SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Saravanan *et al*., 2026
doi: 10.21276/SSR-IIJLS.2026.12.1.17

Original Article

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Does Surgical Start Time Influence Postoperative Outcomes in Total Knee Arthroplasty? A Retrospective Hospital-Based Study

Sabapathy Parvathy Saravanan[1], Manoranjan Jena[2], Avijeet Swain[3]*

[1]Assistant Professor, Department of Orthopedics, SRM Medical College & Hospital, Bhawanipatna, Odisha, India
[2]Associate Professor, Department of Community Medicine, PRM Medical College & Hospital, Baripada, Odisha, India
[3]Associate Professor, Department of Anaesthesiology and Critical Care, Pabitra Mohan Pradhan Medical College & Hospital, Talcher, Angul, India

***Address for Correspondence:** Dr. Avijeet Swain, Associate Professor, Department of Anaesthesiology and Critical Care, Pabitra Mohan Pradhan Medical College & Hospital, Talcher, Angul, India
E-mail: dravijeet79@gmail.com

Received: 18 Oct 2025/ Revised: 13 Nov 2025/ Accepted: 22 Dec 2025

ABSTRACT

Background: Total knee arthroplasty (TKA) is a widely performed procedure for advanced knee osteoarthritis with generally predictable outcomes. While patient-related factors and surgical technique are well-recognized determinants of postoperative results, the influence of non-clinical factors such as the timing of surgery during the day remains inadequately explored. Emerging evidence suggests that circadian physiology and institutional scheduling practices may influence postoperative complications.

Methods: This retrospective observational study analyzed 80 patients undergoing primary unilateral total knee arthroplasty at SCB Medical College, Cuttack (January 2023–December 2024). Patients were grouped by surgical start time into early morning, mid-day, and late-day categories. Demographic data, operative duration, hospital stay, and in-hospital complications were assessed using one-way ANOVA and chi-square tests, with $p<0.05$ considered significant.

Results: Baseline characteristics, operative time, and hospital stay were similar across all surgical time groups. Although not statistically significant, postoperative complications showed a decreasing trend from early morning to late-day surgeries, with the highest rates in early morning cases and the lowest after 2:00 PM.

Conclusion: Surgical start time did not significantly affect operative duration or hospital stay after total knee arthroplasty. A non-significant trend toward higher complications in early morning surgeries was noted, suggesting a possible role of circadian or scheduling factors. Larger prospective studies are needed to confirm the clinical relevance of surgical timing.

Key-words: Total knee arthroplasty; Surgical timing; Circadian rhythm; Postoperative complications; Orthopaedics; Hospital-based study

INTRODUCTION

Total knee arthroplasty (TKA) is a widely accepted and effective surgical intervention for patients with advanced knee osteoarthritis, resulting in substantial improvements in pain relief, functional capacity, and overall quality of life [1-3].

How to cite this article
Saravanan SP, Jena M, Swain A. Does Surgical Start Time Influence Postoperative Outcomes in Total Knee Arthroplasty? A Retrospective Hospital-Based Study. SSR Inst Int J Life Sci., 2026; 12(1): 9087-9092.

Access this article online
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With increasing life expectancy and a rising burden of degenerative joint disorders, the volume of TKA procedures has grown steadily in recent years. As a result, there is increasing emphasis on optimizing perioperative factors to improve postoperative outcomes, reduce complications, and enhance patient safety [3-4].

Traditionally, outcomes following TKA are influenced by factors such as patient demographics, comorbid conditions, surgical technique, anesthesia, implant selection, and postoperative rehabilitation protocols [4-6]. More recently, attention has been drawn to non-clinical and system-related variables that may influence surgical outcomes. One such factor is the timing of surgery during the operating day, which may affect operative

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efficiency, complication rates, and postoperative recovery [5-7].

The potential influence of surgical start time on outcomes has been attributed to factors such as surgeon and operating room staff fatigue, variations in workflow efficiency, resource availability, and circadian physiological changes [6-9]. Evidence from various surgical specialties suggests that procedures performed later in the day may be associated with prolonged operative time or higher complication rates; however, data specific to orthopaedic procedures, particularly total knee arthroplasty, remain limited and inconclusive [8-10].

In a busy tertiary care teaching hospital setting, understanding whether the timing of surgery affects postoperative outcomes in TKA has important implications for operating room scheduling and healthcare resource utilization. Therefore, this study was undertaken at SCB Medical College and Hospital, Cuttack, to evaluate the impact of surgical start time on selected postoperative outcomes in patients undergoing primary unilateral total knee arthroplasty.

MATERIALS AND METHODS

Study Design and Setting- This retrospective observational study was conducted in the Department of Orthopaedics at SCB Medical College and Hospital, Cuttack, a tertiary care teaching institution. Medical records and operation theatre registers were reviewed to identify patients who underwent primary unilateral total knee arthroplasty between January 2023 and December 2024.

Study Population- A total of 80 consecutive patients who underwent elective primary unilateral total knee arthroplasty for degenerative knee osteoarthritis during the study period were included. Patients undergoing revision arthroplasty, bilateral knee replacement in a single sitting, or those with incomplete medical records were excluded.

Grouping Based on Surgical Start Time- Patients were categorized into three groups according to the scheduled surgical start time recorded in the operation theatre log: Group A (8:00–10:59 AM), Group B (11:00 AM–1:59 PM), and Group C (≥2:00 PM).

Data Collection and Outcome Measures- Data collected included demographic variables (age and gender), intraoperative details (operative duration from skin incision to wound closure), and postoperative outcomes such as early complications and length of postoperative hospital stay, calculated from the day of surgery to discharge.

Statistical Analysis- Data were entered into Microsoft Excel and analyzed using R statistical software. Continuous variables were expressed as mean ± standard deviation and compared using one-way ANOVA. Categorical variables were presented as frequencies and percentages and analyzed using the chi-square test. A p-value<0.05 was considered statistically significant.

RESULTS

The final analysis included 80 patients who underwent primary unilateral total knee arthroplasty during the study period and were categorized into three surgical start time groups: Group A (8:00–10:59 AM; n=30), Group B (11:00 AM–1:59 PM; n=30), and Group C (≥2:00 PM; n=20). Baseline demographic variables were comparable across the three groups, with no statistically significant difference in mean age (p=0.45) or gender distribution (p=0.96). Perioperative parameters, including mean operative duration and mean postoperative hospital stay, were also similar among the groups, with no significant variation observed (p=0.24 and p=0.22, respectively). These findings indicate that patients operated at different times of the day were broadly comparable with respect to demographic characteristics, surgical efficiency, and immediate postoperative recovery (Table 1).

Postoperative complications showed a decreasing trend across the surgical time groups. Group A demonstrated the highest complication rate, with 8 of 30 patients (26.7%) experiencing at least one postoperative complication, followed by Group B with 5 of 30 patients (16.7%) and Group C with 2 of 20 patients (10%). Although this trend did not reach statistical significance (p=0.09), a progressive reduction in complication rates from early morning to late-day surgeries was observed. The detailed distribution of postoperative complications is presented in Table 2. In Group A, complications included surgical site infection (n=2), deep vein thrombosis (n=1), urinary retention (n=1), transient bradycardia (n=1), postoperative delirium (n=1), local hematoma (n=1), and persistent postoperative pain

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requiring extended analgesia (n=1). In Group B, complications comprised surgical site infection (n=1), deep vein thrombosis (n=1), postoperative hypotension (n=2), postoperative delirium (n=1), and catheter-associated urinary tract infection (n=1). Group C had the lowest complication burden, with one patient experiencing transient postoperative hypoxia and one patient developing mild wound ooze that resolved with conservative management.

Table 1: Surgical Timing and Postoperative Outcomes (N=80)

Parameter	8:00–10:59 AM (n=30)	11:00 AM–1:59 PM (n=30)	≥2:00 PM (n=20)	p-value
Mean age (years)	65.1 ± 8.4	66.0 ± 8.7	63.5 ± 9.0	0.45 (ANOVA)
Gender (M/F)	13 / 17	14 / 16	9 / 11	0.96 (Chi-square)
Mean surgery duration (min)	118.7 ± 25.4	114.8 ± 23.1	110.9 ± 21.6	0.24 (ANOVA)
Mean postoperative stay (days)	4.40 ± 1.1	4.25 ± 1.2	4.00 ± 1.1	0.22 (ANOVA)
Complication rate	8 (26.7%)	5 (16.7%)	2 (10.0%)	0.09 (Chi-square)

Table 2: Distribution of Postoperative Complications According to Surgical Start Time

Type of complication	8:00–10:59 AM (n=30)	11:00 AM–1:59 PM (n=30)	≥2:00 PM (n=20)
Surgical site infection	2	1	0
Deep vein thrombosis	1	1	0
Postoperative hypotension	0	2	0
Urinary retention	1	0	0
Catheter-associated UTI	0	1	0
Postoperative delirium	1	1	0
Transient bradycardia	1	0	0
Local hematoma	1	0	0
Persistent postoperative pain	1	0	0
Transient postoperative hypoxia	0	0	1
Mild wound ooze	0	0	1
Total complications	8	5	2

DISCUSSION

Although the present study did not demonstrate statistically significant differences, the findings reveal a consistent trend suggesting that total knee arthroplasty procedures performed earlier in the day may be associated with a higher incidence of postoperative complications. Importantly, operative duration and length of hospital stay remained comparable across all surgical time windows, indicating that procedural efficiency and immediate postoperative recovery were not influenced by surgical start time. However, the progressive decline in complication rates from morning to late afternoon

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raises clinically relevant questions that merit deeper exploration.

One plausible explanation for this observed pattern relates to circadian rhythms, endogenous biological cycles regulated by the suprachiasmatic nucleus that influence numerous physiological processes over 24 hours. These rhythms modulate immune function, inflammatory responses, coagulation pathways, cardiovascular tone, and pain perception [7-10]. Prior physiological studies have demonstrated that cortisol levels, sympathetic activity, and pro-inflammatory mediators tend to peak during early morning hours. Such circadian-driven physiological vulnerability may predispose patients undergoing surgery in the morning to a higher risk of inflammatory, thrombotic, or cardiovascular complications [8,9]. Reduced endothelial function and increased platelet aggregability during early hours, as described in earlier chronobiology literature, provide a biologically plausible mechanism for this trend.

Existing literature has increasingly explored the relationship between surgical timing and specific postoperative complications. Studies have reported higher early-day rates of surgical site infections, thromboembolic events, and perioperative cardiovascular instability [9-12]. Variations in immune surveillance, tissue perfusion, and coagulation status across the circadian cycle may partially explain these findings. The pattern observed in the present study, with higher early-morning complication rates and progressively fewer complications later in the day, aligns with this growing body of evidence, even though statistical significance was not achieved [13].

Beyond patient physiology, institutional scheduling practices likely play an important role. The practice of "frontal loading," in which more complex or higher-risk cases are scheduled earlier in the day, is common in many surgical centres. While this approach ensures maximum resource availability and senior staff presence, it may inadvertently concentrate higher-risk cases in morning time slots [12-15]. Consequently, the surgical start time may serve as a surrogate marker of case complexity rather than an independent determinant of outcomes. Although procedural complexity was not explicitly stratified in the present study, this confounding factor must be considered when interpreting trends in early-day complications.

Contrary to concerns regarding cumulative team fatigue, this study did not demonstrate an increase in complications in later surgical sessions. This suggests that the surgical teams in this high-volume tertiary care center maintained consistent performance throughout the operating day [13-16]. Effective handover protocols, standardized workflows, and stable team composition likely mitigated fatigue-related performance decline. Such findings highlight the importance of institutional systems in maintaining surgical quality irrespective of time of day [11-13].

Surgical scheduling has important operational and economic consequences. Imbalanced operating lists that cluster cases in the morning can lead to inefficient utilization of operating rooms later in the day and increased overtime costs. Incorporating predictive scheduling models that consider patient risk profiles, procedural complexity, and physiological readiness could improve operating room efficiency while maintaining patient safety [10-12].

Chronotherapeutics, which aligns medical interventions with biological rhythms, offers a promising framework for optimizing surgical timing. Emerging evidence suggests that integrating circadian biology into scheduling algorithms, potentially supported by artificial intelligence-based models, may help identify optimal operative windows for specific patient populations and procedures. Such approaches could minimize complication risk and improve outcome predictability [10-14].

Patient-reported outcomes are increasingly recognized as critical indicators of healthcare quality. Previous studies have suggested that surgeries performed later in the morning or early afternoon may be associated with higher patient satisfaction, potentially due to reduced fasting duration and lower preoperative anxiety. Although patient-reported outcome measures were not assessed in the present study, their inclusion in future research would provide a more comprehensive evaluation of surgical timing effects [14-16].

Frailty indices, ASA scores, and comorbidity burden are well-established predictors of adverse postoperative outcomes in total knee arthroplasty. Evidence suggests that frailty may be a stronger determinant of complications than chronological age alone. The absence of these parameters in the present analysis limits causal inference. Future studies should incorporate detailed

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patient-level risk stratification to contextualise the influence of surgical timing better.

Surgical scheduling decisions carry ethical implications, particularly when high-risk patients are repeatedly allocated to early operative slots. If early surgery is indeed associated with increased complications, even indirectly, such practices raise concerns regarding equity and transparency. Ethical frameworks that balance operational efficiency with patient safety and fair risk distribution are essential for responsible scheduling policies.

LIMITATIONS

The present study has several limitations. First, the sample size of 80 patients limits statistical power, particularly for detecting infrequent complications. Although a clear trend was observed, the study may be underpowered to demonstrate statistical significance. Second, important confounding variables, such as ASA grade, body mass index, frailty status, and comorbidity burden, were not included, limiting causal interpretation. Third, patient-reported outcome measures and early functional recovery scores were not assessed, limiting the evaluation of patient-centred outcomes. Finally, the retrospective design inherently limits control over unmeasured confounders.

CONCLUSIONS

This study suggests a possible diurnal trend in postoperative complications following total knee arthroplasty, with a higher incidence observed in early-morning surgeries and progressively fewer complications later in the day. Although these findings did not achieve statistical significance, they highlight a clinically relevant signal that may reflect a complex interaction between circadian physiology and institutional scheduling practices. Given the absence of significant differences in operative duration and hospital stay, surgical timing appears unlikely to influence procedural efficiency but may influence complication risk. Larger, prospective, and multicentric studies incorporating detailed patient risk profiles, procedural complexity, chronobiological parameters, and patient-reported outcomes are required before surgical scheduling policies can be modified. Until such evidence is available, surgical timing should be interpreted cautiously and within the broader context of patient safety and institutional resources.

CONTRIBUTION OF AUTHORS

Research concept- Sabapathy Parvathy Saravanan, Manoranjan Jena

Research design- Sabapathy Parvathy Saravanan, Manoranjan Jena

Supervision- Manoranjan Jena, Avijeet Swain

Materials- Sabapathy Parvathy Saravanan, Manoranjan Jena, Avijeet Swain

Data collection- Sabapathy Parvathy Saravanan, Manoranjan Jena

Data analysis and interpretation- Manoranjan Jena, Avijeet Swain

Literature search- Sabapathy Parvathy Saravanan, Avijeet Swain

Writing article- Sabapathy Parvathy Saravanan, Avijeet Swain

Critical review- Manoranjan Jena, Avijeet Swain

Article editing- Avijeet Swain

Final approval- Manoranjan Jena, Avijeet Swain

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