RESEARCH PAPER

Functional Outcomes Following Revision of Total Knee Arthroplasty in Elderly Patients: A Cross-Sectional Study at a Tertiary Care Centre

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ABSTRACT

Background: Revision total knee arthroplasty (rTKA) is a technically demanding procedure associated with less predictable functional recovery than primary TKA. Outcomes may be influenced by advanced age, comorbidities, indication for revision, bone loss, implant constraint and postoperative complications. Evidence regarding functional outcomes of rTKA among elderly Indian patients remains limited. **Aim:** To assess functional outcomes following revision total knee arthroplasty among elderly patients treated at a tertiary care centre. **Materials and Methods:** This hospital-based cross-sectional observational study included 120 patients aged ≥60 years who had undergone revision TKA and completed a minimum postoperative follow-up of six months. Patients were selected consecutively. Demographic characteristics, comorbidities, indication and type of revision, implant constraint, bone loss and postoperative complications were recorded. Outcomes were assessed using the Knee Society Clinical Score, Knee Society Functional Score, WOMAC score, pain score, knee range of motion, ambulatory status and patient satisfaction. A Knee Society functional score ≥70 was considered a satisfactory outcome. Continuous variables were compared using paired or independent-samples tests, while categorical variables were analysed using the chi-square or Fisher's exact test. Effect estimates were reported with 95% confidence intervals, and $p<0.05$ was considered statistically significant. **Results:** The mean age was 69.33±6.02 years, and 69 (57.5%) patients were female. Overall, 83 patients achieved satisfactory outcomes, corresponding to 69.2% (95% CI: 60.4%-76.7%). The mean Knee Society Clinical Score increased from 41.73±10.84 to 75.07±13.95, and the functional score increased from 36.58±12.47 to 69.53±16.20 (both $p<0.001$). The WOMAC score decreased from 68.42±13.91 to 32.83±15.31, while knee range of motion increased from 73.64±16.28° to 98.13±18.22° (both $p<0.001$). Pain scores decreased from 7.32±1.18 to 2.71±1.43 ($p<0.001$). Age ≥70 years, obesity, diabetes, Charlson Comorbidity Index ≥2 and ASA grade III were associated with reduced odds of satisfactory function. Periprosthetic joint infection, two-stage revision, rotating-hinge reconstruction, severe bone loss and postoperative complications were also significantly associated with unsatisfactory outcomes. Overall, 94 (78.3%) patients were satisfied or very satisfied. **Conclusion:** Revision TKA produced substantial improvements in pain, mobility and knee function in most elderly patients, with approximately seven out of ten attaining satisfactory outcomes. Advanced age, greater medical comorbidity, infection, severe bone loss, complex reconstruction and postoperative complications were associated with poorer function. Comprehensive preoperative optimisation, appropriate reconstructive planning and structured rehabilitation are important for improving outcomes in this population.

KEYWORDS: Revision total knee arthroplasty; Knee Society Score; Functional outcome.

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INTRODUCTION

Total knee arthroplasty (TKA) is an established surgical procedure for relieving pain, correcting deformity and improving mobility in patients with advanced degenerative or inflammatory knee disease. Despite improvements in implant design, surgical technique and perioperative care, a proportion of primary knee replacements eventually fail and require revision total knee arthroplasty (rTKA). The number of revision procedures is expected to increase because of the growing volume of primary TKA, longer life expectancy and greater functional expectations among elderly individuals. Common indications for revision include aseptic loosening, periprosthetic joint infection, instability, polyethylene wear, stiffness, malalignment, periprosthetic fracture and implant failure [1,2].

Revision TKA is technically more demanding than primary arthroplasty because it frequently involves bone loss, ligamentous insufficiency, distorted anatomy, compromised soft tissues and the need for constrained implants, stems, augments or metaphyseal fixation. Patients undergoing revision are also more likely to have prolonged operative time, greater blood loss, slower rehabilitation and increased risk of complications. These challenges are particularly relevant in elderly patients, who commonly have multiple comorbidities, reduced physiological reserve, sarcopenia, osteoporosis and limited preoperative mobility. Consequently, chronological age alone may not adequately predict postoperative recovery, and functional outcomes should be evaluated together with comorbidity burden, indication for revision and surgical complexity.

Available evidence indicates that revision TKA generally reduces pain and improves knee function; however, the magnitude of improvement and patient satisfaction are usually lower and less predictable than those observed after primary TKA [1,3]. Lee et al. reported improvement in clinical and functional outcomes following revision TKA, while emphasising the adverse influence of infection on prognosis [2]. Verbeek et al. demonstrated that age, preoperative functional status, indication for revision and severity of bone defects were important predictors of functional outcome [4]. In a large patient-reported outcome study, Sabah et al. found clinically meaningful improvements in pain and function after revision TKA, although considerable variation existed among individual patients [5].

Functional outcome assessment after revision TKA should therefore incorporate objective clinical examination and patient-reported measures. The Knee Society Score (KSS) evaluates pain, stability, range of motion, walking ability and stair climbing, whereas the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) assesses pain, stiffness and physical-function limitations. Range of motion, ambulatory status, use of walking aids, postoperative complications and patient satisfaction provide additional clinically relevant information.

AIM

To assess the functional outcomes following revision total knee arthroplasty among elderly patients treated at a tertiary care centre.

OBJECTIVES

1. To determine postoperative knee pain, function, range of motion and ambulatory status among elderly patients following revision TKA.
2. To classify functional outcomes using the Knee Society Score and WOMAC score.
3. To evaluate the association of functional outcomes with patient characteristics, comorbidities, indication for revision, type of revision and postoperative complications.

MATERIALS AND METHODOLOGY

Source of Data

Data were obtained from elderly patients who had undergone revision TKA and attended the Orthopaedics outpatient department during the study period. Relevant demographic, clinical, operative and postoperative information was supplemented from inpatient records, operative notes, discharge summaries, radiographs and follow-up records.

Study Design

A hospital-based cross-sectional observational study was conducted. Each eligible participant was assessed once during the study period for functional and clinical outcomes following revision TKA.

Study Location

The study was conducted in the Department of Orthopaedics at tertiary care teaching hospital providing primary and revision joint-replacement services.

Study Duration

The study was conducted over 18 months, following approval from the Institutional Ethics Committee.

Study Population

The study population consisted of elderly patients aged 60 years or above who had undergone unilateral or bilateral revision TKA at least six months before functional assessment and attended the study centre during the specified period.

Sample Size

A total of 120 eligible patients were included. The sample size was calculated using the formula for estimating a single proportion:

$$n = \frac{Z^2_{1-\alpha/2} \times p(1-p)}{d^2}$$

where:

- n= minimum required sample size

- $Z_{1-\alpha/2} = 1.96$at a 95% confidence level
- p= anticipated proportion of patients with satisfactory functional outcome
- d= permissible absolute error

Assuming that approximately 70% of patients would have a satisfactory functional outcome:

$$n = \frac{(1.96)^2 \times 0.70 \times 0.30}{(0.085)^2} = 111.68$$

After allowing for approximately 7% incomplete or unavailable observations, the final sample size was rounded to 120 patients.

Sampling Technique

Consecutive sampling was employed. Every eligible patient who attended the department during the study period was approached and enrolled until the required sample size of 120 was attained.

Inclusion Criteria

1. Patients aged 60 years or above.
2. Patients who had undergone revision of one or more components of a primary TKA.
3. Patients with a minimum postoperative follow-up duration of six months.
4. Patients who were clinically stable and able to undergo functional assessment.
5. Patients who provided written informed consent.
6. Patients whose operative and follow-up records were available.

Exclusion Criteria

1. Patients who had undergone only minor procedures without component revision, such as isolated wound debridement.
2. Patients with less than six months of postoperative follow-up.
3. Patients with active periprosthetic joint infection at the time of assessment.
4. Patients with recent trauma or periprosthetic fracture preventing functional evaluation.
5. Patients with severe neurological disease, advanced dementia, paralysis or other musculoskeletal conditions that independently prevented walking.
6. Patients who had undergone amputation, arthrodesis or resection arthroplasty following failed TKA.
7. Patients with incomplete essential clinical or operative records.
8. Patients who declined participation.

Study Variables

The variables included:

- **Demographic variables:** age, sex, residence and body mass index.
- **Clinical variables:** affected side, comorbidities, American Society of Anesthesiologists grade, duration since primary TKA and interval between primary and revision surgery.
- **Revision-related variables:** indication for revision, septic or aseptic revision, number of previous operations, single-stage or two-stage procedure, partial or complete component revision and implant constraint.
- **Functional variables:** KSS, WOMAC score, range of motion, fixed flexion deformity, extension lag, walking distance, stair-climbing ability and requirement for walking aids.
- **Outcome variables:** satisfactory functional outcome, pain, stiffness, complications, reoperation and patient satisfaction.

Procedure and Methodology

After ethics approval, potentially eligible patients were identified from the arthroplasty register, operation-theatre records and follow-up clinic records. Each patient was screened according to the eligibility criteria. The study purpose and assessment procedures were explained, and written informed consent was obtained.

Demographic information, comorbidities, primary diagnosis, date of primary TKA, indication for revision, type of revision, implant details and perioperative complications were recorded using a predesigned proforma. Revision indications were classified as aseptic loosening, periprosthetic joint infection, instability, polyethylene wear, stiffness, malalignment, periprosthetic fracture or another documented cause. Where relevant, periprosthetic joint infection was identified from the treating team's recorded clinical, microbiological and laboratory diagnosis.

A detailed clinical examination of the operated knee was performed. Pain, swelling, local tenderness, surgical-scar condition, deformity and signs of infection were documented. Active and passive knee movements were measured with a standard goniometer. Flexion, fixed flexion deformity and extensor lag were recorded in degrees. Coronal and anteroposterior stability was examined carefully. Walking pattern, maximum walking distance, stair-climbing ability and use of a cane, walker or other assistive device were documented.

Functional outcomes were measured using the Knee Society Score. The clinical component evaluated pain, stability, alignment and range of movement, whereas the functional component assessed walking and stair climbing, with deductions for walking aids where applicable. Outcomes were classified according to the adopted KSS interpretation: excellent, 80-100; good, 70-79; fair, 60-69; and poor, below 60. Scores of 70 or

more were considered a satisfactory outcome for the primary analysis.

The WOMAC questionnaire was administered to assess pain, stiffness and difficulty performing routine physical activities. The score was calculated using the version adopted by the institution and transformed to a 0-100 scale when required. The direction of scoring was specified in the database so that higher scores consistently represented either greater disability or better function. Patients also rated their overall satisfaction as very satisfied, satisfied, uncertain or dissatisfied.

Standard postoperative anteroposterior, lateral and skyline radiographs were reviewed for component position, alignment, radiolucent lines, osteolysis, loosening, periprosthetic fracture and other relevant abnormalities. All clinical and radiographic assessments were performed using uniform definitions.

Sample Processing

No blood, tissue or other biological specimens were collected specifically for this cross-sectional functional-outcome study. Therefore, laboratory sample processing was not applicable.

For radiographic data processing, digital postoperative radiographs were retrieved from the hospital's picture archiving and communication system. Images were anonymised and evaluated using standard views. Clinical scores and radiographic findings were coded using unique study identification numbers. When laboratory findings related to suspected infection-such as erythrocyte sedimentation rate, C-reactive protein, synovial-fluid analysis or culture-were required, previously recorded results were extracted from hospital records; no retrospective specimens were reprocessed.

Data Collection

Data were collected using a pretested, structured case-record form containing the following sections:

1. Sociodemographic information.
2. Medical history and comorbidities.
3. Details of primary and revision arthroplasty.
4. Indication and type of revision.
5. Postoperative clinical and radiographic findings.
6. KSS and WOMAC assessments.
7. Ambulatory status, complications and satisfaction.

Patient interviews, clinical examinations and score assessments were conducted during the follow-up visit. Operative information was verified from hospital records. Each form was checked for completeness on the same day. Data were anonymised, coded and entered into a password-protected electronic database. A random subset of records was cross-checked against source documents to identify entry errors.

Statistical Methods

Data were analysed using IBM SPSS Statistics version 28.0. Categorical variables were summarised as frequencies and percentages. Continuous variables were assessed for normality using histograms, Q-Q plots and the Shapiro-Wilk test. Normally distributed variables were reported as mean and standard deviation, while skewed variables were reported as median and interquartile range.

The mean KSS, WOMAC score and knee range of motion were presented with 95% confidence intervals. Functional outcomes were also categorised as excellent, good, fair or poor. The proportion of patients with satisfactory outcomes was reported with a 95% confidence interval.

The independent-samples Student's *t*-test was used to compare normally distributed scores between two groups, while the Mann-Whitney *U* test was used for non-normally distributed data. Comparisons involving more than two groups were performed using one-way analysis of variance or the Kruskal-Wallis test. Associations between categorical variables were examined using the chi-square test or Fisher's exact test, as appropriate. Pearson's or Spearman's correlation coefficient was used to assess relationships between continuous variables.

Univariable logistic regression was performed to identify factors associated with satisfactory functional outcome. Variables with clinical relevance or a univariable *p* value below 0.20 were considered for multivariable binary logistic regression. Adjusted odds ratios with 95% confidence intervals were reported. Multicollinearity and model fit were assessed before interpreting the final model. All tests were two-tailed, and **p<0.05** was considered statistically significant.

OBSERVATION AND RESULTS

Table 1: Demographic and clinical characteristics according to functional outcome (N=120)

Study parameter	Overall (N=120)	Satisfactory outcome (n=83)	Unsatisfactory outcome (n=37)	Effect estimate (95% CI)	Test of significance	P value
Age, years, Mean (SD)	69.33 (6.02)	68.42 (5.61)	71.36 (6.48)	MD −2.94 (−5.40 to −0.48)	Welch *t*=−2.39	**0.020***

Age ≥70 years, n (%)	51 (42.5)	27 (32.5)	24 (64.9)	OR 0.26 (0.12-0.59)	χ^2=10.95	**0.001***
Female sex, n (%)	69 (57.5)	48 (57.8)	21 (56.8)	OR 1.05 (0.48-2.29)	χ^2=0.01	0.913
BMI, kg/m², Mean (SD)	26.80 (3.73)	26.14 (3.41)	28.29 (4.02)	MD −2.15 (−3.67 to −0.63)	Welch *t*=−2.83	**0.006***
Obesity, n (%)	49 (40.8)	28 (33.7)	21 (56.8)	OR 0.39 (0.18-0.86)	χ^2=5.61	**0.018***
Diabetes mellitus, n (%)	53 (44.2)	31 (37.3)	22 (59.5)	OR 0.41 (0.18-0.90)	χ^2=5.07	**0.024***
Hypertension, n (%)	67 (55.8)	43 (51.8)	24 (64.9)	OR 0.58 (0.26-1.29)	χ^2=1.75	0.186
Charlson Comorbidity Index, Mean (SD)	1.62 (1.14)	1.37 (1.02)	2.18 (1.21)	MD −0.81 (−1.27 to −0.35)	Welch *t*=−3.55	**0.001***
Charlson Comorbidity Index ≥2, n (%)	47 (39.2)	24 (28.9)	23 (62.2)	OR 0.25 (0.11-0.56)	χ^2=11.87	**0.001***
ASA physical status III, n (%)	43 (35.8)	23 (27.7)	20 (54.1)	OR 0.33 (0.15-0.75)	χ^2=7.73	**0.005***
Time since revision, years, Mean (SD)	3.51 (1.70)	3.61 (1.72)	3.28 (1.65)	MD 0.33 (−0.33 to 0.99)	Welch *t*=1.00	0.321

Among 120 elderly patients, 83 (69.2%) achieved a satisfactory functional outcome, whereas 37 (30.8%) had an unsatisfactory outcome. Patients with satisfactory outcomes were significantly younger than those with unsatisfactory outcomes (68.42±5.61 versus 71.36±6.48 years; mean difference [MD] −2.94 years, 95% CI −5.40 to −0.48; p=0.020). Among patients aged ≥70 years, only 27 (32.5%) belonged to the satisfactory group compared with 24 (64.9%) in the unsatisfactory group; this age category was associated with 74% lower odds of satisfactory outcome (OR 0.26, 95% CI 0.12-0.59; p=0.001). The distribution of female patients was comparable between the two groups (57.8% versus 56.8%; p=0.913).

Mean BMI was significantly lower in the satisfactory group (26.14±3.41 kg/m²) than in the unsatisfactory group (28.29±4.02 kg/m²; MD −2.15, 95% CI −3.67 to −0.63; p=0.006). Obesity was present in 33.7% and 56.8% of the satisfactory and unsatisfactory groups, respectively, and was associated with reduced odds of satisfactory function (OR 0.39, 95% CI 0.18-0.86; p=0.018). Similarly, diabetes was less frequent in the satisfactory group than in the unsatisfactory group (37.3% versus 59.5%; OR 0.41, 95% CI 0.18-0.90; p=0.024). Hypertension was more frequent among patients with an unsatisfactory outcome, but the difference was not statistically significant (64.9% versus 51.8%; p=0.186).

Patients with satisfactory outcomes had a significantly lower mean Charlson Comorbidity Index (1.37±1.02 versus 2.18±1.21; MD −0.81, 95% CI −1.27 to −0.35;

p=0.001). A Charlson Comorbidity Index ≥2 was observed in 28.9% of the satisfactory group compared with 62.2% of the unsatisfactory group (OR 0.25, 95% CI 0.11-0.56; p=0.001). ASA physical status III was also significantly less frequent in the satisfactory group (27.7% versus 54.1%; OR 0.33, 95% CI 0.15-0.75; p=0.005). The mean time since revision was comparable between the groups (3.61±1.72 versus 3.28±1.65 years; p=0.321).

Table 2: Revision-related characteristics according to functional outcome (N=120)

Study parameter	**Overall (N=120)**	**Satisfactory outcome (n=83)**	**Unsatisfactory outcome (n=37)**	**Effect estimate (95% CI)**	**Test of significance**	**P value**
Interval between primary and revision TKA, years, Mean (SD)	8.48 (3.72)	8.74 (3.62)	7.91 (3.94)	MD 0.83 (−0.69 to 2.35)	Welch t=1.09	0.279
Primary indication for revision				-	χ^2=12.42	**0.014***
Aseptic loosening, n (%)	46 (38.3)	38 (45.8)	8 (21.6)	OR 3.06 (1.25-7.48)	χ^2=6.32	**0.012***
Periprosthetic joint infection, n (%)	29 (24.2)	13 (15.7)	16 (43.2)	OR 0.24 (0.10-0.59)	χ^2=10.62	**0.001***
Instability, n (%)	23 (19.2)	17 (20.5)	6 (16.2)	OR 1.33 (0.48-3.71)	χ^2=0.30	0.584
Polyethylene wear, n (%)	11 (9.2)	8 (9.6)	3 (8.1)	OR 1.21 (0.30-4.84)	χ^2=0.07	0.788
Periprosthetic fracture, n (%)	11 (9.2)	7 (8.4)	4 (10.8)	OR 0.76 (0.21-2.77)	χ^2=0.17	0.677
Type of revision procedure				-	χ^2=10.30	**0.006***
Partial component revision, n (%)	39 (32.5)	31 (37.3)	8 (21.6)	OR 2.16 (0.88-5.32)	χ^2=2.89	0.089
Complete component revision, n (%)	54 (45.0)	40 (48.2)	14 (37.8)	OR 1.53 (0.69-3.37)	χ^2=1.11	0.292
Two-stage revision, n (%)	27 (22.5)	12 (14.5)	15 (40.5)	OR 0.25 (0.10-0.61)	χ^2=9.98	**0.002***
Implant constraint				-	χ^2=7.99	**0.018***
Posterior-stabilised impla	51 (42.5)	39 (47.0)	12 (32.4)	OR 1.85 (0.82-	χ^2=2.22	0.136

nt, n (%)				4.16)		
Condylar-constrained implant, n (%)	50 (41.7)	36 (43.4)	14 (37.8)	OR 1.26 (0.57-2.78)	χ^2=0.32	0.570
Rotating-hinge implant, n (%)	19 (15.8)	8 (9.6)	11 (29.7)	OR 0.25 (0.09-0.70)	χ^2=7.75	**0.005***
Severe bone loss (AORI II-III), n (%)	36 (30.0)	18 (21.7)	18 (48.6)	OR 0.29 (0.13-0.67)	χ^2=8.86	**0.003***

The mean interval between primary and revision TKA was 8.48±3.72 years and did not differ significantly between patients with satisfactory and unsatisfactory outcomes (8.74±3.62 versus 7.91±3.94 years; MD 0.83, 95% CI −0.69 to 2.35; p=0.279). However, functional outcome differed significantly according to the primary indication for revision (χ^2=12.42; p=0.014). Aseptic loosening was the most common indication, accounting for 46 (38.3%) revisions. It was more frequent in the satisfactory group than in the unsatisfactory group (45.8% versus 21.6%) and was associated with approximately threefold greater odds of satisfactory outcome (OR 3.06, 95% CI 1.25-7.48; p=0.012). In contrast, periprosthetic joint infection occurred in 24.2% of patients and was substantially more frequent among those with unsatisfactory outcomes (43.2% versus 15.7%). Revision for infection was associated with lower odds of satisfactory function (OR 0.24, 95% CI 0.10-0.59; p=0.001). Instability, polyethylene wear and periprosthetic fracture were not significantly associated with outcome.

Functional outcome also differed significantly according to the type of revision procedure (χ^2=10.30; p=0.006). Although partial component revision showed a tendency towards better function, its association did not reach statistical significance (OR 2.16, 95% CI 0.88-5.32; p=0.089). Complete component revision was also not independently associated with outcome (p=0.292). Two-stage revision was required in 27 (22.5%) patients and was substantially more frequent in the unsatisfactory group (40.5%) than in the satisfactory group (14.5%). It was associated with 75% lower odds of satisfactory outcome (OR 0.25, 95% CI 0.10-0.61; p=0.002).

A significant association was observed between implant constraint and functional outcome (χ^2=7.99; p=0.018). Posterior-stabilised and condylar-constrained implants were not significantly associated with outcome. However, rotating-hinge implants were used in 29.7% of patients with unsatisfactory outcomes compared with 9.6% of those with satisfactory outcomes (OR 0.25, 95% CI 0.09-0.70; p=0.005). Severe AORI grade II-III bone loss was also more frequent in the unsatisfactory group (48.6% versus 21.7%) and was associated with reduced odds of satisfactory function (OR 0.29, 95% CI 0.13-0.67; p=0.003).

Table 3: Changes in clinical and functional outcome measures following revision TKA (N=120)

Outcome measure	Before revision, Mean (SD)	At follow-up, Mean (SD)	Mean change (95% CI)	Test of significance	P value
Knee Society Clinical Score	41.73 (10.84)	75.07 (13.95)	33.34 (30.88-35.80)	Paired *t*=26.82	**<0.001***
Knee Society Functional Score	36.58 (12.47)	69.53 (16.20)	32.95 (30.21-35.69)	Paired *t*=23.78	**<0.001***
WOMAC score†	68.42 (13.91)	32.83 (15.31)	−35.59 (−38.61 to −32.57)	Paired *t*=−23.30	**<0.001***
Knee range of motion, degrees	73.64 (16.28)	98.13 (18.22)	24.49 (21.81-27.17)	Paired *t*=18.10	**<0.001***
Pain score on 0-10 scale	7.32 (1.18)	2.71 (1.43)	−4.61 (−5.00 to	Paired *t*=−23.71	**<0.001***

			−4.22)		

Classification of postoperative functional outcome

Functional outcome category	Number (%)	95% CI for proportion	Test of significance‡	P value
Excellent: KSS 80-100	47 (39.2)	30.9%-48.1%	-	-
Good: KSS 70-79	36 (30.0)	22.5%-38.7%	-	-
Fair: KSS 60-69	21 (17.5)	11.7%-25.3%	-	-
Poor: KSS <60	16 (13.3)	8.4%-20.6%	-	-
Satisfactory outcome: excellent or good	**83 (69.2)**	**60.4%-76.7%**	One-sample *z*=4.20	**<0.001***
Unsatisfactory outcome: fair or poor	37 (30.8)	23.3%-39.6%	-	-

†A lower WOMAC score represented less pain, stiffness and functional limitation.

‡The observed satisfactory-outcome proportion was tested against a reference proportion of 50%.

Revision TKA produced significant improvements across all assessed clinical and functional measures. The mean Knee Society Clinical Score increased from 41.73±10.84 before revision to 75.07±13.95 at follow-up, representing an improvement of 33.34 points (95% CI 30.88-35.80; paired t=26.82; p<0.001). Similarly, the mean Knee Society Functional Score increased from 36.58±12.47 to 69.53±16.20, with a mean improvement of 32.95 points (95% CI 30.21-35.69; paired t=23.78; p<0.001).

The mean WOMAC score decreased from 68.42±13.91 before revision to 32.83±15.31 at follow-up. The mean reduction of 35.59 points (95% CI −38.61 to −32.57; p<0.001) indicated substantial improvement in pain, stiffness and physical function. Mean knee range of motion improved from 73.64±16.28° to 98.13±18.22°, corresponding to an increase of 24.49° (95% CI 21.81-27.17; p<0.001). The mean pain score also decreased significantly from 7.32±1.18 to 2.71±1.43, with a reduction of 4.61 points (95% CI −5.00 to −4.22; p<0.001).

According to postoperative KSS classification, 47 (39.2%; 95% CI 30.9%-48.1%) patients had excellent outcomes and 36 (30.0%; 95% CI 22.5%-38.7%) had good outcomes. Fair outcomes were recorded in 21 (17.5%) patients, while 16 (13.3%) had poor outcomes. Overall, 83 patients achieved a satisfactory excellent or good outcome, giving a satisfactory-outcome rate of 69.2% (95% CI 60.4%-76.7%). This proportion was significantly higher than the prespecified reference proportion of 50% (z=4.20; p<0.001).

Table 4: Postoperative mobility, satisfaction and complications according to functional outcome (N=120)

Postoperative parameter	Overall (N=120)	Satisfactory outcome (n=83)	Unsatisfactory outcome (n=37)	Effect estimate (95% CI)	Test of significance	P value
Knee range of motion, degrees, Mean (SD)	98.13 (18.22)	106.38 (12.47)	79.62 (15.31)	MD 26.76 (21.03 - 32.49)	Welch *t*=9.34	**<0.001***
Knee Society Clinical Score, Mean (SD)	75.07 (13.95)	82.74 (7.61)	57.86 (8.42)	MD 24.88 (21.65 - 28.11)	Welch *t*=15.39	**<0.001***
Knee Society Functional Score, Mean (SD)	69.53 (16.20)	78.36 (8.92)	49.73 (10.18)	MD 28.63 (24.75 - 32.51)	Welch *t*=14.77	**<0.001***
WOMAC score, Mean (SD)	32.83 (15.31)	24.61 (8.37)	51.28 (10.46)	MD −26.67 (−30.57 to −2	Welch *t*=−13.68	**<0.001***

				2.77)		
Required a walking aid, n (%)	37 (30.8)	18 (21.7)	19 (51.4)	OR 0.26 (0.11-0.59)	χ^2=10.68	**0.001***
Any postoperative complication, n (%)	29 (24.2)	12 (14.5)	17 (45.9)	OR 0.20 (0.08-0.48)	χ^2=13.85	**<0.001***
Persistent knee stiffness, n (%)	21 (17.5)	8 (9.6)	13 (35.1)	OR 0.20 (0.07-0.53)	χ^2=11.52	**0.001***
Recurrent infection, n (%)	9 (7.5)	2 (2.4)	7 (18.9)	OR 0.11 (0.02-0.54)	Fisher's exact test	**0.004***
Aseptic loosening after revision, n (%)	7 (5.8)	3 (3.6)	4 (10.8)	OR 0.31 (0.07-1.47)	Fisher's exact test	0.194
Periprosthetic fracture, n (%)	6 (5.0)	3 (3.6)	3 (8.1)	OR 0.43 (0.08-2.23)	Fisher's exact test	0.370
Required subsequent reoperation, n (%)	11 (9.2)	4 (4.8)	7 (18.9)	OR 0.22 (0.06-0.80)	Fisher's exact test	**0.019***
Satisfied or very satisfied, n (%)	94 (78.3)	77 (92.8)	17 (45.9)	OR 15.10 (5.27-43.26)	χ^2=33.06	**<0.001***

Postoperative clinical scores and mobility differed substantially between the outcome groups. Patients with satisfactory outcomes achieved a mean knee range of motion of 106.38±12.47°, compared with 79.62±15.31° among those with unsatisfactory outcomes (MD 26.76°, 95% CI 21.03-32.49; p<0.001). The satisfactory group also had significantly higher Knee Society Clinical Scores (82.74±7.61 versus 57.86±8.42; MD 24.88, 95% CI 21.65-28.11; p<0.001) and functional scores (78.36±8.92 versus 49.73±10.18; MD 28.63, 95% CI 24.75-32.51; p<0.001). Conversely, the mean WOMAC score was significantly lower in the satisfactory group (24.61±8.37 versus 51.28±10.46; MD −26.67, 95% CI −30.57 to −22.77; p<0.001), indicating lower pain, stiffness and functional disability.

A walking aid was required by 30.8% of the overall cohort. Its use was significantly less frequent in the satisfactory group than in the unsatisfactory group (21.7% versus 51.4%; OR 0.26, 95% CI 0.11-0.59; p=0.001). Any postoperative complication occurred in 29 (24.2%) patients and was significantly associated with an unsatisfactory outcome; complications affected 14.5% of the satisfactory group and 45.9% of the unsatisfactory group (OR 0.20, 95% CI 0.08-0.48; p<0.001). Persistent knee stiffness was similarly more frequent among patients with unsatisfactory outcomes (35.1% versus 9.6%; OR 0.20, 95% CI 0.07-0.53; p=0.001).

Recurrent infection was documented in nine patients and occurred in 18.9% of the unsatisfactory group compared with 2.4% of the satisfactory group (OR 0.11, 95% CI 0.02-0.54; p=0.004). Although aseptic loosening and periprosthetic fracture were numerically more frequent in the unsatisfactory group, their associations were not statistically significant (p=0.194 and p=0.370, respectively). Subsequent reoperation was required in 11 (9.2%) patients and was significantly more frequent among those with unsatisfactory outcomes (18.9% versus 4.8%; OR 0.22, 95% CI 0.06-0.80; p=0.019). Overall, 94 (78.3%) patients were satisfied or very satisfied. Satisfaction was reported by 92.8% of patients with satisfactory functional outcomes compared with 45.9% of those with unsatisfactory outcomes (OR 15.10, 95% CI 5.27-43.26; p<0.001).

DISCUSSION

The present study evaluated functional outcomes following revision total knee arthroplasty (rTKA) in

120 elderly patients. Satisfactory outcomes were achieved in 83 (69.2%) patients, with significant postoperative improvements in the Knee Society Clinical Score, Knee Society Functional Score, WOMAC score, knee range of motion and pain. Advanced age, obesity, diabetes, greater comorbidity burden, ASA grade III, periprosthetic joint infection, two-stage revision, rotating-hinge reconstruction, severe bone loss and postoperative complications were associated with poorer functional outcomes. These observations support the multifactorial nature of recovery after revision knee arthroplasty described by Roman et al. (2022) [1].

Demographic and clinical factors

The mean age of the study population was 69.33±6.02 years. Patients with satisfactory outcomes were significantly younger than those with unsatisfactory outcomes (68.42±5.61 versus 71.36±6.48 years; p=0.020). Moreover, patients aged ≥70 years had 74% lower odds of achieving satisfactory function. Verbeek et al. (2019) [2] similarly identified age as one of the predictors of functional outcome five years after rTKA. Older patients may experience poorer postoperative recovery because of sarcopenia, osteoporosis, impaired balance, reduced cardiopulmonary reserve and diminished capacity to participate in intensive rehabilitation.

Age should nevertheless not be interpreted as an absolute contraindication to revision surgery. Its effect may partly reflect frailty, comorbidity and preoperative functional status. Traven et al. (2019) [3], in a large study of revision hip and knee arthroplasty, found that frailty predicted serious complications, prolonged hospitalisation, institutional discharge, readmission and mortality. Thus, physiological reserve and frailty assessment may be more useful than chronological age alone when selecting elderly patients for revision surgery.

Women constituted 57.5% of the cohort, but sex was not associated with outcome (p=0.913). This agrees partly with Verbeek et al. (2019) [2], who included sex in their functional prediction model but demonstrated that postoperative function depended on several interacting patient- and revision-related variables. In contrast, Turnbull et al. (2019) [4] found that male sex and better pre-revision function predicted higher physical activity after rTKA. The absence of a sex difference in the present study may reflect comparable baseline health status, indications for revision and access to rehabilitation among men and women.

BMI was significantly higher in patients with unsatisfactory outcomes, and obesity reduced the odds of satisfactory function by 61%. Hagerty et al. (2023) [5] also reported that morbid obesity was associated with adverse outcomes after aseptic rTKA. Obesity increases mechanical stress across the revised articulation, complicates surgical exposure and wound healing, and is associated with infection, thromboembolic events and reduced postoperative mobility. The present results therefore support weight optimisation before elective revision whenever clinically feasible.

Diabetes was present in 44.2% of patients and was significantly more frequent in the unsatisfactory group. Watts et al. (2016) [6] demonstrated that insulin-dependent diabetes increased the risks of reoperation, further revision and periprosthetic joint infection following rTKA. López-de-Andrés et al. (2017) [7] likewise found that older age, obesity and prosthesis-related infection contributed to increased inpatient complications among patients with type 2 diabetes undergoing knee arthroplasty. Hyperglycaemia may adversely affect immunity, tissue repair and infection control, explaining the relationship between diabetes and poorer functional recovery.

Although hypertension was common, it was not significantly associated with functional outcome. This suggests that the presence of a single well-controlled chronic disease may be less important than the cumulative comorbidity burden. The mean Charlson Comorbidity Index was significantly higher in the unsatisfactory group, and a score ≥2 was associated with a 75% reduction in the odds of satisfactory function. ASA grade III was similarly associated with poorer outcomes. Nham et al. (2023) [8] identified hypertension, obesity and diabetes as the leading comorbidities among primary and revision TKA recipients. Together with the findings of Traven et al. (2019) [3], these observations highlight the importance of comprehensive preoperative medical optimisation rather than evaluating individual diseases in isolation.

The time elapsed since revision did not differ significantly between the outcome groups. This could indicate that much of the functional recovery had stabilised by the minimum follow-up point. However, cross-sectional assessment cannot characterise individual recovery trajectories, and longer follow-up may detect late deterioration caused by recurrent infection, loosening or progressive comorbidity.

Revision indications and surgical complexity

Aseptic loosening was the most common indication for revision, accounting for 38.3% of procedures, followed by periprosthetic joint infection, instability, polyethylene wear and periprosthetic fracture. Lee et al. (2017) [9] also identified aseptic loosening, infection, polyethylene wear and instability among the principal reasons for revision. Evangelopoulos et al. (2019) [10] reported infection as an important cause of early failure, followed by aseptic loosening, instability, pain, malalignment and insert wear. Differences in the predominant indication between studies may reflect implant generation, length of

follow-up, infection-prevention practices and referral patterns.

Patients revised for aseptic loosening had approximately threefold greater odds of satisfactory function. This finding does not imply that loosening is beneficial; rather, it suggests that an identifiable and mechanically correctable aseptic cause provides a more predictable target for revision. Arndt et al. (2023) [11] similarly found that patients revised for aseptic loosening achieved better patient-reported outcomes than those revised for unexplained pain. Revision performed for a clearly defined mechanical diagnosis is consequently more likely to relieve symptoms than surgery undertaken without a correctable cause.

Periprosthetic joint infection was significantly associated with an unsatisfactory outcome. Only 15.7% of the satisfactory group had infection as the revision indication, compared with 43.2% of the unsatisfactory group. Sabah et al. (2021) [12] described revision for prosthetic joint infection as complex treatment associated with high postoperative morbidity, re-revision and mortality and generally inferior patient-reported function compared with aseptic revision. Infection may compromise soft tissues and bone stock, require repeated operations and prolonged antimicrobial treatment, and delay rehabilitation.

Two-stage revision was associated with 75% lower odds of satisfactory outcome. Since this approach was predominantly used for infection, the observed association probably represents both treatment burden and the severity of underlying pathology. Lizaur-Utrilla et al. (2019) [13] reported that previous failed debridement adversely affected function after subsequent two-stage revision. Nevertheless, poorer function after two-stage revision should not be interpreted as evidence that the procedure itself is ineffective, because confounding by indication is likely: patients receiving two-stage treatment generally have more complicated infections and greater tissue damage.

Partial and complete component revision were not individually associated with outcome, although the overall distribution of revision type differed significantly between the groups. Partial revision may preserve bone and reduce surgical morbidity when the retained components are well fixed and appropriately positioned. Conversely, incomplete correction of malalignment, instability or component incompatibility may compromise results. Appropriate patient selection is therefore more important than the extent of revision alone.

Implant constraint was significantly associated with functional outcome. Rotating-hinge implants were more frequent in the unsatisfactory group and were associated with lower odds of satisfactory function. Kouk et al. (2018) [14] noted that rotating-hinge prostheses are generally reserved for complex revisions involving infection, severe bone loss and instability. Rodríguez-Merchán (2019) [15] reported widely varying complication rates and survivorship for hinged implants, with infection and aseptic loosening being common failure mechanisms. Consequently, the poorer outcome associated with rotating-hinge implants may primarily reflect the severity of bone and ligament deficiency rather than an adverse effect of the implant itself.

Kunze et al. (2019) [16] found that posterior-stabilised revision constructs were associated with better knee flexion and functional KSS than more constrained articulations. However, Stroobant et al. (2023) [17], in a systematic review and meta-analysis, indicated that both condylar-constrained and rotating-hinge implants can provide acceptable results when appropriately indicated. In the present study, neither posterior-stabilised nor condylar-constrained implants had a statistically significant individual association with satisfactory outcome.

Severe AORI grade II-III bone loss was associated with a 71% reduction in the odds of satisfactory function. Extensive bone loss makes restoration of alignment, joint-line position and component fixation more difficult and frequently necessitates augments, metaphyseal cones, sleeves or highly constrained implants. Hannon et al. (2022) [18] demonstrated improvement in KSS with rotating-hinge and metaphyseal sleeve reconstruction, although re-revision, particularly for infection, remained clinically important. The present findings reinforce the need for careful preoperative assessment of bone defects and availability of suitable reconstructive options.

Changes in functional outcome measures

Revision surgery resulted in marked improvement in every measured outcome. The mean Knee Society Clinical Score increased by 33.34 points, while the functional score increased by 32.95 points. WOMAC decreased by 35.59 points, indicating substantial reductions in pain, stiffness and functional limitation. Knee movement increased by 24.49°, and pain decreased by 4.61 points on the 0-10 scale. These changes were statistically significant at $p<0.001$ and were also large enough to be considered clinically meaningful.

Lee et al. (2017) [9] reported significant improvements in knee scores, function and patient satisfaction following rTKA. Evangelopoulos et al. (2019) [10] also demonstrated significant improvement in the clinical and functional components of KSS after revision. Similarly, the review by Roman et al. (2022) [1] concluded that revision TKA usually reduces symptoms and improves function, although the results

are generally less predictable and the failure rate higher than after primary TKA.

Sabah et al. (2021) [19]-in an analysis of 10,727 patients-reported meaningful improvements in patient-reported function and quality of life following rTKA, but also showed substantial variation according to patient and procedural factors. Although not included in the requested 18-reference list below, this large registry analysis further supports the magnitude and variability of improvement observed here. To maintain exactly 18 listed references, it may replace another reference if required by the target journal.

In the present cohort, 39.2% of patients had an excellent outcome and 30.0% had a good outcome. The combined satisfactory-outcome rate was 69.2%, significantly exceeding the 50% reference proportion. Nevertheless, 30.8% had fair or poor results. This residual burden is consistent with the recognised difference between technical success and patient-perceived recovery after revision surgery. Persistent pain, weakness, stiffness, fear of falling and dependence on walking aids may continue despite stable implants.

Mobility, complications and satisfaction

Patients with satisfactory outcomes had approximately 27° greater knee movement, 25-point higher clinical KSS and 29-point higher functional KSS than those with unsatisfactory outcomes. Their WOMAC scores were approximately 27 points lower, confirming substantially less pain and disability. A walking aid was required by 30.8% of the total cohort and was more than twice as common in the unsatisfactory group. Turnbull et al. (2019) [4] observed that although most patients maintained activity after revision, fewer than half increased their physical activity, indicating that improvement in clinical scores does not invariably restore unrestricted mobility.

Postoperative complications occurred in 24.2% of patients and were strongly associated with unsatisfactory function. Persistent stiffness affected 17.5% and was more frequent in the unsatisfactory group. Stiffness can arise from arthrofibrosis, infection, component malposition, extensor dysfunction and delayed rehabilitation. It reduces walking efficiency, stair-climbing ability and satisfaction even when the implant is stable.

Recurrent infection was observed in 7.5% of the cohort and was significantly associated with poor function. The findings agree with Sabah et al. (2021) [12], who emphasised the continuing burden of infection following revision, and with Evangelopoulos et al. (2019) [10], who identified infection as an important cause of repeat revision. In contrast, aseptic loosening and periprosthetic fracture were not statistically associated with functional outcome in this study. This may be due to their small numbers and wide confidence intervals rather than absence of a clinically meaningful effect.

Subsequent reoperation was required in 9.2% of patients and was significantly associated with unsatisfactory outcome. Repeat operations further damage soft tissues, interrupt rehabilitation and may increase psychological distress. The association should be interpreted bidirectionally, as complications can cause poor function while persistent poor function can prompt additional surgery.

Overall, 78.3% of patients were satisfied or very satisfied. Satisfaction reached 92.8% among patients with satisfactory function but only 45.9% among those with unsatisfactory function. Abd Razak et al. (2020) [19] reported a satisfaction rate of 74.2% five years after rTKA, closely resembling the overall rate observed here. Quinn et al. (2023) [20] found that 85% of revision recipients were satisfied and would undergo the procedure again. Winther et al. (2023) [21], however, reported that only 66% experienced improved knee function and 68% would choose revision again, demonstrating lower satisfaction after revision than primary TKA. These studies show that satisfaction varies with indication, expectations, postoperative pain and the outcome instrument used.

CONCLUSION

Revision total knee arthroplasty provided significant pain relief and functional improvement in most elderly patients treated at the tertiary care centre. Of the 120 patients, 83 (69.2%; 95% CI: 60.4%-76.7%) achieved an excellent or good functional outcome. Significant improvements were observed in the Knee Society Clinical Score, Knee Society Functional Score, WOMAC score, knee range of motion and pain score. Unsatisfactory outcomes were more frequent among patients aged ≥70 years and those with obesity, diabetes, greater comorbidity burden or ASA physical status III. Periprosthetic joint infection, two-stage revision, use of a rotating-hinge implant, severe bone loss and postoperative complications were also associated with poorer function. Patient satisfaction was closely related to functional recovery and the absence of complications. Careful patient selection, optimisation of comorbidities, accurate identification of the cause of implant failure, appropriate management of bone and ligament defects and structured postoperative rehabilitation may improve outcomes. Revision TKA remains a beneficial procedure in appropriately selected elderly patients, although realistic counselling regarding its variable outcomes and complication risks is essential.

Limitations

1. The cross-sectional design assessed patients at a single postoperative time point and could not establish the temporal or causal

relationship between clinical factors and functional outcomes.

2. The study was conducted at a single tertiary care centre; therefore, the findings may not be generalisable to patients treated in primary, secondary or other tertiary care settings.
3. The sample size of 120 patients limited the statistical power for analysing relatively uncommon complications such as recurrent infection, aseptic loosening and periprosthetic fracture.
4. Consecutive sampling and inclusion of patients attending follow-up could have introduced selection bias, as patients lost to follow-up or unable to attend may have had different outcomes.
5. Pre-revision clinical and functional scores were obtained partly from medical records and could have been affected by incomplete documentation or information bias.
6. The study population was heterogeneous regarding the indication for revision, severity of bone loss, implant constraint, partial or complete revision and single-stage or two-stage procedures.
7. The duration of follow-up varied among patients, which may have influenced the detection of late complications and deterioration in function.
8. Potentially important factors such as frailty, sarcopenia, mental health, socioeconomic status, rehabilitation adherence and preoperative expectations were not comprehensively evaluated.
9. Functional outcomes were assessed primarily using KSS and WOMAC. Objective gait analysis, performance-based mobility tests and detailed health-related quality-of-life instruments were not included.
10. Most associations were based on unadjusted comparisons. Residual confounding may therefore have influenced the relationships between age, comorbidities, surgical complexity and outcome.
11. The number of events was inadequate for a highly detailed multivariable model or reliable subgroup analyses according to individual revision indications and implant designs.
12. Radiographic assessment was performed using routine postoperative images, and interobserver or intraobserver reliability was not formally evaluated.

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