contacts the shaft of femur.

The anterior or posterior size is indicated on the distal face of the A-P femoral sizer. The sizing is between sizes, select the smaller of the two sizes. Select the femoral resection block (4 in 1 resection block) corresponding to the size indicated by the A-P femoral sizer. Place the femoral resection block flush against the distal and anterior femoral surfaces. Stabilize the block against the bone using 3.2mm diameter headed pins on the medial and lateral sides of the block.

Assemble the trial tibial base equal in size to the femoral implant with the trial base handle and place against the proximal tibial surface. If the size is appropriate, align the base and pin it to the tibia using short headed anchoring pins. If the tibial size is too small, a "plus size" will provide additional tibial coverage.

An alignment rod can be inserted through the handle to check alignment to the ankle. Attach the keel punch guide to the keel punch handle and secure it to the trial base by turning the knurled handle. Prepare the entry hole for the tibial stem using the 1/2" drill guide and oversize reamer. Using the threaded punch handle and appropriate keel punch, slide the punch through the guide until the punch is fully seated. The rim of the punch is designed to engage the trial base, keeping it from being inserted too deep. The threaded handle has a mark indicating the depth that the punch should be impacted. Once the punch is seated, remove the punch guide leaving the trial base and stem in place for a trial reduction. After satisfactory reduction, the patella was denervated circumferentially using the cautery.

With the knee flexed, place the appropriate size femoral trial on the distal femur using the femoral impactor. Insert the trial tibial insert of equal size and appropriate thickness onto the trial base and complete the trial reduction.

Bone cement was spread over the cut surfaces of femur and tibia for preparing for the femoral and tibial component implantation. Once the cement surrounding the tibial base has cured, the appropriate tibial insert may be locked into place. Torniquet of that limb is deflated, homeostasis is achieved and while closure is started by the first assistant, the main surgeon and 2nd assistant will be operating on the second knee. Same technique as described above will be followed for the second knee also. After closure of the capsule and the extensor mechanism patella femoral tracking was assessed. Wound closure done in layers. Compressive dressing was given.

Results

Table 1: Comparison of KSS score Right knee

KSS Rt knee	Mean	Std. Deviation	F value	p value
pre op	99.67	26.123	60.420	<0.001
3 months	132.90	9.391		
6 months	144.57	8.418		
12 months	159.86	8.138		

One way ANOVA was performed to assess the improvement in KSS score in right knee it was observed that the increase in score was statistically significant with F value of 60.4 and $p < 0.05$. Further post Hoc analysis was done to assess the level of significance by multiple comparison it was observed that KSS score of right knee was significantly more at 3 months, 6 months, 12 months compared to preop levels $p < 0.05$. The KSS score of right knee was significantly more at 6 months, 12 months compared to 3 months $p < 0.05$ and The KSS score of right knee was significantly more at 12 months compared to 6 months $p < 0.05$.

Table 2: Comparison of KSS score Left knee

KSS Lt Knee	Mean	Std. Deviation	F value	p value
pre op	100.76	26.378	65.600	<0.001
3 months	133.71	7.149		
6 months	145.29	5.917		
12 months	161.10	7.402		

One way ANOVA was performed to assess the improvement in KSS score in left knee it was observed that the increase in score was statistically significant with F value of 65.6 and $p < 0.05$. Further post Hoc analysis was done to assess the level of significance by multiple comparison it was observed that KSS score of left knee was significantly more at 3 months, 6 months, 12 months compared to preop levels $p < 0.05$. The KSS score of left knee was significantly more at 6 months, 12 months compared to 3 months $p < 0.05$ and The KSS score of left knee was significantly more at 12 months compared to 6 months $p < 0.05$.

Table 3: Comparison of Oxford score

Oxford score	Mean	Std. Deviation	F value	p value
pre op	21.00	3.924	201.780	<0.001
3 months	32.19	2.695		
6 months	36.76	1.895		
12 months	40.38	1.802		

One way ANOVA was performed to assess the improvement in Oxford score it was observed that the increase in score was statistically significant with F value of 201.78 and $p < 0.05$. Further post Hoc analysis was done to assess the level of significance by multiple comparison it was observed that Oxford score was significantly more at 3 months, 6 months, 12 months compared to pre op levels $p < 0.05$. The Oxford score was significantly more at 6 months, 12 months compared to 3 months $p < 0.05$ and The Oxford score was significantly more at 12 months compared to 6 months $p < 0.05$.

Discussion

Y.H Kim *et al.* [7] in their study titled "simultaneous bilateral sequential total knee replacement is as safe as unilateral total knee replacement" published in the journal of bone and joint surgery (Br) Simultaneous bilateral sequential TKR can be offered to patients at low and high risk and has an expected rate of complications similar to that of unilateral TKR. Low risk implies ASA grade 1&2, high risk implies ASA grade 3&4. They included 2385 patients who had undergone bilateral sequential TKR under one anaesthetic and 719 who had unilateral TKR. There were no significant pre-operative differences between the groups in terms of age, gender, height, weight, body mass index, diagnosis, comorbidity and duration of follow-up, which was a mean of 10.2 years (5 to 14) in the bilateral and 10.4 years (5 to 14) in the unilateral group.

Sanjeev Jain *et al.* [8] in their study titled "simultaneous bilateral TKR; a prospective study of 150 patients" published in the journal of orthopedic surgery 2013 said that SBTKR is safe for properly selected patients. They included 124 women and 26 men (mean age, 66 years) underwent simultaneous bilateral TKR for tricompartmental osteoarthritis using a posterior- stabilised, high-flexion implant. All patients underwent dobutamine stress echocardiography for detection of any silent cardiac comorbidity by a cardiologist.

T.P. Sculco *et al.* [9] in their study "simultaneous bilateral TKA" published in the bone and joint journal 2012 said that

bilateral one stage TKR is a safe and efficacious treatment for patients with severe bilateral arthritic knee disease but should be reserved for selected patients without significant medical comorbidities.

Zhao YT *et al.* [10] in their study "Comparison of the effectiveness and safety of one-stage versus two-stage bilateral total knee arthroplasty" published in the journal *actaorthopbelg* 2015 said that one-stage BTKA may be safely performed with similar knee function to those of two-stage procedure, and has the added benefit of single anaesthetic, reduced costs and decreased hospital stay when compared to two-stage BTKA. Patients in both groups had a similar KSS ($p = 0.839$) and ROM ($p = 0.383$).

Odum SM *et al.* [11] in their study titled "In-Hospital Complication Rates and Associated Factors After Simultaneous Bilateral Versus Unilateral Total Knee Arthroplasty" said that While complication rates following either unilateral or simultaneous bilateral total knee arthroplasty are low, simultaneous bilateral total knee arthroplasty was associated with higher odds of in-hospital complications, including mortality, compared with unilateral total knee arthroplasty. Patient demographic information, preoperative health status, payer type, and hospital total knee arthroplasty volume were all significant factors in complication rates following bilateral total knee arthroplasty.

Ekinci Y *et al.* [12] in their study titled "Comparison of simultaneous bilateral with unilateral total knee arthroplasty." Published in *actaorthop.* 2014 said that Simultaneous BTKA should be considered in selected patients under 70 years of age with good compliance and no comorbid disease. The study included 48 simultaneous BTKAs (46 females, 2 males; mean age: 64.00 ± 8.31 years) and 53 UTKAs (46 females, 7 males; mean age: 64.40 ± 7.45 years) performed between November 2007 and June 2012. Groups were compared with respect to comorbidity, complications, blood transfusion, hospital stay, clinical and radiological (American Knee Society Score) findings and quality of life (SF-36).

Odum SM *et al.* [13] in their study titled "A cost-utility analysis comparing the cost-effectiveness of simultaneous and staged bilateral total knee arthroplasty" said that simultaneous bilateral total knee arthroplasty is more cost-effective than staged bilateral total knee arthroplasty, with lower costs and better outcomes for the average patient. A Markov model was designed to compare the cost-effectiveness of simultaneous bilateral total knee arthroplasty with that of staged bilateral total knee arthroplasty. Nationwide Inpatient Sample data sets from 2004 to 2007 were used to identify 24,574 simultaneous and 382,496 unilateral procedures. On the basis of the codes of the International Classification of Diseases, Ninth Revision, Clinical Modification, peri-operative complications were categorized as minor, major, and mortality, and respective probability values were calculated. Nationwide Inpatient Sample data were used to determine hospital costs conditional on procedure type and complications. Rehabilitation costs, anesthesia costs, and health utilities were estimated from the literature. To minimize selection bias, propensity score matching was used to match the groups on comorbid conditions, socioeconomic variables, and hospital characteristics.

Sheth DS *et al.* [14] in the study "Bilateral Simultaneous vs. Staged Total Knee Arthroplasty: A Comparison of Complications and Mortality" (*J Arthroplasty* 2016) said that there is a lack of evidence to support superiority of either BTKA - Simultaneous or BTKA - Staged. An integrated health care system total joint registry was used to compare

patients undergoing BTKA-Simultaneous to BTKA-Staged. For outcomes related to revision and infection, the sample included 11,118 patients, and for outcomes of death, acute myocardial infarction, stroke, and venous thromboembolism, a subsample of 7991 patients with comorbidity data was selected.

Abram SG *et al.* [15] in a study "Patient reported outcomes in three hundred and twenty eight bilateral total knee replacement cases (simultaneous versus staged arthroplasty) using the Oxford Knee Score" (*intorthop* 2016) said that Individual patients attained a comparable post-operative score in both their knees, independent of age, pre-operative function and the duration of any staging interval. They compared outcomes measured by the Oxford Knee Score (OKS; /48) in a series of 656 bilateral TKRs (328 patients). One hundred and fifty-six TKRs were simultaneous and 500 TKRs staged.

Poultides LA *et al.* [16] in a study "Infection is following simultaneous bilateral total knee arthroplasty." Said that the Regression analysis showed UTKA patients were 2.5 times more likely to develop in-hospital infection compared to SBTKA, while staged patients were almost 3.4 times more likely. Each additional hospital day increased the risk of late infection by 11.3%. SBTKA on strates an advantage over staged and maintains the safety profile of unilateral approaches with respect to infectious complications.

Merrill A Ritter *et al.* [17] in a study "Simultaneous Bilateral, Staged Bilateral, and Unilateral Total Knee Arthroplasty" (*JBJS Am* 2003) said "the significantly higher rate of thrombophlebitis in the simultaneous bilateral group compared with that in the unilateral group may represent a greater risk to those patients.

However, we believe that when there are adequate indications for bilateral total knee replacement, simultaneous bilateral arthroplasty is beneficial to patients, with a minimal increase in the risk of death or other complications compared with that associated with unilateral and staged procedures."

Conclusion

Even in patients undergoing SBTKR, With the use of posterior cruciate substituting design, at one year follow up an average pre-op Knee Clinical Scores of 99.67 and 100.76 (right and left knee) improved to an average post- op Knee Clinical Scores of 161.1 and 158.8 respectively and an average oxford knee score of 21 improved to an average post-op oxford Knee Score of 41.38. (P value <0.001) (One way ANOVA used).

This implies functional outcomes are not significantly different between bilateral and unilateral TKR With age <70 and ASA grade 1/2, the 90 day mortality rate in patients undergoing SBTKR can be significantly reduced.

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