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**EDITORIAL**

- 683 Total hip arthroplasty for sequelae of childhood hip disorders: Current review of management to achieve hip centre restoration  
*Oommen AT*
- 696 Offset restoration in total hip arthroplasty: Important: A current review  
*Oommen AT*

**MINIREVIEWS**

- 704 Intra-articular interventions in osteoarthritis: Navigating the landscape of hyaluronic acid, mesenchymal stem cells, and platelet-rich plasma  
*Soufan S, Al Khoury J, Hamdan Z, Rida MA*

**ORIGINAL ARTICLE****Retrospective Study**

- 713 Readmission rate and early complications in patients undergoing total knee arthroplasty: A retrospective study  
*Jethi T, Jain D, Garg R, Selhi HS*
- 722 Native and prosthetic septic arthritis in a university hospital in Saudi Arabia: A retrospective study  
*Kaki R*

**Observational Study**

- 734 Factors that influence the results of indirect decompression employing oblique lumbar interbody fusion  
*Bokov AE, Kalinina SY, Khalturov MI, Saifullin AP, Bulkin AA*
- 744 Anterior cruciate ligament reconstruction: Effect of graft tunnel position on early to mid-term clinical outcomes  
*Mann O, Al-Dadah O*
- 754 Three-dimensional analysis of age and sex differences in femoral head asphericity in asymptomatic hips in the United States  
*Hassan MM, Feroe AG, Douglass BW, Jimenez AE, Kuhns B, Mitchell CF, Parisien RL, Maranhão DA, Novais EN, Kim YJ, Kiapour AM*
- 764 Coronal plane stability of cruciate-retaining total knee arthroplasty in valgus gonarthrosis patients: A mid-term evaluation using stress radiographs  
*Chaiyakit P, Wattanapreechanon P*

**Prospective Study**

- 773 Blood metal concentrations and cardiac structure and function in total joint arthroplasty patients  
*Brennan PC, Peterson SM, O'Byrne TJ, Laporta ML, Wyles CC, Jannetto PJ, Kane GC, Vassilaki M, Maradit Kremers H*

**SYSTEMATIC REVIEWS**

- 783 Clinical effect of operative *vs* nonoperative treatment on humeral shaft fractures: Systematic review and meta-analysis of clinical trials  
*Li Y, Luo Y, Peng J, Fan J, Long XT*

**META-ANALYSIS**

- 796 Comparative efficacy of proximal femoral nail *vs* dynamic condylar screw in treating unstable intertrochanteric fractures  
*Yousif Mohamed AM, Salih M, Abdulgadir M, Abbas AE, Lutfi Turjuman D*

**CASE REPORT**

- 807 Neglected congenital bilateral knee dislocation treated by quadricepsplasty with semitendinosus and sartorius transfer: A case report  
*Qasim OM, Abdulaziz AA, Aljabri NK, Albaqami KS, Suqaty RM*
- 813 Hemophagocytic lymphohistiocytosis triggered by relapsing polychondritis: A case report  
*Han MR, Hwang JH, Cha S, Jeon SY, Jang KY, Kim N, Lee CH*
- 820 Needle arthroscopic-assisted repair of tibio-fibular syndesmosis acute injury: A case report  
*Wojtowicz BG, Domzalski M, Lesman J*

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## Retrospective Study

# Readmission rate and early complications in patients undergoing total knee arthroplasty: A retrospective study

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## Abstract

### BACKGROUND

Total knee arthroplasty (TKA) can improve pain, quality of life, and functional outcomes. Although uncommon, postoperative complications are extremely consequential and thus must be carefully tracked and communicated to patients to assist their decision-making before surgery. Identification of the risk factors for complications and readmissions after TKA, taking into account common causes, temporal trends, and risk variables that can be changed or left unmodified, will benefit this process.

### AIM

To assess readmission rates, early complications and their causes after TKA at 30 days and 90 days post-surgery.

### METHODS

This was a prospective and retrospective study of 633 patients who underwent TKA at our hospital between January 1, 2017, and February 28, 2022. Of the 633 patients, 28 were not contactable, leaving 609 who met the inclusion criteria. Both inpatient and outpatient hospital records were retrieved, and observations were noted in the data collection forms.

### RESULTS

Following TKA, the 30-day and 90-day readmission rates were determined to be 1.1% ( $n = 7$ ) and 1.8% ( $n = 11$ ), respectively. The unplanned visit rate at 30 days following TKA was 2.6% ( $n = 16$ ) and at 90 days was 4.6% ( $n = 28$ ). At 90 days, the

unplanned readmission rate was 1.4% ( $n = 9$ ). Reasons for readmissions included medical (27.2%,  $n = 3$ ) and surgical (72.7%,  $n = 8$ ). Unplanned readmissions and visits within 90 days of follow-up did not substantially differ by age group ( $P = 0.922$ ), body mass index (BMI) ( $P = 0.633$ ), unilateral *vs* bilateral TKA ( $P = 0.696$ ), or patient comorbidity status (30-day  $P = 0.171$  and 90-day  $P = 0.813$ ). Reoperation rates after TKA were 0.66% ( $n = 4$ ) at 30 days and 1.15% ( $n = 8$ ) at 90 days. The average length of stay was 6.53 days.

## CONCLUSION

In this study, there was a low readmission rate following TKA. There was no significant correlation between readmission rate and patient factors such as age, BMI, and co-morbidity status.

**Key Words:** Total knee arthroplasty; Length of stay; Readmission; Rates; Causes; Risk factors; Prospective; Retrospective; Follow-up; Reoperation

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**Core Tip:** As the rates of total knee arthroplasty are currently increasing, there is a need to study the potential complications that may occur after the surgery. This study highlights the complications that occur postoperatively and potential risk factors that can contribute to the complications. It also assesses the relationship between age, sex, co-morbidities, length of stay, and early readmission after surgery, categorizing these readmissions by surgical and medical reasons depending on the type of treatment received by the patients.

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## INTRODUCTION

Knee osteoarthritis (OA) is a chronic degenerative disorder of multifactorial etiology characterized by the loss of articular cartilage, hypertrophy of bone at the margins, subchondral sclerosis, and range of biochemical and morphological alterations of the synovial membrane and joint capsule[1]. However, OA is difficult to define, and a better understanding of its pathophysiology is required. All forms of OA and related disorders have in common a loss of cartilage associated with bone features such as osteophytes and subchondral bone sclerosis[2].

The risk factors for OA vary from person to person, including age, sex, obesity, genetics, diet, and joint injury, according to the stage of the disease[3]. It is difficult to distinguish between single and clustered risk factors associated with the development or progression of the disease.

There is no cure for OA, and most treatments aim to improve symptoms and function. Optimal management of patients with knee OA requires a combination of non-pharmacological, pharmacological, surgery, arthroscopic debridement, and lavage modalities of therapy[4]. Total knee arthroplasty (TKA), known as “the gold standard,” is a surgical procedure that involves replacing the articular surfaces (femoral condyles and tibial plateau) of the knee joint with smooth metal and highly cross-linked polyethylene plastic, with the goal of restoring full function at the knee joint, providing substantial relief from pain and improvement in function in patients with knee arthritis[5]. TKA is a common and effective treatment option for individuals with symptomatic OA in at least two of the three compartments of their knee who have failed conservative therapy[6].

In most situations, TKA is indicated for patients who have chronic, severe symptoms that persist beyond the limits of all conservative and non-operative therapy options. TKA is contraindicated in patients suffering from local knee infection (sepsis) or ongoing remote (extra-articular) infection or bacteremia, vascular dysfunction, or neuroarthropathic degenerative joint disease, *etc*[7].

Demographic factors such as age, sex, and body mass index (BMI) have varying and complicated effects. Age intervals are not uniform among studies, with some using 5- or 10-year intervals, and others using a specific number. The classification of predictive factors by various studies when estimating risk, as well as increasing age, weight, and the physical activity of TKA patients, may complicate matters[8].

Complications occurring after TKA include the following: Thromboembolism, which is one of the most significant complications; deep venous thrombosis, which is one of the most serious and potentially life-threatening complications; pulmonary embolism, one of the most feared complications; and infection, which is rare, occurring in only 2% to 3% of cases. Patellofemoral complications after TKA include patellofemoral instability, patellar fracture, patellar component failure, patellar component loosening, patellar clunk syndrome, and extensor mechanism rupture. Neurovascular complications after TKA, such as arterial injury, are rare and occur in only 0.03% to 0.2% of patients, with 25% resulting in amputation. Periprosthetic supracondylar femur fractures after TKA are also infrequent (0.3% to 2%)[9].



As there is an increased rate of patients undergoing TKA, readmission rates have increased. Studying the risk factors helps us identify different preventable causes of readmission in TKA. In a population of TKA recipients, understanding the risk factors for readmission following joint arthroplasty helps clinicians better understand the postoperative course of their patients. Knowing the potential risks and mitigation strategies, as well as how to identify patients with the highest risk of readmission, will improve the effectiveness and efficiency of care[10].

The largest hospital readmission rates have been found to occur in the first 30 days after surgery, indicating that patients are at greatest risk of being readmitted to the hospital in the early phase of post-surgery. The reported 5%-8% readmission rate of patients after TKA is concerning[11]. Readmission may be an indication that patients were not thoroughly prepared for discharge after surgery and may have not fully understood the discharge instructions and guidelines for the postoperative phase, which could have supported better post-surgical outcomes[11].

Compared to the number of readmissions from day 31 to day 90, more 30-day readmissions have been reported as problems related to surgery; in particular, 71% of the issues during the first 30 days are related to surgery, as opposed to 47% of the remaining 60 days in a 90-day period. After completing joint replacement, 90 days is a preferable time period for recording readmissions due to surgery[12]. There is a prominent trend towards reduced hospital length of stay (LOS) after TKA. There has also been increased utilization of TKA surgery on an outpatient basis[13]. A short LOS is associated with higher 30-day readmission rates, and following an index surgery, LOS > 1 day increases the odds of 90-day readmission[14]; however, the optimal LOS after TKA remains a subject of debate.

There is limited literature on this topic in the Indian population. Thus, the present study was conducted to study the pattern of readmission in patients who underwent primary TKA in order to study complications and risk factors in this patient population.

## MATERIALS AND METHODS

### *Patients*

The present prospective and retrospective study included patients who underwent TKA from January 1, 2017, through February 28, 2022, with a minimum follow-up of 3 months. Patients were contacted by either telephone or personal interview. Hospital in-patient and outpatient records were retrieved and data collection forms were filled.

### *Inclusion and exclusion criteria*

The study included all patients who underwent primary TKA and excluded patients who underwent revision TKA and who were not willing to participate in the study. Readmission rates at 30 days and 90 days were assessed. Of the 633 patients, 28 were not able to be contacted, leaving 609 who met the inclusion criteria. Variables that were studied included time and reason for readmission, LOS, complications after TKA, and hospital visits not requiring admission to the hospital.

## RESULTS

### *Demographic characteristics*

The average age of patients in the study was 62.87 years (range: 35-91 years), and 69% were females while 31% were males (Table 1). The majority (54.5%) of patients were overweight, of whom 4.6% had class 1 obesity; the remaining patients had normal BMI. The BMI range of patients in the study was 22 kg/m<sup>2</sup> to 35.64 kg/m<sup>2</sup>, with a mean BMI of 26.7 kg/m<sup>2</sup> (Table 1).

### *Diagnosis and procedure details*

Of the total patients who underwent TKA, 97.4% had OA and only 2.6% of patients had rheumatoid arthritis. In total, 304 of 609 patients underwent bilateral TKA and 305 patients underwent unilateral TKA, for a total of 913 operated knees. The majority of patients had Charlson co-morbidity scores < 2 (65.5%), indicating mild severity of the associated co-morbidity. Another (8.9%) patients had scores > 4, whereas (25.6%) had scores ranging from 2 to 3.0. The LOS in the hospital for most patients was 7 days, with a range of LOS from 6 days to 13 days; the average LOS was 6.53 days. The majority of patients undergoing TKA had complaints for 2-10 years (2-5 years: 27.6%; 5-10 years: 39.2%). A total of 4.8% of patients had complaints for less than 2 years, whereas 28.4% had complaints for more than 10 years (Table 1).

### *Hospital stay duration*

In our study, 16 of the 28 unplanned visits occurred within the first 30 days after TKA, comprising 2.6% of total cases (Table 2).

### *Incidence of unplanned visits and readmissions*

Of the 16 unplanned visits, there were 7 unplanned readmissions, occurring in the first 30 days of TKA. The rate of readmission in the first 30 days of follow-up was found to be 1.1%. In our 90-day follow-up, there were a total of 28 unplanned visits to the hospital, and the rate of unplanned visits was found to be 4.6% (Table 3). The reasons for unplanned visits at the 30-day and 90-day follow-up are depicted in Figure 1A. In our 90-day post-TKA follow-up, there were 11 readmissions, 2 of which were planned and 9 of which were unplanned, yielding a readmission rate of 1.8% ( $n =$

**Table 1** Characteristics of the study population

Study variable		Cases, <i>n</i>	Percent, %
Age in year	≤ 40	5	0.8
	41-50	43	7.1
	51-60	197	32.3
	61-70	251	41.2
	71-80	104	17.1
	> 80	9	1.5
Sex	Female	420	69
	Male	189	31
Body mass index in kg/m <sup>2</sup>	< 24.9 (normal)	249	40.8
	25-29.9 (overweight)	332	54.5
	> 30 (class 1 obesity)	28	4.6
Diagnosis	Osteoarthritis	593	97.4
	Rheumatoid arthritis	16	2.6
Laterality	Bilateral	304	49.9
	Unilateral	305	50.1
Duration of complaint	< 1	3	0.5
	1-2.0	26	4.3
	2-5.0	168	27.6
	5-10.0	239	39.2
	> 10	173	28.4
Charlson comorbidity index	< 2	399	65.5
	2-3.0	156	25.6
	> 4	54	8.9
Length of stay in day	6	297	48.8
	7	306	50.2
	8	4	0.7
	10	1	0.2
	13	1	0.2

11) and an unplanned readmission rate of 1.4% ( $n = 9$ ). The reasons for readmission at the 30-day and 90-day follow-up are illustrated in [Figure 1B](#) ([Table 4](#)).

### Reoperation rates

The 30-day and 90-day reoperation rates after TKA were 0.66% ( $n = 4$ ) and 1.15% ( $n = 8$ ), respectively ([Table 5](#)).

### Correlation analysis

Unplanned readmissions and visits within 90 days of follow-up after TKA did not significantly correlate with age group ( $P = 0.922$ ), BMI ( $P = 0.633$ ), or unilateral *vs* bilateral TKA ( $P = 0.696$ ). Unplanned and planned readmissions within 90 days are shown in [Figure 1C](#). The data on unplanned visits and readmissions within the first 30 days of follow-up were not significant enough to determine a correlation with age, BMI, or unilateral *vs* bilateral TKA.

### Mortality rate

There were no mortalities at the 30-day and 90-day follow-ups.

### Readmission rate analysis

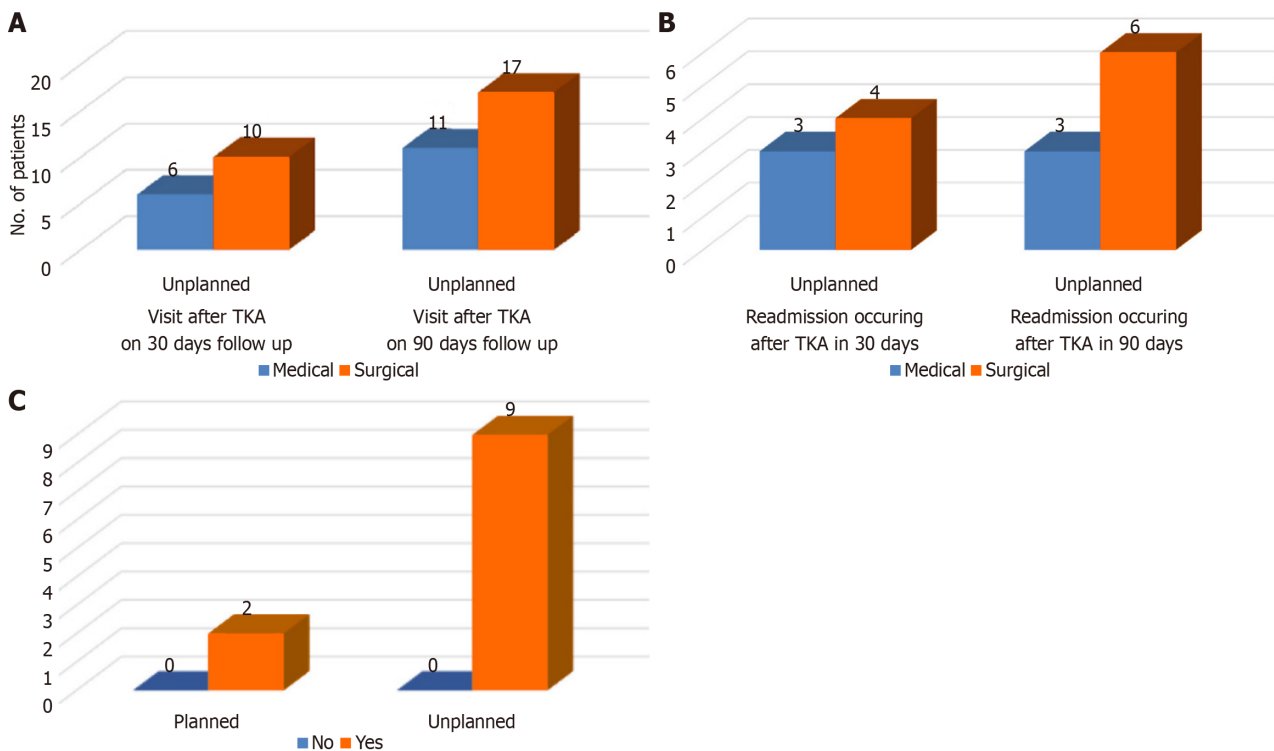
There was a low readmission rate following TKA. There was no significant correlation between readmission rates at the 90 days follow-up and patient factors such as age, BMI, and co-morbidity status. Comparisons of unplanned readmissions



**Table 2** Unplanned visits within 30 days after total knee arthroplasty

Unplanned visit after TKA within 30 days	Follow-up	Cases, <i>n</i>	Percent, %
Occurred	No	593	97.40
	Yes	16	2.60
Reason	Febrile illness	2	0.40
	Urinary tract infection	2	0.40
	Neurological issues	1	0.20
	Lower back ache	1	0.20
	Post TKA pain	3	0.60
	Wound complications	5	1.00
	Other surgery-related complications	2	0.40

TKA: Total knee arthroplasty.



**Figure 1** Follow-up after total knee arthroplasty. A: Reasons for unplanned visits at the 30-day and 90-day follow up after total knee arthroplasty; B: Reasons for readmission at the 30-day and 90-day follow-up after total knee arthroplasty; C: Unplanned and planned readmissions within 90 days. TKA: Total knee arthroplasty.

after TKA with other studies are shown in Table 6.

## DISCUSSION

The current study enrolled 633 patients who underwent TKA between January 1, 2017, through February 28, 2022, 28 of whom were excluded as they could not be reached. The mean patient age was 62.87 years. The average age of readmitted patients was 63 years. No positive correlation was found between age and unplanned visits and readmissions at 90 days following TKA ( $P = 0.922$ ). The average age of readmitted patients in this study is in the range of that reported in previous studies. For example, the mean ages of readmitted patients after TKA in studies by Avram *et al*[15], Cassard *et al* [16], and Schmidt *et al*[17] were 71.4 years, 65.4 years, and 61 years, respectively. In addition, Schairer *et al*[18] conducted a study on the readmission rate and causes of readmission in patients with a mean age of 63.6 years for primary TKA and

**Table 3** Unplanned visits within 90 days after total knee arthroplasty

Unplanned visit after TKA within 90 days	Follow-up	Cases, <i>n</i>	Percent, %
Occurred	No	815	95.40
	Yes	8	4.60
Reason for unplanned visits within 90 days	Febrile illness	3	0.60
	Urinary tract infection	3	0.60
	Neurological issues	2	0.40
	Generalized body weakness	1	0.20
	Lower back ache	2	0.40
	Soft tissue injury over knee	2	0.40
	Post TKA pain	7	1.40
	Wound complications	5	1.00
	Other surgery-related complication	3	0.60

TKA: Total knee arthroplasty.

**Table 4** Reasons for readmissions at 90 days

Reasons for readmissions within 90 days	Cases, <i>n</i>	Percent, %
Febrile illness	2	0.40
Neurological issues	2	0.40
Talonavicular degeneration	1	0.20
Soft tissue injury over the knee	2	0.40
Wound complications	4	0.80

62.1 years for revision TKA. Urish *et al*[19] conducted a study in patients with a mean age of 67 years to compare re-admission and early revision rates.

Yohe *et al*[20] examined the rate and risks of 30-day complications and unplanned readmissions in patients older than 80 years and concluded that patients older than 84 years are at higher risk of minor complications than those aged 80 years to 84 years. Ali and Bottle[21], D'Apuzzo *et al*[22], and Gould *et al*[23] showed that increasing age is associated with a significant and progressive increase in the risk of all-cause readmission for all age groups. Schairer *et al*[18] showed no differences in age between patients who were or were not readmitted.

In patients undergoing TKA, females predominate over males. In our study, male patients had significantly higher co-morbidities ( $P = 0.003$ ). The study by Ali and Bottle[21] showed that males had a significantly higher risk of readmission for all types of readmissions. D'Apuzzo *et al*[22], Gould *et al*[23], and Urish *et al*[19] showed that male patients had a higher risk of readmission independent of other risk factors. The study by Yohe *et al*[20] showed that male patients had a lower risk than female patients for minor complications postoperatively after TKA. Schairer *et al*[18] concluded that there was no relationship between sex type and patient readmission rate in their study.

In our study, 32.8% of patients suffered from hypertension. Other associated co-morbidities found in a minority of patients were type 2 diabetes (14.4%), coronary artery disease (4.4%), asthma (0.3%), hypothyroidism (2.6%), and rheumatoid arthritis (2.6%). Most patients in our study group had Charlson comorbidity scores of 0-1 (66.5%), indicating mild severity of the associated co-morbidities. Male patients had significantly higher co-morbidities ( $P = 0.003$ ). Patients with a high comorbidity status were found to have a greater duration of knee pain ( $> 5$  years) prior to TKA ( $P = 0.001$ ) and had undergone bilateral TKA ( $P = 0.002$ ).

There was no significant correlation between the co-morbidity status of patients and unplanned readmissions at 30 days ( $P = 0.171$ ) and 90 days ( $P = 0.813$ ), or between co-morbidity status and unplanned visits at 30 days ( $P = 0.363$ ) and 90 days ( $P = 0.554$ ). Benito *et al*[14] concluded in their study that diabetes and coronary artery disease represent potential risk factors for 90-day readmission after TKA. In their systematic review and meta-analysis, Gould *et al*[23] included 69 studies in which risk factors associated with 30-day readmission were hypertension, congestive heart failure, diabetes, an elevated preoperative international normalized ratio, elevated serum blood urea nitrogen, reduced serum albumin, depression, drug abuse, a history of cancer, and chronic kidney disease. A review on readmission rates by Fischer *et al*[24] found that, for certain diseases such as heart failure, the patient's condition is the major driver behind repeated admissions. Urish *et al*[19] found that older patients with diabetes with a LOS longer than 5 days and who were readmitted had an increased risk of reoperation within 1 year. Benito *et al*[14] showed that patients with a LOS  $> 1$  day had greater

**Table 5 Comparisons of readmissions after total knee arthroplasty in various studies**

Readmission after TKA	On 30-day follow-up	On 90-day follow-up
Our study	1.1% ( <i>n</i> = 7)	1.8% ( <i>n</i> = 11)
Urish <i>et al</i> [19]	4% ( <i>n</i> = 703)	5.8% ( <i>n</i> = 1209)
Cassard <i>et al</i> [16]	3.3% ( <i>n</i> = 2) outpatient 4.9% ( <i>n</i> = 25) inpatient	NA
Avram <i>et al</i> [15]	2% ( <i>n</i> = 55)	NA
Workman <i>et al</i> [26]	2.8% ( <i>n</i> = 210)	NA
Ali and Bottle[21]	6.0% ( <i>n</i> = 37195)	NA
D'Apuzzo <i>et al</i> [22]	5.8% ( <i>n</i> = 22076)	NA

TKA: Total knee arthroplasty; NA: Not available.

**Table 6 Comparisons of unplanned readmissions after total knee arthroplasty in various studies**

Unplanned readmission after TKA	On 30-day follow-up	On 90-day follow-up
In our study	1.1% ( <i>n</i> = 7)	1.4% ( <i>n</i> = 9)
Schairer <i>et al</i> [18]	4% ( <i>n</i> = 57)	8% ( <i>n</i> = 118)
Urish <i>et al</i> [19]	4% ( <i>n</i> = 703)	5.8% ( <i>n</i> = 1209)
Cassard <i>et al</i> [16]	3.3% ( <i>n</i> = 2) outpatient 4.9% ( <i>n</i> = 25) inpatient	NA
D'Apuzzo <i>et al</i> [22]	5.8% ( <i>n</i> = 22076)	NA
Odum and Springer[27]	12% outpatient <sup>1</sup> 6% inpatient <sup>1</sup>	NA
Ali and Bottle[21]	6.0% ( <i>n</i> = 37195)	NA
Workman <i>et al</i> [26]	2.8% ( <i>n</i> = 210)	NA
Avram <i>et al</i> [15]	2% ( <i>n</i> = 55)	NA
Yohe <i>et al</i> [20]	4.7% ( <i>n</i> = 566)	NA

<sup>1</sup>Number data not reported.

NA: Not available; TKA: Total knee arthroplasty.

odds of 90-day readmission compared with those in the control group (LOS 1 day). Cassard *et al*[16] reported that the average LOS in the inpatient group was 2.9 days, decreasing from 3.5 days in 2014 to 2.2 days in 2017. Avram *et al*[15] showed that the mean readmission hospital LOS for all causes was 8.3 days, with an average LOS of 6.53 days (range: 6 days to 13 days). The average LOS for TKA patients readmitted within the first 30 days and 90 days of follow-up was 6.86 days and 5.59 days, respectively (range: 1 day to 15 days).

In our study, 5 of 609 patients had developed a surgical site wound complication that prompted unplanned visits at the 30-day follow-up. Of these patients, 4 had been readmitted and required surgical intervention, with 1 patient having developed erythema at the surgical site, 1 having bleeding from the suture line, and 2 patients having discharge from the suture line. Three of these patients were managed with knee arthrotomy and lavage and one with debridement with vacuum-assisted closure (VAC) application. A total of 2 of 609 patients were admitted with soft tissue injuries requiring readmission between 30 days and 90 days after TKA. In all, 28 of 609 patients had an unplanned visit to the hospital within 90 days of TKA; specifically, 16 (2.6%) of the 28 unplanned visits occurred within the first 30 days of TKA. Ten of the unplanned visits within the first 30 days of TKA were for surgical reasons, whereas the remaining six were for medical reasons. In our 90-day follow-up after TKA, of the 28 (4.6%) unplanned visits, 17 were due to surgical reasons and 11 were due to medical reasons. Cassard *et al*[16] found that unplanned visits to the hospital within 30 days of TKA was 4.8% (*n* = 3) in the outpatient setting and 2.4% (*n* = 12) in the inpatient setting. In our study, 11 of the 609 (1.8%) patients were readmitted to the hospital in the 90 days follow-up period. Of the 11 patients, 2 had a planned readmission and 9 had an unplanned readmission. Of these 11 readmissions, there were a total of 7 (1.1%) unplanned readmissions that occurred within the first 30 days of TKA and no planned readmissions. Of the seven unplanned readmissions, two

were due to febrile illnesses, which were managed with oral antibiotics with packed red blood cell transfusion and intravenous antibiotics, respectively, one was due to stroke, for which anticoagulants and thrombolytics were given, and four were due to wound-related complications, which were managed with knee arthrotomy and lavage and debridement with VAC application. Three of these unplanned readmissions occurred for medical reasons and four were due to surgical causes.

In our 30-day to 90-day follow-up period, four readmissions occurred, of which two were planned and two were unplanned; one was due to a spine tumor, which was excised, one was due to talonavicular degeneration, which was managed with ankle arthrodesis, and two were due to soft tissue injuries over the knee, which were managed with wound wash and suturing and debridement and VAC application, respectively. All patients were discharged to their homes.

Re-operation rates in the 30-day and 90-day follow-up after TKA were found to be 0.66% ( $n = 4$ ) and 1.15% ( $n = 8$ ), respectively. Unplanned readmissions and visits within 90 days of follow-up did not significantly correlate with age group ( $P = 0.922$ ), BMI ( $P = 0.633$ ), or unilateral *vs* bilateral TKA ( $P = 0.696$ ). Unplanned readmissions within the first 30 days after TKA and data on unplanned visits within the first 30 days of follow-up following TKA were not substantial enough for a correlation to be identified.

Reduced LOS after TKA is a noticeable trend in the Western world. The use of TKA as an outpatient procedure has also increased. Because most patients are transferred to nursing homes or inpatient rehabilitation facilities in the west, the average LOS is shorter. Low LOS was linked to greater 30-day readmission rates in studies by Ali and Bottle[21] and Cram *et al*[25]. In India, many patients are discharged home with limited access to medical care, which justifies a longer LOS and adequate optimization (physiotherapy, wound dressings, intravenous antibiotics) of patients before discharge. In our study, there was a low rate of unplanned visits and readmissions, as patients were optimized following surgery before being discharged. However, additional studies with a larger sample size are needed in the Indian population to determine the effect of LOS on readmission and other factors that affect readmission rates.

## CONCLUSION

In our study, patients had a low readmission rate following TKA. There was no significant correlation between readmission rate and patient factors such as age, BMI, and co-morbidity status.

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## FOOTNOTES

**Author contributions:** Jethi T contributed to the study design and conducted the data analysis, data collection, and statistical analyses; Jain D contributed to the study design and conceptualization of the core concepts, and made other important intellectual contributions; Garg R and Selhi HS made important intellectual contributions.

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**Informed consent statement:** Before being enrolled in the study, each participant or their legal guardian gave their informed verbal consent as participants and their guardians were contacted by phone during follow up.

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