Section: Orthopaedics

Original Research Article

PROSPECTIVE STUDY ON FUNCTIONAL RECOVERY AFTER UNILATERAL VS BILATERAL TOTAL KNEE REPLACEMENT IN OSTEOARTHRITIS PATIENTS

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Received *: 26/10/2024*
Received in revised form *: 03/12/2024*
Accepted *: 19/12/2024*

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DOI: 10.70034/ijmedph.2024.4.218

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2024; 14 (4); 1183-1188

ABSTRACT

Background: This study aimed to compare functional recovery outcomes following unilateral versus bilateral total knee replacement (TKR) in patients with advanced osteoarthritis (OA), focusing on pain relief, joint mobility, functional performance, and patient satisfaction.

Materials and Methods: This prospective observational study included 100 patients with advanced knee OA, divided into two groups: unilateral TKR (n=50) and bilateral TKR (n=50). Baseline demographics and clinical characteristics were comparable between groups. Functional recovery was assessed using the Knee Society Score (KSS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Timed Up and Go Test (TUG), and range of motion (ROM) measurements at baseline, 6 weeks, 3 months, and 6 months postoperatively.

Results: Both groups demonstrated significant improvements in KSS, WOMAC, TUG, and ROM scores at all postoperative time points, with no statistically significant differences between the groups. At 6 months, patient satisfaction was high in both groups (unilateral: 88%, bilateral: 90%), and pain reduction and return to daily activities were similarly observed in 86% of patients in both groups. Rehabilitation compliance was excellent, and complication rates were low in both groups (8% unilateral, 10% bilateral).

Conclusion: Unilateral and bilateral TKR are equally effective for advanced OA, with comparable improvements in functional recovery and patient satisfaction. The choice of procedure should be individualized based on patient health and clinical indications to optimize outcomes.

Keywords: Unilateral total knee replacement, Bilateral total knee replacement, Osteoarthritis, Functional recovery, Patient satisfaction.

INTRODUCTION

Osteoarthritis (OA) is a degenerative joint disease characterized by progressive cartilage deterioration, subchondral bone remodeling, and synovial inflammation. It is one of the leading causes of disability worldwide, with the knee joint being the most commonly affected. Patients with advanced knee osteoarthritis often experience severe pain, joint stiffness, and significant functional limitations, which can profoundly affect their quality of life. When conservative treatment options such as physical therapy, pharmacological interventions, and lifestyle modifications fail to alleviate symptoms, total knee replacement (TKR) becomes the treatment of choice.[1] Total knee replacement is a surgical procedure that involves the removal of damaged cartilage and bone surfaces in the knee joint and their replacement with artificial prosthetic components. The primary goal of TKR is to relieve pain, restore joint function, and improve the overall quality of life. However, the decision between unilateral TKR, where one knee is replaced, and bilateral TKR, where both knees are replaced simultaneously, remains a topic of considerable debate in the orthopedic community.[2] Unilateral TKR is often recommended for patients who have severe osteoarthritis in only one knee or when other

medical conditions make simultaneous bilateral surgery riskier. This approach allows for a more focused recovery process and reduces the surgical burden on the patient. On the other hand, simultaneous bilateral TKR is performed when both knees are affected by advanced osteoarthritis and require replacement. The bilateral approach has the potential advantage of addressing both knees in a single surgical session, thereby eliminating the need for a second surgery and potentially shortening the total recovery time.[3] The decision to perform unilateral or bilateral TKR is influenced by various factors, including the patient's overall health, the severity of OA in each knee, and their functional demands. While bilateral TKR may offer the advantage of a single recovery period, it is associated with increased perioperative risks such as higher blood loss, longer anesthesia time, and a potentially higher rate of complications. Conversely, unilateral TKR is considered safer for patients with significant comorbidities but requires a second surgery if both knees are affected, resulting in prolonged cumulative recovery time.[4] Functional recovery following TKR is a critical outcome measure, as it reflects the patient's ability to return to daily activities, regain mobility, and achieve independence. Functional recovery encompasses various parameters, including pain relief, joint range of motion, muscle strength, gait patterns, and overall physical activity levels. Standardized tools such as the Knee Society Score (KSS), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the Timed Up and Go Test (TUG), and range of motion (ROM) measurements are commonly used to assess functional outcomes following TKR. Several factors influence the rate and extent of functional recovery after TKR. These include the patient's age, preoperative functional status, body mass index (BMI), the presence of comorbidities, surgical technique, and adherence to postoperative rehabilitation protocols. The rehabilitation process, in particular, plays a pivotal role in optimizing functional recovery.[5] Early mobilization, weight-bearing exercises, and structured physiotherapy programs are essential components of recovery, regardless of whether the surgery is unilateral or bilateral.[6] The comparative efficacy of unilateral versus bilateral TKR in terms of functional recovery has been extensively studied, but the findings remain inconclusive. Some studies suggest that bilateral TKR offers superior functional outcomes due to the simultaneous correction of biomechanical abnormalities in both knees, resulting in improved gait patterns and reduced compensatory stress on the unaffected limb. However, other studies highlight the potential challenges of bilateral TKR, including increased pain, delayed early mobilization, and the psychological burden of managing bilateral rehabilitation.[7] Given the growing prevalence of knee osteoarthritis and the increasing demand for TKR procedures, understanding the nuances of functional recovery after unilateral versus bilateral TKR is essential for guiding clinical decision-making. By comparing these approaches, clinicians can better tailor treatment plans to individual patients, ensuring optimal surgical outcomes and patient satisfaction. This study aims to compare functional recovery outcomes following unilateral and bilateral TKR in patients with advanced knee osteoarthritis. Using standardized assessment tools, we will evaluate pain levels, joint mobility, functional performance, and patient satisfaction at multiple postoperative time points. The findings of this study will contribute to the growing body of evidence, aiding in the identification of the most suitable surgical approach for patients with varying clinical presentations. Ultimately, this research seeks to enhance the quality of care provided to patients undergoing TKR and improve their long-term functional and quality-of-life outcomes.

MATERIALS AND METHODS

This prospective observational study was conducted to compare functional recovery in osteoarthritis (OA) patients undergoing unilateral versus bilateral total knee replacement (TKR). The study included 100 patients diagnosed with primary knee osteoarthritis who underwent TKR at tertiary care hospital. Institutional ethical committee approval was obtained prior to the initiation of the study, and all participants provided written informed consent.

Inclusion Criteria

1. Patients diagnosed with advanced primary knee OA based on clinical and radiographic criteria.
2. Age between 50 and 80 years.
3. Indication for TKR as determined by the orthopedic surgeon.
4. Patients opting for either unilateral or bilateral TKR after informed consultation.

Exclusion Criteria

1. Previous knee surgeries or interventions.
2. Severe medical comorbidities contraindicating surgery.
3. Cognitive or psychiatric disorders affecting compliance with postoperative rehabilitation protocols.
4. Patients lost to follow-up within the study period.

Patient Allocation

The study population was divided into two groups:

- **Group A (Unilateral TKR):** 50 patients undergoing unilateral TKR.
- **Group B (Bilateral TKR):** 50 patients undergoing simultaneous bilateral TKR.

Patients were not randomized but were assigned based on their preference and clinical suitability after preoperative counseling by the surgical team.

Surgical Procedure

All surgeries were performed by the same team of experienced orthopedic surgeons using a standard medial parapatellar approach, with cemented

prostheses utilized for all patients. Postoperative pain management involved a multimodal analgesia approach, and a standardized thromboprophylaxis regimen was administered to minimize the risk of complications. A uniform rehabilitation protocol was implemented for all patients to promote early mobilization and progressive functional recovery. On the first postoperative day, assisted passive range of motion exercises and bedside physiotherapy were initiated. From the second day onwards, weight-bearing was encouraged as tolerated, with a focus on gait training and strengthening exercises. Between weeks 2 and 6, patients attended supervised outpatient physiotherapy sessions three times a week, transitioning to an independent exercise program from weeks 6 to 12, aimed at improving strength, endurance, and functional activities.

Outcome Measures

Functional recovery was assessed using validated measures at baseline (preoperative), and at 6 weeks, 3 months, and 6 months postoperatively. The **Knee Society Score (KSS)** was utilized to evaluate both knee function and patient satisfaction, providing a comprehensive assessment of surgical outcomes. The **Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)** was employed to measure pain, stiffness, and functional limitations, capturing the impact of osteoarthritis on daily activities. Mobility and balance were assessed using the **Timed Up and Go Test (TUG)**, a simple and reliable measure of functional mobility. Additionally, **Range of Motion (ROM)** was measured using a goniometer to quantify the improvement in joint flexibility post-surgery. These tools collectively provided a robust framework for evaluating the effectiveness of unilateral and bilateral total knee replacement surgeries.

Statistical Analysis

Data were collected at all follow-up visits by independent assessors blinded to the type of surgery. Continuous variables were expressed as means ± standard deviations, and categorical variables as frequencies and percentages. Between-group differences were analyzed using an independent t-test for continuous variables and chi-square tests for categorical variables. A p-value < 0.05 was considered statistically significant. Statistical analysis was performed using SPSS 25.0 version.

RESULTS

Table 1: Demographic and Baseline Characteristics

The demographic and baseline characteristics of the study groups were well-matched. The mean age of patients in the unilateral TKR group (Group A) was 66.2 ± 5.8 years, compared to 65.8 ± 6.2 years in the bilateral TKR group (Group B) (p=0.74). Both groups had similar gender distributions, with a slightly higher number of females in both groups (p=0.68). The mean BMI was 29.4 ± 3.1 kg/m² for Group A and 30.2 ± 3.6 kg/m² for Group B (p=0.25). The prevalence of comorbidities was also comparable, with 68% in Group A and 70% in Group B (p=0.81). These findings indicate that the two groups were comparable at baseline, minimizing confounding factors.

Table 2: Knee Society Score (KSS) Over Time

The Knee Society Score (KSS), which evaluates knee function and patient satisfaction, showed consistent improvement over time in both groups. At baseline, the scores were similar (42.6 ± 8.5 in Group A vs. 43.1 ± 9.1 in Group B, p=0.68). At 6 weeks, the scores improved to 62.3 ± 9.2 in Group A and 63.7 ± 9.6 in Group B (p=0.42). This trend continued at 3 months (76.5 ± 7.8 vs. 77.9 ± 8.1, p=0.38) and 6 months (88.1 ± 6.3 vs. 89.5 ± 5.9, p=0.31). There was no significant difference between the two groups at any time point, suggesting comparable recovery in knee function and patient satisfaction.

Table 3: Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) Scores

The WOMAC scores, measuring pain, stiffness, and functional limitations, demonstrated a significant reduction in symptoms over time in both groups. At baseline, scores were 74.3 ± 6.4 in Group A and 73.8 ± 5.9 in Group B (p=0.63). At 6 weeks, scores improved to 62.7 ± 7.5 and 61.3 ± 7.1, respectively (p=0.41). By 3 months, scores further decreased to 48.9 ± 5.8 in Group A and 47.5 ± 6.1 in Group B (p=0.29), and at 6 months, they were 32.4 ± 4.9 and 31.8 ± 5.2, respectively (p=0.53). Both groups showed significant improvement, with no significant differences between them.

Table 4: Timed Up and Go Test (TUG) Results

The TUG test, which assesses mobility and balance, also showed similar improvements between the two groups. At baseline, the mean times were 14.2 ± 1.8 seconds for Group A and 14.5 ± 1.7 seconds for Group B (p=0.47). At 6 weeks, times improved to 11.8 ± 1.5 seconds in Group A and 12.2 ± 1.6 seconds in Group B (p=0.34). At 3 months, the times were 9.5 ± 1.3 seconds for Group A and 9.2 ± 1.2 seconds for Group B (p=0.27), and by 6 months, they improved further to 8.1 ± 1.0 seconds and 7.9 ± 1.1 seconds, respectively (p=0.42). Both groups showed significant improvements, with no statistically significant differences.

Table 5: Range of Motion (ROM) Improvement

Range of motion improved significantly in both groups postoperatively. At baseline, ROM was 90.5 ± 8.2 degrees in Group A and 91.2 ± 7.9 degrees in Group B (p=0.57). At 6 weeks, ROM increased to 108.4 ± 6.7 degrees in Group A and 109.1 ± 6.5 degrees in Group B (p=0.48). By 3 months, it improved further to 118.7 ± 5.4 degrees and 119.6 ± 5.2 degrees, respectively (p=0.33), and at 6 months, it reached 125.3 ± 4.9 degrees in Group A and 126.1 ± 4.7 degrees in Group B (p=0.40). These findings

highlight comparable recovery in ROM between the two groups.

Table 6: Patient Satisfaction and Overall Outcomes at 6 Months

At 6 months, patient satisfaction was high in both groups, with 88% (44/50) in Group A and 90% (45/50) in Group B (p=0.73). Pain reduction was observed in 86% of patients in both groups (p=1.00). A return to daily activities was achieved by 84% (42/50) in Group A and 86% (43/50) in Group B (p=0.76). The complication rate was low, at 8% (4/50) in Group A and 10% (5/50) in Group B (p=0.74). Rehabilitation compliance was excellent in both groups, with 92% (46/50) in Group A and 90% (45/50) in Group B (p=0.69). These results indicate similar satisfaction and functional outcomes between the two groups.

Table 1: Demographic and Baseline Characteristics

Variable	Group A (Unilateral TKR, n=50)	Group B (Bilateral TKR, n=50)	p-value
Age (years)	66.2 ± 5.8	65.8 ± 6.2	0.74
Gender (Male/Female)	20/30	22/28	0.68
BMI (kg/m²)	29.4 ± 3.1	30.2 ± 3.6	0.25
Comorbidities (%)	68	70	0.81

Table 2: Knee Society Score (KSS) Over Time

Time point	Group A (Unilateral TKR)	Group B (Bilateral TKR)	p-value
Baseline	42.6 ± 8.5	43.1 ± 9.1	0.68
6 Weeks	62.3 ± 9.2	63.7 ± 9.6	0.42
3 Months	76.5 ± 7.8	77.9 ± 8.1	0.38
6 Months	88.1 ± 6.3	89.5 ± 5.9	0.31

Table 3: Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) Scores

Time point	Group A (Unilateral TKR)	Group B (Bilateral TKR)	p-value
Baseline	74.3 ± 6.4	73.8 ± 5.9	0.63
6 Weeks	62.7 ± 7.5	61.3 ± 7.1	0.41
3 Months	48.9 ± 5.8	47.5 ± 6.1	0.29
6 Months	32.4 ± 4.9	31.8 ± 5.2	0.53

Table 4: Timed Up and Go Test (TUG) Results

Time point	Group A (Unilateral TKR)	Group B (Bilateral TKR)	p-value
Baseline	14.2 ± 1.8	14.5 ± 1.7	0.47
6 Weeks	11.8 ± 1.5	12.2 ± 1.6	0.34
3 Months	9.5 ± 1.3	9.2 ± 1.2	0.27
6 Months	8.1 ± 1.0	7.9 ± 1.1	0.42

Table 5: Range of Motion (ROM) Improvement

Time point	Group A (Unilateral TKR)	Group B (Bilateral TKR)	p-value
Baseline	90.5 ± 8.2	91.2 ± 7.9	0.57
6 Weeks	108.4 ± 6.7	109.1 ± 6.5	0.48
3 Months	118.7 ± 5.4	119.6 ± 5.2	0.33
6 Months	125.3 ± 4.9	126.1 ± 4.7	0.40

Table 6: Patient Satisfaction and Overall Outcomes at 6 Months

Outcome Measure	Group A (Unilateral TKR, n=50)	Group A (%)	Group B (Bilateral TKR, n=50)	Group B (%)	p-value
Patient Satisfaction	44	88%	45	90%	0.73
Pain Reduction	43	86%	43	86%	1.00
Return to Daily Activities	42	84%	43	86%	0.76
Complication Rate	4	8%	5	10%	0.74
Rehabilitation Compliance	46	92%	45	90%	0.69

DISCUSSION

The demographic comparability between the unilateral and bilateral TKR groups aligns with findings from other studies. For example, a study by Pugely et al. (2017) reported no significant differences in demographic variables, including age and BMI, between unilateral and bilateral TKR groups, reinforcing the reliability of our matched cohort design.[8] Similarly, Teng et al. (2020) observed comparable comorbidity profiles across patient groups undergoing TKR, suggesting that baseline characteristics do not inherently bias postoperative outcomes. Our study, consistent with these reports, ensures that differences in recovery are attributable to surgical approach rather than baseline disparities.[9]

The consistent improvement in KSS scores observed in both groups reflects effective recovery, consistent with the findings by Martin et al. (2018), who reported parallel trajectories of functional recovery between unilateral and bilateral TKR at 6 months.[10] A study by Crawford et al. (2021) also supports our results, showing no significant differences in

functional scores, indicating that bilateral procedures are as effective as unilateral in terms of knee-specific outcomes.[11]

The significant reduction in WOMAC scores over time reflects improved pain and function, consistent with the findings of Kim et al. (2019), who demonstrated that both unilateral and bilateral TKR effectively reduce WOMAC scores at 6 months postoperatively.[12] Additionally, Cheng et al. (2022) reported no significant differences in WOMAC improvements between unilateral and bilateral TKR, supporting the comparability of our results.[13]

The improvements in TUG times align with the findings of Husted et al. (2017), who noted similar recovery rates in mobility between unilateral and bilateral TKR groups at 6 months.[14] A more recent study by Li et al. (2023) also demonstrated that bilateral TKR patients achieve comparable mobility outcomes to unilateral TKR patients, indicating that both approaches are effective in restoring functional mobility.[15]

The progressive improvements in ROM are consistent with previous studies. For instance, Huang et al. (2019) reported that ROM improvements were similar between unilateral and bilateral TKR patients at 6 months postoperatively.[16] Likewise, Tan et al. (2022) demonstrated that ROM recovery is comparable between these groups, suggesting that surgical approach does not significantly impact joint flexibility.[17]

High patient satisfaction and comparable pain reduction between groups are consistent with the findings of Gandhi et al. (2018), who reported that both surgical approaches yield similar satisfaction rates at 6 months.[18] Moreover, a study by Patel et al. (2021) found that the complication rates and compliance with rehabilitation were also comparable, supporting the safety and efficacy of both approaches.[19]

CONCLUSION

This study demonstrates that both unilateral and bilateral total knee replacement (TKR) are effective surgical options for patients with advanced knee osteoarthritis, offering comparable improvements in functional recovery, pain relief, and patient satisfaction. While bilateral TKR reduces the need for a second surgery and allows for simultaneous correction of biomechanical issues, unilateral TKR provides a safer option for patients with significant comorbidities. The choice of approach should be individualized, considering patient health, severity of disease, and functional goals, to optimize outcomes and ensure successful rehabilitation.

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