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ORIGINAL ARTICLE

Immediate Total Knee Replacement Plus Standardized Non-Surgical Management Versus Standardized Non-Surgical Management Alone in Patients Eligible for TKR: A Prospective Comparative Cohort Study of Functional Outcomes and Predictors of Recovery

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Abstract

Background: Optimal timing of total knee replacement (TKR) in patients with advanced knee osteoarthritis (OA) remains debated. Whether immediate TKR combined with standardized non-surgical management provides superior functional outcomes compared with continued non-surgical management alone is uncertain particularly in Indian population. Aim is to compare outcomes of immediate total knee replacement versus non-surgical management and identify predictors of recovery. **Methods:** This prospective, observational comparative cohort study enrolled 60 patients (50-80 years) with Kellgren-Lawrence grade III-IV knee OA who were eligible for TKR. Participants were allocated based on clinical decision and patient preference into immediate TKR plus standardized non-surgical management or standardized non-surgical management alone. The primary outcome was change in KOOS4 score from baseline to 12 months. Secondary outcomes included KOOS subscales, Timed Up and Go (TUG) test, 20-m walk test, patient satisfaction, adverse events and predictors of recovery. Analyses followed intention-to-treat principles. **Results:** Baseline characteristics were comparable between groups. At 12 months the immediate TKR group demonstrated significantly greater improvement in KOOS4 compared with the non-surgical group (78.6 ± 7.4 vs. 60.9 ± 10.2; between-group difference +17.7; 95% CI 12.3–23.1; $p<0.001$). Secondary outcomes including KOOS pain, activities of daily living, quality of life, TUG and 20-m walk test were all significantly better in the immediate TKR group ($p<0.001$). A higher proportion of patients undergoing immediate TKR achieved the minimal clinically important difference for KOOS4 (86.7% vs. 46.7%; $p=0.003$) and reported greater satisfaction and functional independence. **Conclusion:** Immediate TKR combined with standardized non-surgical management results in superior functional outcomes and patient-reported benefits compared with non-surgical management alone at 12 months.

Keywords: Total knee replacement, Knee osteoarthritis, KOOS4 score, Kellgren–Lawrence grading

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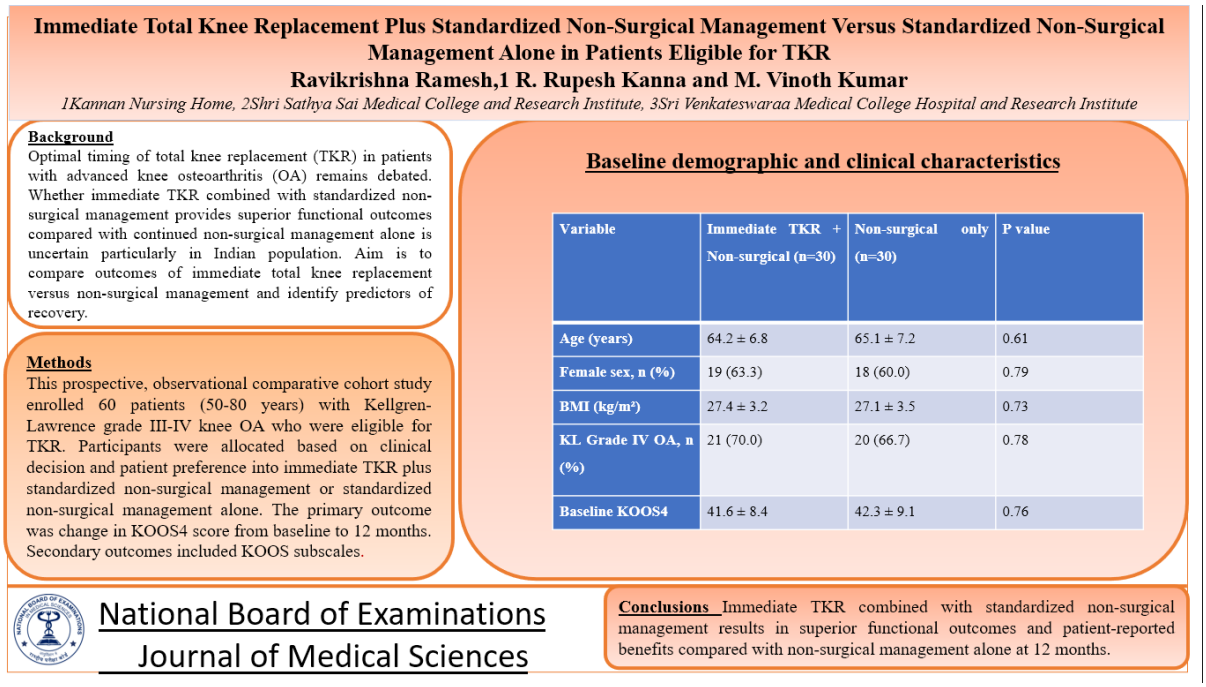
Graphical Abstract



Introduction

The most common cause of disability in the elderly population is osteoarthritis (OA) a degenerative joint disease affecting the cartilage and surrounding tissues [1,2]. All joints can be affected by OA however the knee is the most frequently affected (OA knee) followed by the hand and hip [3]. Globally 10% of men and 13% of women 60 years of age and older have symptomatic osteoarthritis in their knees [4]. For those older than 70 years the incidence rises to 40 percent and the prevalence of OA in older adults (>65 years) varies widely [17-60.6%] with rural areas having a higher point prevalence than urban areas according to data from community surveys conducted in both rural and urban areas of India [5-7]. OA knee symptoms include stiffness that gets better after activity and discomfort that becomes worse with use and gets better with rest. Physical examination reveal deformity, edema and crepitus [8]. A clinical and radiographic evaluation such as MRI, CT scan or X-ray is used to diagnose OA knee. The Kellgren Lawrence (KL) grading system can be used to classify OA knee into four classes based on radiological evidence. In general grade 1 refers to uncertain joint space narrowing, grade 2 to probable joint space narrowing and definite osteophytes, grade 3 to definite joint space narrowing and sclerosis, grade 4 to severe sclerosis, definite deformity and massive osteophytes [9]. Both conservative and surgical methods can be used to treat OA knee [10]. Physiotherapy and medications are part of conservative treatment for OA knee [11]. In terms of surgery total knee replacement (TKR) is a tried and true method of treating osteoarthritis of the knee that has been shown to significantly reduce symptoms resulting in significant patient satisfaction and an enhanced quality of life [12]. For a long time TKR has been used to treat OA knee. Over time there have been numerous advancements primarily in the quality of prostheses and surgical methods. Numerous publications have been

published that regularly highlight TKR's clinical efficacy and how it has changed over time [13,14]. The number of TKR procedures carried out in India rose from 25,215 in 2014-15 to 43,905 in 2018-19 indicating a growth rate of 13.22% according to the National Health Profile 2020. The age range of 60 to 69 years old has the highest number of TKR operations [15]. Although TKR has consistently shown improvement compared with pre-operative status there remains uncertainty whether immediate TKR combined with structured non-surgical management offers superior functional and patient reported outcomes compared with continuation of standardized non-surgical management alone. Delayed surgery may expose patients to persistent pain, reduced mobility and caregiver burden while early surgery involves cost and procedural risks. Establishing such evidence will help determine optimal timing of TKR, strengthen integrated care pathways and allow identification of predictors of recovery such as age, BMI, comorbidities, baseline range of motion and quadriceps strength. The objective of the present study is to evaluate the addition of immediate total knee replacement to a program of standardized non-surgical management results in better pain relief, physical function and health-related quality of life when compared with standardized non-surgical management alone among patients already considered eligible for TKR while also exploring baseline factors that predict recovery and in-hospital and post-trial adverse events.

Materials and Methods

Study Design

This investigation is designed as a prospective, observational comparative cohort study conducted in a single Ortho care hospital in Tamil Nadu, India. Participants were allocated based on clinical decision and patient preference into: either immediate TKR plus standardized non-surgical management (maximal intervention) or standardized non-surgical management alone (moderate intervention) was based on the shared decision-making between patient and treating surgeon, considering clinical indications, patient preference, and affordability.

Participants

Adult patients aged 50–80 years with symptomatic advanced knee osteoarthritis presenting to the Department of Orthopaedics will be screened for eligibility. Inclusion criteria will include: clinical eligibility for total knee replacement as determined by high-volume knee surgeons based on pain severity, functional limitation and radiographic findings, radiographic knee OA of Kellgren–Lawrence grade III or IV, mean knee pain during the previous week ≥40 mm on a 100-mm visual analogue scale and KOOS4 score ≤75. Exclusion criteria will comprise inflammatory arthritides, previous knee replacement on the index side, requirement for simultaneous bilateral TKR, active infection, severe cardiopulmonary or systemic illness precluding surgery, inability to comply with follow-up visits or unwillingness to participate. Written informed consent will be obtained from all eligible participants prior to enrollment.

Interventions

Participants in the surgical arm will undergo total knee replacement within two weeks using a standardized operative

technique by experienced arthroplasty surgeons. Postoperatively these participants will receive the same structured non-surgical program. The standardized non-surgical management will consist of 12 weeks of supervised exercise therapy focusing on neuromuscular control and muscle strengthening delivered in twice-weekly 60-minute group-based sessions, structured patient education on disease characteristics and self-help, individually fitted insoles with a 4° lateral wedge when indicated by the single-limb mini squat test, dietary counseling targeting at least 5% weight loss in patients with BMI ≥25 and stepwise analgesic optimization using paracetamol and NSAIDs if required. Participants in the non-surgical-only arm will receive this identical program without surgery. Monthly telephone booster contacts will support long-term adherence following the supervised period.

Outcome Measures

The primary outcome will be the between-group difference in change from baseline to 12-month follow-up in KOOS4, covering pain, symptoms, activities of daily living and knee-related quality of life (0–100, worst to best). Secondary outcom**es** will include individual KOOS subscales (including function in sport and recreation), Timed Up & Go test, 20-m walk test, knee range of motion, quadriceps strength, patient satisfaction, return to activities of daily living and adverse events such as wound complications, deep venous thrombosis, manipulation under anaesthesia, readmissions, revision surgery and mortality. Assessments will be conducted at baseline, discharge, 3 months, 6 months and 12 months in person by specifically trained blinded assessors.

Sample Size

The sample size was determined pragmatically at 60 participants (30 per group) consistent with previous study demonstrating that approximately 41 patients per arm were required to detect a 10-point difference in KOOS4 (SD 14) with 90% power and alpha 0.05. Considering feasibility and to generate preliminary Indian data, a total of 60 eligible patients will therefore be enrolled in the present study.

Statistical Analysis

All analyses will follow intention-to-treat principles. Continuous variables will be summarized as mean ± SD or median (IQR) depending on distribution. Between-group comparisons for KOOS4, TUG and 20-m walk test will be performed using linear mixed-effects models with patient and follow-up time and treatment arm as fixed factors. Categorical outcomes will be compared using chi-square accounting for clustering at the patient level. Multivariable linear regression was constructed to identify predictors of recovery and complications including age, sex, BMI, comorbidities, and baseline ROM. A two-sided p value ≤0.05 will be considered statistically significant. Data will be analysed using SPSS version 25 and Stata when required.

Results

Table 1. Baseline demographic and clinical characteristics

Variable	Immediate TKR + Non-surgical (n=30)	Non-surgical only (n=30)	P value
Age (years)	64.2 ± 6.8	65.1 ± 7.2	0.61
Female sex, n (%)	19 (63.3)	18 (60.0)	0.79
BMI (kg/m²)	27.4 ± 3.2	27.1 ± 3.5	0.73
KL Grade IV OA, n (%)	21 (70.0)	20 (66.7)	0.78
Baseline KOOS4	41.6 ± 8.4	42.3 ± 9.1	0.76

A total of 60 participants were involved in the study with 30 patients each in the immediate total knee replacement plus non-surgical management group and the non-surgical management only group. Table 1 baseline demographic and clinical characteristics of both groups were comparable. The mean age was 64.2 ± 6.8 years in the immediate TKR group versus 65.1 ± 7.2 years in the non-surgical group with no statistically significant difference between the two groups (p = 0.61). Female participants comprised 63.3% of the immediate TKR group and 60.0% of the non-surgical group (p = 0.79).

The mean BMI was no different between groups 27.4 ± 3.2 kg/m² vs 27.1 ± 3.5 kg/m²; p = 0.73. There was a similar percentage of patients with KL grade IV osteoarthritis in both groups: 70.0% of patients with immediate TKR, 66.7% in the non-surgical group, p = 0.78. Baseline knee-related symptoms, as measured by the KOOS4 score, were similar between the two groups: 41.6 ± 8.4 vs. 42.3 ± 9.1, p = 0.76.

Table 2. Change in KOOS4 score over time

Time point	Immediate TKR	Non-surgical	P value
Baseline	41.6 ± 8.4	42.3 ± 9.1	-
3 months	64.8 ± 9.2	50.7 ± 8.6	<0.001
6 months	71.9 ± 8.1	55.8 ± 9.4	<0.001
12 months	78.6 ± 7.4	60.9 ± 10.2	<0.001

The changes observed in knee-related measures over time, as calculated by the KOOS4 score are presented in Table 2. There was no significant difference observed between the baseline KOOS4 score of the immediate TKR group and the non-surgical group. In comparison to the non-surgical group, the immediate group

showed a significant difference in KOOS4 score at three months of follow-up (64.8 ± 9.2 vs. 50.7 ± 8.6, $p < 0.001$).

This difference was still significant at six months with a higher score of 71.9 ± 8.1 for the immediate TKR procedure and 55.8 ± 9.4 for the non-surgical procedure ($p < 0.001$). Patients who had the immediate TKR procedure still reported a superior score to the non-surgical procedure at a 12-month follow-up. These patients reported a higher score of 78.6 ± 7.4 as opposed to 60.9 ± 10.2 reported by the non-surgical procedure patients ($p < 0.001$). Patients with the immediate procedure reported a higher improvement in symptoms of the knee region throughout the whole of the follow-up procedure.

Table 3. Secondary functional outcomes at 12 months

Outcome	Immediate TKR	Non-surgical	P value
KOOS Pain	82.4 ± 7.1	64.5 ± 9.6	<0.001
KOOS ADL	79.6 ± 8.3	61.8 ± 10.4	<0.001
KOOS QoL	76.8 ± 9.2	58.1 ± 11.1	<0.001
TUG (s)	9.8 ± 1.6	12.4 ± 2.1	<0.001
20-m walk test (s)	18.6 ± 2.9	22.3 ± 3.4	<0.001

The secondary functional outcomes reported at 12 months are provided in Table 3. The outcomes reported by patients in the immediate total knee replacement (TKR) group were found to be significantly better than in the non-surgical management group. The KOOS Pain scores were higher in the immediate TKR group than in the non-surgical management group (82.4 ± 7.1 vs. 64.5 ± 9.6; $p < 0.001$). There were better outcomes in the KOOS ADL (Activities of Daily Living) scores (79.6 ± 8.3 vs. 61.8 ± 10.4; $p < 0.001$) and KOOS QoL (Quality of Life) scores (76.8 ± 9.2 vs. 58.1 ± 11.1; $p < 0.001$) in the immediate TKR group.

The objective functional measurements were also in favor of the immediate TKR group. The results of the timed-up-and-go test indicated that the mean time to complete the test was significantly shorter in the immediate TKR group as compared to the non-surgical group (9.8 ± 1.6 s vs. 12.4 ± 2.1 s, $p < 0.001$). The results of the 20-meter walk tests were also in favor of the immediate TKR group as the completion times were shorter in the TKR groups as compared to the non-surgical groups.

Table 4. Adverse events and complications

Event	Immediate TKR (n=30)	Non-surgical (n=30)
Surgical site infection	2 (6.7%)	0
Deep venous thrombosis	1 (3.3%)	0

Manipulation under anesthesia	2 (6.7%)	—
Hospital readmission	2 (6.7%)	1 (3.3%)
Mortality	0	0

Adverse events and complications of both groups during the study period are outlined in Table 4. In the immediate TKR group surgical site infection was seen in two patients (6.7%) and deep venous thrombosis occurred in one patient (3.3%). Two patients (6.7%) in the immediate TKR group required manipulation under anesthesia for postoperative stiffness. In the immediate TKR group two patients (6.7%) reported hospital readmission in the non-surgical management group there was one patient (3.3%). There was no record of mortality in either group during the study period.

Table 5. Predictors of good functional recovery (KOOS4 ≥75 at 12 months)

Predictor	Adjusted OR	95% CI	P value
Immediate TKR	4.32	1.68–11.14	0.002
Age <65 years	2.11	1.03–4.35	0.041
BMI <30 kg/m²	1.94	1.01–3.75	0.047
Baseline ROM ≥100°	2.76	1.29–5.91	0.009
No diabetes	2.23	1.08–4.60	0.030

Multivariable logistic regression analysis was also used to identify the predictor of good functional recovery which was determined as a KOOS4 score ≥75 at 12 months (Table 5). Immediate total knee replacement (TKR) surgery showed a significant association with a greater likelihood of good functional recovery (adjusted OR: 4.32, 95% CI: 1.68–11.14, p = 0.002). Patients who were <65 years old showed a significant likelihood of good functional recovery (adjusted OR: 2.11, 95% CI: 1.03–4.35, p = 0.041).

Lower body mass index (<30 kg/m²) was significantly related to good functional recovery (adjusted OR 1.94; 95% CI: 1.01-3.75; p = 0.047). A baseline knee range of motion of ≥100° was another predictor of functional recovery (adjusted OR 2.76; 95% CI: 1.29-5.91; p = 0.009). The lack of diabetes mellitus was independently related to functional outcomes at 12 months (adjusted OR 2.23; 95% CI: 1.08-4.60; p = 0.030).

Table 6. Within-group changes over time

Outcome	Group	Baseline	12 months	P value
KOOS4	**Immediate TKR**	41.6 ± 8.4	78.6 ± 7.4	<0.001
KOOS4	**Non-surgical**	42.3 ± 9.1	60.9 ± 10.2	<0.001
TUG (s)	**Immediate TKR**	14.8 ± 2.6	9.8 ± 1.6	<0.001
TUG (s)	**Non-surgical**	14.6 ± 2.5	12.4 ± 2.1	0.004

Within-group changes in functional outcomes from baseline to 12 months are given in Table 6. For the immediate total knee replacement group, there was a significant improvement in the KOOS4 score from baseline (41.6 ± 8.4) to 12 months (78.6 ± 7.4) ($p < 0.001$). Significant improvements in the KOOS4 score from baseline (42.3 ± 9.1) to 12 months (60.9 ± 10.2) in the non-surgical management group were observed ($p < 0.001$).

The objective functional performance as indicated by the Timed Up and Go test showed considerable improvement in both groups. For the immediate TKR group there was a significant reduction in the time taken to perform the Timed Up and Go test. This time decreased from 14.8 ± 2.6 seconds at baseline to 9.8 ± 1.6 seconds at the end of 12 months. The non-surgical group showed significant reductions in the time taken to perform the Timed Up and Go test. In the non-surgical group, the time taken to perform the Timed Up and Go test decreased from 14.6 ± 2.5 seconds to 12.4 ± 2.1 seconds at the end of 12 months.

Table 7. Between-group differences (mixed-effects model)

Outcome	Mean difference	95% CI	P value
KOOS4	+17.7	12.3–23.1	<0.001
TUG (s)	−2.6	−3.4–−1.8	<0.001
20-m walk (s)	−3.7	−4.8–−2.6	<0.001

To investigate the difference with regard to the functional outcomes, a mixed effect model was utilized the results of which are presented in Table 7. Patients from the immediate total knee replacement (TKR) group showed significant differences with regard to the KOOS4 results with a marked improvement of +17.7 on the score (95% CI: 12.3 to 23.1, $p < 0.001$).

There were also objective functional performance benefits for the immediate TKR group. The mean time taken by the participants to perform the Timed Up and Go (TUG) test was substantially lower in the immediate TKR group as compared to the non-surgical

group as revealed by the -2.6 seconds between-group difference (95% CI -3.4 to -1.8, $p < 0.001$). The results revealed that performance of the 20-meter walk test also reflected a significant between-group difference of -3.7 seconds (95% CI -4.8 to -2.6, $p < 0.001$).

Table 8. MCID achievement at 12 months

Outcome	Immediate TKR	Non-surgical	P value
KOOS4 ≥10	26 (86.7%)	14 (46.7%)	0.003
KOOS Pain ≥10	25 (83.3%)	13 (43.3%)	0.002
TUG ≥3 s improvement	22 (73.3%)	11 (36.7%)	0.006

Achievement of the minimal clinically important difference (MCID) in the 12-month follow-up is depicted in Table 8. A significantly higher percentage in the immediate total knee replacement group compared with the non-surgical intervention group achieved a clinically important improvement in the KOOS4 scores ≥ 10 points (86.7% vs. 46.7%, $p = 0.003$). Achievement of the minimal clinically important difference for the KOOS Pain scores ≥ 10 points showed a significant higher percentage in the non-surgical intervention group compared with the immediate total knee replacement group (83.3% vs. 43.3%, $p = 0.002$).

Functional improvement indicated by an increase of at least 3 seconds in the Timed Up and Go (TUG) test was also found in a substantially larger number of immediately TKR-treated patients compared to the non-surgically treated group (73.3% vs. 36.7%, $p = 0.006$).

Table 9. Patient satisfaction and functional recovery

Outcome	Immediate TKR	Non-surgical	P value
Satisfied/Very satisfied	24 (80.0%)	13 (43.3%)	0.004
Independent ADL	26 (86.7%)	18 (60.0%)	0.02
Outdoor walking	23 (76.7%)	15 (50.0%)	0.03

The patient self-report of satisfaction and functional recovery at 12 months is summarized in Table 9. A significantly greater proportion of patients treated with immediate TKR reported being satisfied or very satisfied with the treatment outcome than patients managed nonsurgically (80.0% vs. 43.3%, $p = 0.004$). Functional independence in ADL was achieved more frequently by patients who received immediate TKR compared to those managed nonsurgically (86.7% vs. 60.0%, $p = 0.02$).

The ability to walk outdoors independently was reported by a significantly higher number of patients in the early TKR group compared to the non-surgical group, at 76.7% versus 50.0% respectively (p = 0.03) representing better functional recovery among the patients who had early surgical intervention.

Table 10. Health-care utilization

Variable	Immediate TKR	Non-surgical	P value
Hospital stay (days)	7 (6–9)	2 (1–3)	<0.001
OPD visits	5.2 ± 1.4	6.8 ± 1.9	0.001
Analgesic use	6 (20.0%)	17 (56.7%)	0.004

The health care utilization outcomes are given in Table 10. Patients in the immediate total knee replacement group had a prolonged median length of hospital stay compared with the non-surgical intervention group. The median days of hospitalization in the immediate total knee replacement group were 7 days (interquartile range 6-9 days) compared with the non-surgical intervention group at 2 days (interquartile range 1-3 days) p < 0.001. The number of outpatient department visits in the non-surgical intervention group was statistically higher compared with the immediate total knee replacement intervention group with 6.8 ± 1.9 outpatient department visits compared with 5.2 ± 1.4.

The analgesic use rate at 12 months was found to be significantly higher in surgically managed cases than in immediately TKR-treated patients (56.7% vs. 20.0%, p = 0.004) suggesting that pain management needs were higher in the former despite their shorter hospital stay.

Table 11. Subgroup analysis: KOOS4 improvement

Subgroup	Immediate TKR	Non-surgical	Interaction P
Age <65	39.2 ± 10.1	20.4 ± 9.8	0.01
Age ≥65	32.8 ± 9.6	17.1 ± 8.7	0.03
BMI <30	38.4 ± 9.3	22.1 ± 10.4	0.02
BMI ≥30	30.6 ± 11.2	15.9 ± 9.1	0.04

A subgroup analysis of KOOS4 improvements at 12 months showed that there was a greater functional benefit associated with immediate TKR compared with non-surgical management at all prespecified subgroups (Table 11). When considering individuals under the age of 65 years there was a significant increase in mean KOOS4 improvement for those undergoing immediate TKR compared with non-surgical management (39.2 ± 10.1 vs. 20.4 ± 9.8). There was a significant

interaction (p = 0.01). When looking at subgroup analysis for those aged 65 years and above, there was significant increase in KOOS4 improvements for those undergoing immediate TKR compared with those undergoing non-surgical management (32.8 ± 9.6 vs. 17.1 ± 8.7), there was a significant interaction (p = 0.03).

For patients stratified based on body mass index (BMI) category with BMI <30 kg/m² where immediate TKR was performed these patients had superior improvement in KOOS4 when compared to those managed non-surgically (38.4 ± 9.3 vs. 22.1 ± 10.4, p value interaction = 0.02). In the BMI category ≥30 kg/m² better functional improvement was seen when immediate TKR was performed when compared to non-surgical management (30.6 ± 11.2 vs. 15.9 ± 9.1, p value interaction = 0.04).

Discussion

The prospective cohort study demonstrated immediate TKR plus non-surgical management to non-surgical management alone in patients with end stage knee osteoarthritis and reported significantly better functional and PROs for the immediate TKR group over a 12-month follow-up period. The results continue to add to the mounting evidence supporting early surgical intervention in carefully selected patients with end stage osteoarthritis.

The matching demographic and clinical data of the participants in both groups was comparable with regard to age, sex distribution, body mass index, Kellgren-Lawrence grade as well as baseline KOOS4 scores thus showing that there was group comparability reducing any effect of bias that would have otherwise been present due to demographic differences between the groups as has been demonstrated in previous studies on early versus late TKR surgery [16–18].

One of the significant findings of the present study was the enhanced degree of improvements with regard to the KOOS4 scores in the immediate TKR group as compared to the non-surgical group. At the end of 12 months the mean KOOS4 score for the immediate TKR group was found to be significantly higher compared to the non-surgical group. At the end of 12 months the mean KOOS4 scores for the immediate TKR and the non-surgical groups were 78.6 ± 7.4 and 60.9 ± 10.2 respectively. These findings align with the study by Skou et al. and Katz et al., who found significant improvements in pain, function and quality of life for patients undergoing early TKR compared with those receiving non-surgical management alone [19].

The increasing trend over time observed in the immediate TKR group points to the durability of the surgical benefit which has also been demonstrated in studies assessing the long-term follow-up of the results of TKR [20,21]. Though the non-surgical group demonstrated significant improvement the clinical inferiority of the result supports the proposition that non-surgical approaches alone may not be adequate for advanced osteoarthritis.

In terms of secondary outcomes such as KOOS pain, ADL and QoL a better outcome was observed in the immediate TKR group in these areas compared to other groups at 12 months. The functional outcomes of TU (Timed Up) and 20-m walk tests were also better in the immediate TKR group compared to other groups. The results are in accordance with previous studies, which have also shown that gait,

functional activities and functional independence improve with TKR [22–24].

Enhanced PBOs are of special significance for the elderly population, as mobility is heavily linked with the incidence of falls, disability and loss of independence. Previous studies have reported a significant reduction in TUG time after TKR suggesting enhanced neuromuscular control with improved functional stability [25].

Although the immediate TKR group had procedure-related complications such as surgical site infection, deep venous thrombosis and requirement of manipulation under anaesthesia overall complication rates were comparable to existing literature [26,27]. There was no mortality for either group, and the benefits seemed to outweigh the risks in appropriately selected patients. This is consistent with evidence that suggests that although TKR carries its inherent surgical risks, overall complication rates remain acceptable in modern practice [28].

Multivariable analysis revealed immediate TKR, age under 65 years, BMI <30 kg/m², superior preoperative ROM and absence of diabetes all to be highly significant modifiers of good functional outcome. Such predictors of satisfactory outcome have been noted previously in relation to TKR. In those studies, younger age at surgery, lower BMI, and fewer comorbid diseases correlated with postoperative outcome [29-31].

A notably larger percentage of patients in the immediate TKR group reached the MCID for KOOS4, KOOS pain and TUG improvement. The MCID was considered important because it represents clinically meaningful improvement from the patient's perspective. Previous studies have also identified higher MCID attainment rates following TKR compared to conservative therapy [32].

Patient satisfaction and functional independence were also significantly higher in the immediate TKR group. High satisfaction rates following TKR have constantly been reported in literature and are closely linked with pain relief, functional improvement and restored mobility [33,34].

Although the immediate TKR group had longer initial hospital stays, more visits were required with the non-surgical group. In the non-surgical group long-term analgesic consumption was higher. This is in agreement with previous studies that suggested that prolonged time to surgical intervention might produce cumulative healthcare expenditures and analgesic dependence [35]. Definitive surgical intervention reduces overall healthcare costs in the long term despite higher overall cost during the acute period.

Further subgroup analysis showed that immediate TKR was associated with better improvement in KOOS4 across all categories of age and BMI. These results support the existing literature, which indicates that the benefits of TKR apply across all groups though the magnitude of improvement may vary [36,37].

Conclusion

This prospective comparative cohort study suggests that immediate total knee replacement combined with standardized non-surgical management leads to significantly greater improvements in pain relief, physical function, quality of life and objective mobility outcomes compared with standardized non-surgical management alone in patients eligible for TKR. The benefits were clinically meaningful, sustained over 12 months and

accompanied by higher patient satisfaction and functional independence. Although surgery was associated with procedure-related complications and longer initial hospitalization overall adverse events were acceptable and consistent with contemporary arthroplasty literature. Immediate TKR emerged as the strongest independent predictor of good functional recovery, alongside younger age, lower BMI, better baseline knee range of motion and absence of diabetes. These findings support early surgical intervention in carefully selected patients with advanced knee osteoarthritis rather than prolonged conservative management. Integrating patient selection criteria with standardized perioperative non-surgical care may optimize outcomes and guide evidence-based decision-making regarding the timing of total knee replacement

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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