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Research Article

Predictors of Post-Operative Functional Outcomes Following Total Knee Replacement

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ABSTRACT
Background: Total knee replacement (TKR) is an effective surgical intervention for advanced knee osteoarthritis, providing substantial pain relief and functional improvement. However, postoperative recovery varies among patients due to demographic, clinical, and preoperative functional factors. Identifying predictors of functional outcomes may help optimize patient selection and rehabilitation strategies.
Objectives: To evaluate postoperative functional outcomes following total knee replacement and identify demographic and clinical factors associated with functional recovery.
Methods: This prospective observational study included 90 patients undergoing primary total knee replacement for advanced knee osteoarthritis. Demographic characteristics, body mass index (BMI), comorbidities, radiographic severity, and preoperative knee range of motion were assessed. Functional outcomes were evaluated using the Knee Society Score (KSS), Visual Analogue Scale (VAS), and knee flexion measurements at baseline, six weeks, three months, and six months postoperatively.
Results: The majority of patients were females (64.4%), and 42.2% belonged to the 60–69-year age group. The mean Knee Society Knee Score improved from 42.6 ± 10.4 to 86.8 ± 8.6, while the Function Score increased from 38.4 ± 11.2 to 82.6 ± 10.3 ($p<0.001$). Mean VAS pain score decreased from 7.6 ± 1.1 to 1.8 ± 0.9. At six months, 84.4% achieved good-to-excellent functional outcomes. Younger age, lower BMI, absence of diabetes, and better preoperative knee flexion showed favorable descriptive associations with postoperative function.
Conclusion: Total knee replacement demonstrated substantial functional improvement and pain reduction. Preoperative clinical assessment and optimization of modifiable risk factors may help improve postoperative recovery and patient outcomes.

Keywords: Total Knee Replacement, Knee Osteoarthritis, Functional Outcomes, Knee Society Score, Body Mass Index, Predictors, Postoperative Recovery.

INTRODUCTION
Osteoarthritis (OA) of the knee is one of the most common degenerative joint disorders and a major cause of chronic pain, disability, and reduced quality of life worldwide. With increasing life expectancy, population ageing, and rising obesity rates, the burden of knee osteoarthritis continues to increase [1]. Knee osteoarthritis accounts for a substantial proportion of the global osteoarthritis burden and is characterized by progressive articular cartilage degeneration, joint stiffness, deformity, pain, and functional limitations [2]. Advanced disease significantly affects daily activities, including walking, stair climbing, and rising from a seated position, often necessitating surgical intervention.Total knee replacement (TKR), also known as total knee arthroplasty (TKA), is an established surgical treatment for advanced knee osteoarthritis when conservative management fails to provide adequate symptomatic relief. The procedure aims to alleviate pain, restore joint mobility, correct deformity, and improve functional independence. Despite advances in surgical techniques, implant design, and rehabilitation protocols, postoperative functional recovery remains variable [3,4]. Approximately one in eight patients experiences persistent knee pain one year after surgery, while a considerable proportion continues to report functional limitations and difficulty performing daily

activities during the postoperative period [5–7].Postoperative functional outcomes following TKR are influenced by multiple patient-related, clinical, and perioperative factors[8]. Age, sex, body mass index (BMI), duration and severity of osteoarthritis, preoperative pain, baseline functional status, knee range of motion (ROM), and associated comorbidities have been investigated as potential predictors of recovery. Advanced age, obesity, poor preoperative mobility, reduced muscle strength, and chronic medical conditions may adversely affect rehabilitation and functional improvement. However, the predictive significance of these factors remains inconsistent across studies [9,10].Preoperative knee ROM and functional status are particularly important determinants of postoperative recovery[11]. Restricted knee flexion, fixed deformities, and severe preoperative disability may limit functional improvement despite successful surgery. Adequate knee flexion is essential for walking, stair negotiation, and sitting comfortably. Postoperative stiffness and restricted ROM may therefore contribute to persistent disability and patient dissatisfaction [12,13]. Additionally, postoperative pain control, early mobilization, physiotherapy, and adherence to rehabilitation protocols play important roles in achieving satisfactory functional outcomes[14].Assessment of postoperative recovery using standardized scoring systems, such as the Knee Society Score (KSS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and Oxford Knee Score (OKS), enables objective evaluation of pain relief, mobility, and functional improvement[15].Identifying reliable predictors of postoperative functional outcomes is essential for improving patient selection, preoperative counselling, risk stratification, and individualized rehabilitation strategies. Therefore, the present study aims to evaluate the demographic, clinical, and preoperative functional factors associated with postoperative outcomes following total knee replacement and identify significant predictors of functional recovery, thereby contributing to improved patient management and surgical outcomes.

MATERIALS AND METHODS

This study was designed as a hospital-based prospective observational study to evaluate the predictors of postoperative functional outcomes among patients undergoing total knee replacement (TKR).The study was conducted in the Department of Orthopaedics at a tertiary care hospital. Patients undergoing primary total knee replacement for advanced knee osteoarthritis were enrolled and followed up to assess postoperative functional recovery.The study was conducted over a period of 18 months, including patient recruitment, preoperative evaluation, surgical intervention, postoperative follow-up, and data analysis.A total of 90 patients undergoing primary total knee replacement were included in the study.

Study Population

The study population comprised adult patients diagnosed with advanced primary osteoarthritis of the knee who underwent primary total knee replacement at the study institution.

Inclusion Criteria

1. Patients aged 40 years and above.
2. Patients diagnosed with advanced primary osteoarthritis of the knee.
3. Patients undergoing primary unilateral total knee replacement.
4. Patients willing to provide written informed consent.
5. Patients willing to participate in scheduled postoperative follow-up assessments.

Exclusion Criteria

1. Patients undergoing revision total knee replacement.
2. Patients with secondary osteoarthritis due to inflammatory arthritis, trauma, or infection.
3. Patients with previous major surgery involving the affected knee.
4. Patients with neurological or neuromuscular disorders significantly affecting mobility.
5. Patients with severe medical conditions preventing postoperative rehabilitation.
6. Patients who declined participation or were unwilling to attend follow-up assessments.

Study Procedure

Preoperative Assessment

All enrolled patients underwent a detailed clinical evaluation before surgery. Demographic characteristics, including age, sex, height, weight, and body mass index (BMI), were recorded. Relevant clinical information, including duration of knee pain, duration of osteoarthritis, affected side, associated medical comorbidities, and previous treatment history, was documented.A comprehensive musculoskeletal examination of the affected knee was performed. Preoperative pain intensity was assessed using the Visual Analogue Scale (VAS). Knee range of motion (ROM) was measured using a standard

goniometer, and the presence of fixed flexion deformity or varus/valgus deformity was documented.Preoperative functional status was assessed using the Knee Society Score (KSS), which included evaluation of knee pain, stability, range of motion, walking ability, and stair-climbing capacity.Standard anteroposterior and lateral radiographs of the affected knee were obtained. Radiographic severity of osteoarthritis was assessed using the Kellgren–Lawrence grading system.

Surgical Procedure

All patients underwent primary total knee replacement performed by experienced orthopaedic surgeons using standard surgical techniques. The procedure involved resection of the damaged articular surfaces, appropriate soft-tissue balancing, correction of deformity, and implantation of suitable prosthetic components.The surgical approach, implant selection, and intraoperative management were determined according to institutional protocols and individual patient requirements. Intraoperative complications, if any, were recorded.

Postoperative Management and Rehabilitation

Following surgery, patients received standard postoperative care, including analgesia, antibiotic prophylaxis, thromboprophylaxis, and wound management according to institutional protocols.Early mobilization and physiotherapy were initiated as clinically appropriate. Rehabilitation included quadriceps-strengthening exercises, ankle-pump exercises, active and assisted knee movements, gait training, and progressive weight-bearing activities.Patients were encouraged to continue prescribed exercises after discharge. Postoperative complications, including wound infection, stiffness, thromboembolic events, and other adverse outcomes, were documented.

Postoperative Follow-up and Outcome Assessment

Patients were evaluated at the following intervals:

- Preoperatively (baseline)
- Six weeks postoperatively
- Three months postoperatively
- Six months postoperatively

At each follow-up visit, clinical and functional assessments were performed using standardized evaluation methods.

Assessment of Pain

Postoperative pain intensity was assessed using the Visual Analogue Scale (VAS), ranging from 0 (no pain) to 10 (worst imaginable pain). Changes in pain scores from baseline were recorded.

Assessment of Knee Range of Motion

Knee flexion and extension were measured using a standard goniometer. The presence of postoperative stiffness, extension lag, and flexion limitations was documented.

Assessment of Functional Outcomes

Functional recovery was evaluated using the Knee Society Score (KSS). The assessment included knee pain, stability, range of motion, walking distance, stair-climbing ability, and the requirement for walking aids.Changes in functional scores between preoperative and postoperative assessments were calculated to determine the magnitude of functional improvement.

Study Variables

Independent Variables

The following variables were evaluated as potential predictors of postoperative functional outcomes:

1. Age
2. Sex
3. Body mass index (BMI)
4. Duration of osteoarthritis
5. Preoperative pain severity
6. Preoperative knee range of motion
7. Preoperative Knee Society Score
8. Radiographic severity of osteoarthritis (Kellgren–Lawrence grade)
9. Presence of medical comorbidities, including diabetes mellitus and hypertension
10. Preoperative knee deformity

Dependent Variables

The primary outcome was postoperative functional status assessed using the Knee Society Score at six months.Secondary outcome measures included postoperative pain intensity, knee range of motion, improvement in functional scores from baseline, and postoperative complications.

Data Collection

Data were collected using a structured case record form. Demographic characteristics, clinical findings, radiographic assessments, operative details, and postoperative outcomes were recorded systematically.Each patient was assigned a unique study identification number to maintain confidentiality. The collected information was entered into a computerized database for statistical analysis.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS.27 statistical software. Continuous variables were expressed as mean ± standard deviation (SD) for normally distributed data and median with interquartile range (IQR) for non-normally distributed data. Categorical variables were presented as frequencies and percentages.The Shapiro–Wilk test was used to assess normality. The independent samples t-test or Mann–Whitney U test was used to compare continuous variables between two independent groups, while one-way analysis of variance (ANOVA) or the Kruskal–Wallis test was used for comparisons involving more than two groups, as appropriate. Categorical variables were compared using the Chi-square test or Fisher's exact test.Changes in functional scores and knee range of motion between preoperative and postoperative assessments were analyzed using paired t-tests or Wilcoxon signed-rank tests, as appropriate. Repeated-measures ANOVA or the Friedman test was used to assess changes across multiple follow-up intervals.Pearson's or Spearman's correlation analysis was performed to examine associations between continuous predictors and postoperative functional outcomes.Univariable linear regression analysis was performed to identify potential predictors of six-month postoperative KSS. Clinically relevant variables and variables showing significant associations in univariable analysis were considered for multivariable linear regression to identify independent predictors, subject to model assumptions and sample-size limitations. Regression coefficients with 95% confidence intervals were reported.A p-value less than 0.05 was considered statistically significant.

RESULTS

Table 1 presents the demographic characteristics of the 90 patients who underwent total knee replacement. The majority of patients belonged to the 60–69 years age group (42.2%), followed by 50–59 years and ≥70 years (24.4% each), while 8.9% were aged 40–49 years. Female patients predominated (64.4%) compared with males (35.6%). Regarding BMI, 46.7% of patients were overweight, 31.1% were obese, and 22.2% had a normal BMI. The right knee was affected in 53.3% of patients, while the left knee was affected in 46.7%.Table 2 summarizes the preoperative clinical characteristics of the study participants. Most patients (51.1%) had experienced knee symptoms for 5–10 years, followed by 26.7% with symptoms lasting less than 5 years and 22.2% with symptoms exceeding 10 years. Kellgren–Lawrence grade IV osteoarthritis was observed in 60.0% of patients, while 40.0% had grade III disease. Varus deformity was the most common preoperative deformity (73.3%), followed by valgus deformity (15.6%). Hypertension was present in 42.2% of patients, while 28.9% had diabetes mellitus. Preoperative knee flexion was ≥90° in 57.8% of patients, whereas 42.2% had flexion below 90°.Table 3 demonstrates significant improvements in clinical and functional outcomes following total knee replacement. The mean Knee Society Knee Score increased from 42.6 ± 10.4 preoperatively to 86.8 ± 8.6 at six months postoperatively ($p<0.001$). Similarly, the mean Knee Society Function Score improved from 38.4 ± 11.2 to 82.6 ± 10.3 ($p<0.001$). The mean VAS pain score decreased significantly from 7.6 ± 1.1 to 1.8 ± 0.9 ($p<0.001$). Mean knee flexion also increased from 88.4 ± 12.6° to 112.8 ± 11.4° ($p<0.001$). These improvements are illustrated in Figure 1, demonstrating substantial postoperative pain relief and functional recovery.Table 4 illustrates the progressive improvement in functional outcomes at different postoperative follow-up intervals. The mean Knee Society Knee Score increased from 42.6 ± 10.4 preoperatively to 68.4 ± 10.2 at six weeks, 79.6 ± 9.4 at three months, and 86.8 ± 8.6 at six months. Similarly, the mean Knee Society Function Score improved from 38.4 ± 11.2 preoperatively to 58.6 ± 12.4, 72.8 ± 11.6, and 82.6 ± 10.3 at the respective follow-up intervals. The mean VAS pain score progressively decreased from 7.6 ± 1.1 preoperatively to 4.2 ± 1.2 at six weeks, 2.8 ± 1.0 at three months, and 1.8 ± 0.9 at six months. Mean knee flexion increased from 88.4 ± 12.6° preoperatively to 112.8 ± 11.4° at six months, indicating continuous functional recovery throughout the postoperative period.Table 5 presents the distribution of patients according to their functional outcomes at six months following total knee replacement. Excellent functional outcomes, defined as a Knee Society Function Score of 80–100, were observed in 52 patients (57.8%), while 24 patients (26.7%) achieved good outcomes. Fair outcomes were observed in 10 patients (11.1%), and only 4 patients (4.4%) had poor functional outcomes. Overall, 76 patients

(84.4%) achieved good-to-excellent functional outcomes. The distribution of postoperative functional outcomes is illustrated in Figure 2, highlighting the predominance of favorable functional recovery at six months.

Table 6 presents the association between patient characteristics and postoperative functional outcomes at six months. Patients younger than 60 years had a higher mean Knee Society Function Score (86.4 ± 8.6) compared with those aged ≥60 years (80.7 ± 10.6). Male patients demonstrated a slightly higher mean functional score (83.8 ± 9.8) than female patients (81.9 ± 10.6). Patients with BMI below 30 kg/m² had better functional scores (85.2 ± 9.0) compared with obese patients (76.8 ± 10.8). Similarly, patients without diabetes mellitus had higher mean functional scores (84.3 ± 9.5) than those with diabetes (78.4 ± 11.2). Patients with preoperative knee flexion ≥90° demonstrated better postoperative functional outcomes (86.3 ± 8.4) compared with those with flexion below 90° (77.6 ± 10.8). Furthermore, patients with Kellgren–Lawrence grade III osteoarthritis had higher functional scores (85.4 ± 9.2) than those with grade IV disease (80.7 ± 10.6). These differences are illustrated in Figure 3, suggesting that younger age, lower BMI, absence of diabetes, better preoperative knee flexion, and lower radiological disease severity may be associated with improved postoperative functional outcomes.

Table 1. Distribution of Patients According to Demographic Characteristics (N = 90)

Parameter	Number (n)	Percentage (%)
Age group (years)		
40–49	8	8.9
50–59	22	24.4
60–69	38	42.2
≥70	22	24.4
Sex		
Male	32	35.6
Female	58	64.4
BMI category (kg/m²)		
Normal (18.5–24.9)	20	22.2
Overweight (25.0–29.9)	42	46.7
Obese (≥30)	28	31.1
Affected knee		
Right	48	53.3
Left	42	46.7

Table 2. Distribution of Patients According to Preoperative Clinical Characteristics (N = 90)

Parameter	Number (n)	Percentage (%)
Duration of knee symptoms		
<5 years	24	26.7
5–10 years	46	51.1
>10 years	20	22.2
Kellgren–Lawrence grade		
Grade III	36	40.0
Grade IV	54	60.0
Preoperative deformity		
Varus	66	73.3
Valgus	14	15.6
No significant deformity	10	11.1
Medical comorbidities		
Diabetes mellitus	26	28.9
Hypertension	38	42.2
Preoperative knee flexion		
<90°	38	42.2
≥90°	52	57.8

Table 3. Comparison of Preoperative and Postoperative Functional Outcomes (N = 90)

Parameter	Preoperative Mean ± SD	6 Months Postoperative Mean ± SD	p-value
Knee Society Knee Score	42.6 ± 10.4	86.8 ± 8.6	<0.001
Knee Society Function Score	38.4 ± 11.2	82.6 ± 10.3	<0.001
VAS pain score	7.6 ± 1.1	1.8 ± 0.9	<0.001
Knee flexion (degrees)	88.4 ± 12.6	112.8 ± 11.4	<0.001

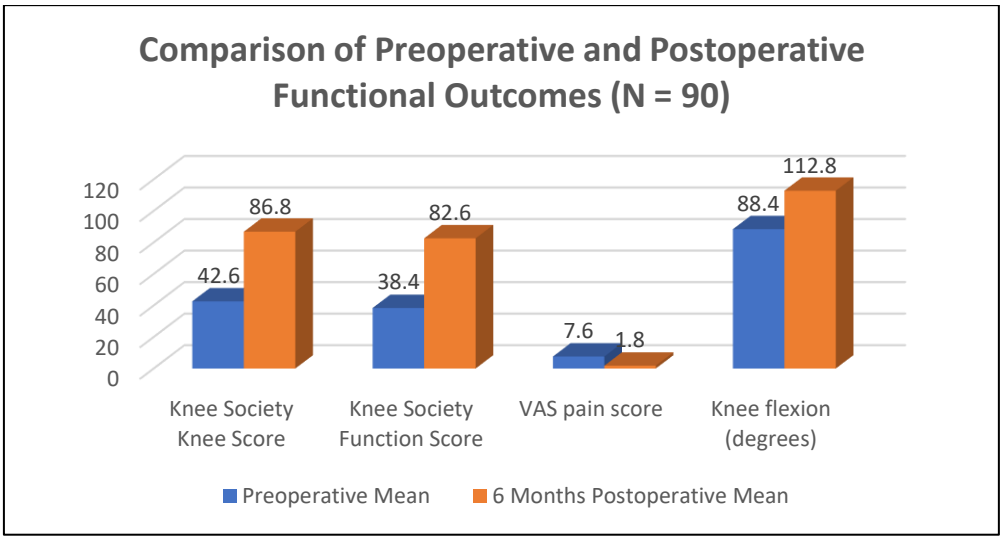

Figure 1 Comparison of Preoperative and Postoperative Functional Outcomes (N = 90)

Table 4. Functional Recovery at Different Postoperative Follow-up Intervals (N = 90)

Parameter	Preoperative	6 Weeks	3 Months	6 Months
Knee Society Knee Score	42.6 ± 10.4	68.4 ± 10.2	79.6 ± 9.4	86.8 ± 8.6
Knee Society Function Score	38.4 ± 11.2	58.6 ± 12.4	72.8 ± 11.6	82.6 ± 10.3
VAS pain score	7.6 ± 1.1	4.2 ± 1.2	2.8 ± 1.0	1.8 ± 0.9
Knee flexion (degrees)	88.4 ± 12.6	96.8 ± 12.4	105.6 ± 11.8	112.8 ± 11.4

Table 5. Distribution of Patients According to Postoperative Functional Outcome at Six Months (N = 90)

Functional outcome (Knee Society Function Score)	Number (n)	Percentage (%)
Excellent (80–100)	52	57.8
Good (70–79)	24	26.7
Fair (60–69)	10	11.1
Poor (<60)	4	4.4
Total	90	100.0

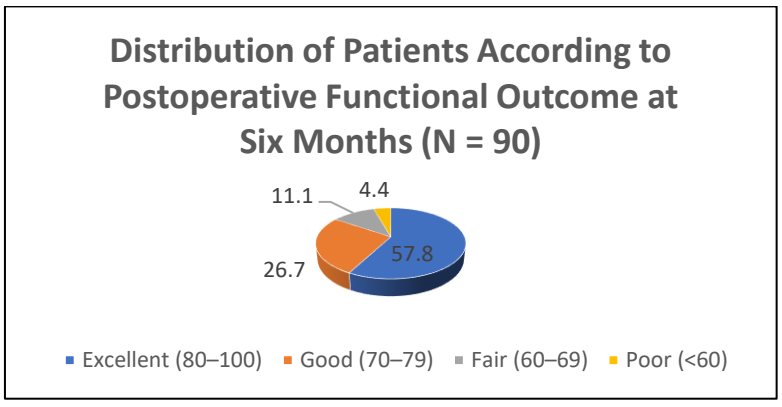

Figure 2 Distribution of Patients According to Postoperative Functional Outcome at Six Months (N = 90)

Table 6. Association of Patient Characteristics with Six-Month Postoperative Functional Outcome (N = 90)

Predictor	Category	n	Mean Function Score ± SD
Age (years)	<60	30	86.4 ± 8.6
	≥60	60	80.7 ± 10.6
Sex	Male	32	83.8 ± 9.8
	Female	58	81.9 ± 10.6
BMI (kg/m²)	<30	62	85.2 ± 9.0
	≥30	28	76.8 ± 10.8
Diabetes mellitus	Present	26	78.4 ± 11.2
	Absent	64	84.3 ± 9.5
Preoperative knee flexion	<90°	38	77.6 ± 10.8
	≥90°	52	86.3 ± 8.4
K–L grade	III	36	85.4 ± 9.2
	IV	54	80.7 ± 10.6

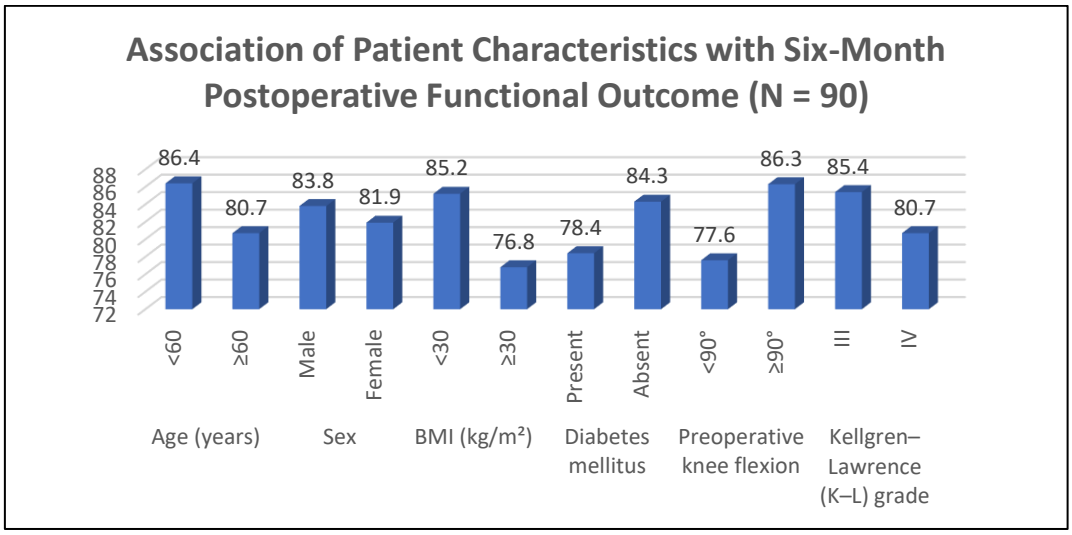

Figure 3 Association of Patient Characteristics with Six-Month Postoperative Functional Outcome (N = 90)

DISCUSSION

The present study evaluated the predictors of postoperative functional outcomes following total knee replacement (TKR) among 90 patients. The majority belonged to the 60–69-year age group (42.2%), and females constituted 64.4% of the study population. Overweight and obese patients accounted for 46.7% and 31.1%, respectively. These findings were comparable to a South Indian prospective study involving 185 patients, of whom 115 (62.2%) were females and 100 (54.1%) belonged to the 56–65-year age group. The predominance of elderly and female patients in both studies reflects the demographic characteristics commonly observed among patients undergoing TKR for advanced osteoarthritis. In the present study, substantial improvement was observed in postoperative functional outcomes. The mean Knee Society Knee Score increased from 42.6 ± 10.4 preoperatively to 86.8 ± 8.6 at six months, while the Knee Society Function Score improved from 38.4 ± 11.2 to 82.6 ± 10.3 (both $p<0.001$). Similarly, the mean VAS pain score decreased from 7.6 ± 1.1 to 1.8 ± 0.9, and knee flexion improved from 88.4° ± 12.6° to 112.8° ± 11.4°. These findings were consistent with a prospective study involving 63 patients and 100 operated knees, which demonstrated significant improvements in Knee Society Scores, functional scores, and pain outcomes across BMI categories during one-year follow-up ($p<0.001$). At six months, 52 patients (57.8%) in the present study achieved excellent functional outcomes, while 24 (26.7%) achieved good outcomes. Overall, 84.4% demonstrated good-to-excellent functional recovery. However, 15.6% continued to experience fair or poor functional outcomes, highlighting the variability in postoperative recovery. A systematic review and meta-analysis involving 20 studies and 11,317 patients reported that more than 20% of patients may not experience improved physical function following TKA, emphasizing the

importance of identifying predictors of unsatisfactory recovery. Age and BMI appeared to influence postoperative functional recovery. Patients younger than 60 years had a higher mean Function Score than those aged ≥60 years (86.4 ± 8.6 versus 80.7 ± 10.6). Similarly, patients with BMI <30 kg/m² demonstrated better functional scores than obese patients (85.2 ± 9.0 versus 76.8 ± 10.8). These findings were supported by Singh et al.[16], who evaluated 4,701 TKRs at two years and 2,935 TKRs at five years and identified older age, higher BMI, and comorbidity burden as predictors of postoperative functional limitations. The influence of obesity was further supported by Guarav et al. (2024)[17], who reported one-year postoperative functional scores of 71.17 among patients with BMI <25 kg/m² compared with 51.7 among those with BMI >25 kg/m². Similarly, Olsen et al. (2022)[10] reported a negative correlation between BMI and postoperative physical function (r = −0.15; 95% CI −0.24 to −0.05). Preoperative knee mobility and comorbidities also appeared relevant. Patients with preoperative flexion ≥90° achieved higher mean functional scores than those with flexion <90° (86.3 ± 8.4 versus 77.6 ± 10.8). Patients without diabetes demonstrated better outcomes than those with diabetes (84.3 ± 9.5 versus 78.4 ± 11.2). Cooper et al. (2017)[18] similarly identified age, BMI, and psychological factors as predictors of different dimensions of postoperative function.

CONCLUSION

Total knee replacement resulted in substantial improvement in pain, knee mobility, and functional outcomes, with 84.4% of patients achieving good-to-excellent functional recovery at six months. The mean Knee Society Function Score improved from 38.4 ± 11.2 to 82.6 ± 10.3 ($p<0.001$). Younger age, lower BMI, absence of diabetes mellitus, and better preoperative knee flexion were associated descriptively with favorable postoperative outcomes. These findings highlight the importance of preoperative assessment, optimization of modifiable risk factors, and individualized rehabilitation to improve functional recovery following total knee replacement.

Limitations

The study was limited by its relatively small sample size of 90 patients and single-centre design, which may restrict the generalizability of the findings. The follow-up period of six months was insufficient to assess long-term functional outcomes and implant-related complications. Potential confounding factors, including psychological status, rehabilitation adherence, and variations in surgical techniques, were not comprehensively evaluated. Additionally, the observational design limited the ability to establish causal relationships between predictive factors and postoperative functional outcomes.

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