

# Total Knee Arthroplasty: Does Day of Surgery Matter?

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## ABSTRACT

**INTRODUCTION:** There has been an influx of research studies aimed at identifying all factors that contribute to minimizing cost and maximizing postoperative care after total knee arthroplasty (TKA). Length of stay (LOS) has been defined as a significant factor that contributes to increased burden. We aimed at looking whether day of surgery has any significant effect on the LOS and postoperative complications following total knee arthroplasty (TKA).

**MATERIALS AND METHODS:** Retrospective cohort study done at the Aga Khan University Hospital, Pakistan, from January 2007 to December 2015. A total of 611 patients who underwent a unilateral or bilateral total knee arthroplasty (TKA) were included in study: 269 (44.0%) patients underwent unilateral TKA and 342 (56.0%) underwent a bilateral TKA.

**RESULTS:** Kruskal-Wallis test and post hoc pairwise comparisons showed that unilateral TKAs performed on Tuesday, Saturday, and Sunday resulted in a lower median LOS ( $P < .05$ ). No significant association was seen in bilateral TKA group. Day of surgery was not associated with postoperative complications.

**CONCLUSIONS:** Unilateral TKAs performed earlier during the week and later on the weekend are associated with a significantly lower LOS. It is highly probable that patch ancillary services during the latter part of the week and a higher workload for the staff are important reasons for this phenomenon.

**KEYWORDS:** Day of surgery, total knee arthroplasty, TKA, length of stay, postoperative complications

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## Introduction

Total knee arthroplasty (TKA) has been widely recognized as the gold standard in the treatment for advanced osteoarthritis of the knee.<sup>1,2</sup> The procedure is one of the most commonly performed operations in the United States with studies predicting a growth projection of 673% by 2030.<sup>3</sup> Studies have shown that it successfully results in pain relief and improvement in the functional outcome in greater than 90% of the patients.<sup>4</sup>

A significant percentage of patients (10%–20%), however, still continue to experience complications and report poor outcomes following this procedure. With the evolution of technology, recent studies are targeting the identification of factors that contribute to an increased cost-effectiveness for the patient and hospital alike. The introduction of newer and fast-track clinical care pathways has also resulted in the influx of newer research studies aimed at identifying all factors contributing to minimizing cost and maximizing perioperative and postoperative care.<sup>5</sup> Previous research has shown that length of stay (LOS) is a significant factor that contributes to an increased cost burden.<sup>6,7</sup> Therefore, it is imperative that identification of all associated hospital and patient predictors contributing to an increased LOS be identified.

Our study aims at looking whether the day of surgery (DOS) has any significant effect on the LOS, postoperative complications, and 30-day morbidity.

## Materials and Methods

This was a retrospective study done at a tertiary care hospital in Pakistan from January 2007 to December 2015. After exemption/approval from the Ethical Review Committee of the hospital, we accessed records for all TKAs done within this time period. All patients, regardless of sex, comorbidities, and age, who underwent a unilateral or bilateral TKA were included in the study. Those patients who underwent a revision TKA were excluded from the study. Those patients who had missing data were also excluded from the study. A total of 611 were finally included in analysis.

All surgeries were performed by consultant orthopedic surgeons with up to two residents assisting during the procedure. An important fact to mention is that orthopedic surgeons in Pakistan are not simply limited to performing only surgeries relevant to their subspecialty, ie, a fellowship-trained hand or orthopedic spine surgeon would also be routinely performing joint replacements due to scarcity of tertiary care hospitals and trained orthopedic surgeons. Moreover, although there may be set days for every consultant orthopedic surgeon often times due to an increased workload, there is a significant overlap in the days as surgeries get either pushed or “squeezed” in whenever an operating room may become available. All surgeries were performed under standard operative and clinical guidelines. Patients were kept in the postanesthesia recovery unit for up to 12 to 24 hours postsurgery after which they were shifted



to the clinical wards. Postoperative rehabilitation protocol consisted of the following steps: knee range of motion and full weight bearing as tolerated were started postoperative day 1 in case of patient undergoing general anesthesia. For patients with regional/epidural anesthesia, knee range of motion exercises were started postoperatively on day one and full weight bearing as tolerated was started after the epidural catheter was removed.

Medical records were reviewed and noted on a proforma. Length of stay was defined as the time from the date of admission to date of discharge. The DOS was extracted from the date of surgery using SPSS Version 20. Postoperative complications such as deep vein thrombosis, urinary tract infection, cardiac complications, surgical site infections and 30-day complications and morbidity were also recorded.

The population was divided into 7 groups each corresponding to the day the surgery was performed (Monday=1, Tuesday=2, Wednesday=3, etc). Kolmogorov-Smirnov tests and Shapiro-Wilk tests showed that the distribution of LOS was skewed ( $P < .05$ ); thus, nonparametric tests were used for analysis of continuous variables. Therefore, Kruskal-Wallis test was used for the analysis of LOS between the 7 groups. The  $\chi^2$  test was used for comparison of categorical variables between the DOS and postoperative complications. All values were considered significant at the 5% level. Analysis was performed using SPSS v20.

## Results

Of a total of 611 patients, 269 (44.0%) underwent a unilateral TKA and 342 (56.0%) underwent a bilateral TKA. Table 1 shows the total number of unilateral TKA and bilateral TKA performed in each of the DOS groups. The highest number of procedures being performed was on Wednesday with 107 unilateral TKAs (39.7%) and 151 bilateral TKAs (44.1%).

Kruskal-Wallis test showed that there was significant association present among the days and the LOS in the unilateral surgery group (Table 2). No significant association was seen in the bilateral TKA group; therefore, no further analysis was conducted in that group. Demographics of the unilateral and bilateral TKA group are shown in Table 3.

Univariate analysis was run to see whether sex, age, and body mass index (BMI) were associated with LOS. This was done to identify any significant predictors which if present could be adjusted for to study the effect of DOS alone. The Spearman correlation showed that both age ( $r = .104$ ;  $P = .09$ ) and BMI ( $r = -.057$ ;  $P = .35$ ) were not associated with LOS. For sex, we conducted a Mann-Whitney  $U$  test which also showed that sex had no effect on the LOS ( $P = .803$ ). Further univariate analysis was done between the days of the week to identify which days were significantly associated with a higher median LOS (Table 4 and Figure 2). Surgeries performed on Tuesday had a significantly lower median LOS when compared with those performed on Wednesday, Thursday, and Friday (Figures 1 and 2). Similarly, surgeries performed on Sunday were associated with significantly lower LOS when compared with those

**Table 1.** Frequencies of the number of procedures performed per day.

	UNILATERAL TKA (N=269)	BILATERAL TKA (N=342)
Monday	3 (1.1%)	1 (0.3%)
Tuesday	22 (8.2%)	20 (5.8%)
Wednesday	107 (39.7%)	151 (44.2%)
Thursday	27 (10.0%)	29 (8.5%)
Friday	51 (18.9%)	74 (21.6%)
Saturday	45 (16.7%)	53 (15.5%)
Sunday	14 (5.2%)	14 (4.1%)

Abbreviation: TKA, total knee arthroplasty.

**Table 2.** Kruskal-Wallis test with grouping variable: day of the week.

TYPE OF SURGERY	LENGTH OF STAY (P VALUE)
Unilateral	.007
Bilateral	.119

**Table 3.** Demographics of patients who underwent a unilateral TKA.

DEMOGRAPHICS OF PATIENTS WHO UNDERWENT A UNILATERAL TKA (N=269)		DEMOGRAPHICS OF PATIENTS WHO UNDERWENT A BILATERAL TKA (N=342)	
Sex		Sex	
Male	77 (28.6%)	Male	62 (18.1%)
Female	192 (71.4%)	Female	280 (81.9%)
Age, years (mean $\pm$ SD)	62.7 $\pm$ 10.6	Age, years (mean $\pm$ SD)	61.7 $\pm$ 9.0
BMI (mean $\pm$ SD)	30.2 $\pm$ 6.2	BMI (median $\pm$ SD)	31.6 $\pm$ 5.5
Length of stay, days (mean $\pm$ SD)	7.9 $\pm$ 2.8	Length of stay, days (mean $\pm$ SD)	9.65 $\pm$ 2.8

Abbreviation: BMI, body mass index; TKA, total knee arthroplasty.

performed on the weekdays (Wednesday, Thursday, and Friday). In addition, surgery performed on Saturday was associated with a lower median LOS when compared with those performed on Thursday. There was no significant association present between DOS and incidence of postoperative complications and 30-day morbidity in both unilateral and bilateral TKA groups (Tables 5 and 6).

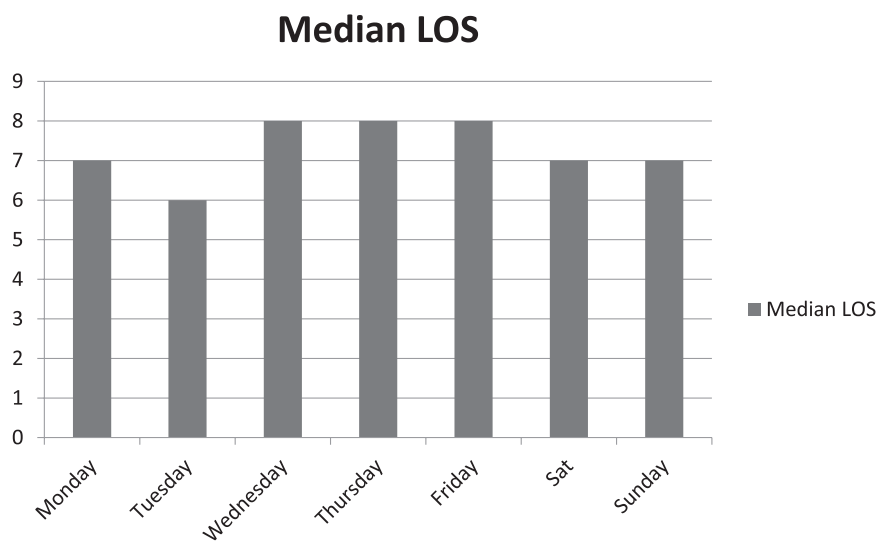
## Discussion

Our study showed that unilateral total knee arthroplasty (TKA) surgeries performed earlier during the week and on the weekends resulted in a significantly shortened LOS when compared with other days. Similar findings were reported by Muppavarapu et al,<sup>8</sup> who also concluded that total joint

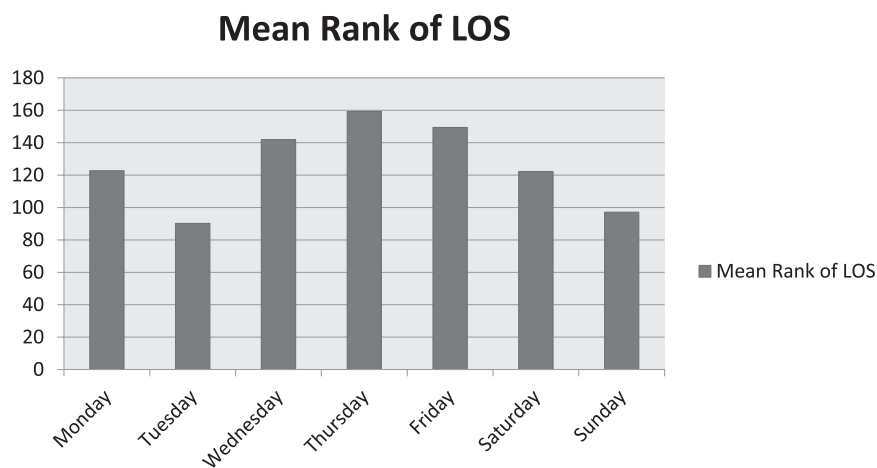
**Table 4.** Pairwise post hoc comparison between day of surgery groups in unilateral total knee arthroplasty.

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
Monday	X	X	X	X	X	X	X
Tuesday	0.345	X	X	X	X	X	X
Wednesday	0.646	<b>0.007</b>	X	X	X	X	X
Thursday	0.374	<b>0.002</b>	0.346	X	X	X	X
Friday	0.526	<b>0.003</b>	0.505	0.619	X	X	X
Saturday	0.948	0.082	0.130	<b>0.032</b>	0.117	X	X
Sunday	0.593	0.414	<b>0.029</b>	<b>0.005</b>	<b>0.033</b>	0.320	X

Values in bold are significant ( $p < 0.05$ ).



**Figure 1.** Median LOS of each day of surgery. LOS indicates length of stay.



**Figure 2.** Mean rank of LOS between groups using Kruskal-Wallis test ( $P < .05$ ). LOS indicates length of stay.

arthroplasties performed earlier in the week resulted in a shorter LOS. Another recent study published in *The Journal of Arthroplasty* investigating the impact of TKAs being performed on later weekdays versus early weekdays also concluded that the former (surgeries on later weekdays) were associated with a longer LOS.<sup>9</sup>

The highest number of TKAs performed was on Wednesday and the lowest number was on Monday, Tuesday, and Sunday. As primary TKAs being performed on itself during Monday are far too less to pose any clinical significance, we deem it suitable to keep Tuesday and Sunday as days with the lowest number of surgeries. There could be multiple reasons for our

**Table 5.** Pearson  $\chi^2$  test between postoperative complications and day of surgery in unilateral TKA.

UNILATERAL TKA	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	P VALUE
UTI	—	1 (4.5%)	2 (1.9%)	—	4 (7.8%)	2 (4.4%)	—	.458
SSI	—	—	1 (0.9%)	—	1 (2.0%)	2 (4.4%)	—	.679
DVT	—	—	—	—	—	—	—	—
Cardiac	—	—	1 (4.5%)	—	—	1 (2.2%)	—	.683
30-d complications	—	—	1 (0.9%)	—	3 (5.9%)	1 (2.2%)	—	.389

Abbreviations: UTI, urinary tract infection; DVT, deep vein thrombosis; SSI, surgical site infections; TKA, total knee arthroplasty.

**Table 6.** Pearson Chi-Square test between postoperative complications and day of surgery in bilateral TKA.

BILATERAL TKA	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	P VALUE
UTI	—	1 (5.0%)	1 (0.7%)	1 (3.4%)	2 (2.7%)	—	1 (7.1%)	.374
SSI	—	—	1 (0.7%)	—	—	—	—	.973
DVT	—	—	—	—	—	—	—	—
Cardiac	—	1 (5.0%)	2 (1.3%)	2 (6.9%)	2 (2.7%)	2 (3.8%)	—	.652
30-d complications	—	—	5 (3.3%)	3 (10.3%)	1 (1.4%)	2 (3.8%)	—	.342

Abbreviations: UTI, urinary tract infection; DVT, deep vein thrombosis; SSI, surgical site infections; TKA, total knee arthroplasty.

findings. A plausible explanation for this could be ancillary services including physiotherapy, that are required to maximally work with the patients for an optimum outcome, are “patchy” over the weekend and hence patients operated earlier during the week who have their predicted discharge over the weekend are not comfortable to go home and spend some more time in the beginning of the next week. To further support this hypothesis, Briggs et al<sup>10</sup> conducted a similar study in a large academic tertiary care centre and concluded that the time to first postoperative physiotherapy was directly related to the LOS. Extrapolating their finding to our study, it is plausible that a lower workload on the weekend can impair the postoperative clinical care protocol and thus lead to a “bottleneck.” Peiris et al<sup>11</sup> showed that providing an additional day of rehabilitation improved functional independence and health-related quality of life at discharge and may have reduced LOS for patients receiving inpatient rehabilitation. Similarly, a study done by Brusco et al<sup>12</sup> showed that provision of additional Saturday physiotherapy intervention resulted in significantly shorter hospital LOS. Another study done in 2012 also showed that a 7-day physiotherapy regime resulted in shorter LOS versus a 5-day physiotherapy regime.<sup>13</sup> Hughes et al<sup>14</sup> also showed that postoperative weekend physiotherapy regime results in a significant reduction in postoperative LOS following TKR. A retrospective cohort study done in Singapore also had similar results showing that a Sunday physiotherapy regime implemented for those who underwent a TKR on Friday resulted in a shorter LOS and a faster short-term knee recovery.<sup>15</sup>

However, patients who have been operated on midweek have “balanced” work time with physiotherapy immediately after operation as well as just before hospital discharge—predicted time “overcoming” the weekend which falls right in between their therapy. Similarly, patients operated on the weekend have consistent physiotherapy throughout the week and by the following weekend are ready to be discharged. Another possibility is that patients who have their surgeries earlier in the week have their epidural catheters removed close to the weekend. This coupled with “patchy” ancillary and physiotherapy services over the weekend may result in the patients having a longer LOS. Along the same lines, patients having their surgery over the weekend have their epidural catheters removed midweek and have ample physiotherapy just before the upcoming week leading to a shortened discharge time. Past research has suggested that early removal of epidural catheters in nonorthopedic fast-track recovery protocols can result in a significantly reduced LOS.<sup>16</sup> Alternatively, another study concluded that for patients undergoing TKA during the later weekdays have to deal with the unavailability of insurance providers and case managers on the weekend. Thus, the patients are unable to get discharged quickly and appropriately and have to wait till the start of the next week.<sup>9</sup> However, that reason can only be partly extrapolated in our study. In Pakistan, there are very limited private health insurance systems in place and most of the patient population tends to pay for the whole services out of their pockets completely.

Promising studies showing that, with implementation of clinical pathway guidelines, day of week no longer remains a predictor of the LOS have definitely introduced a way to battle this problem.<sup>17</sup> With the advent of service lines set up in our hospital to facilitate and expedite patient care, patient outcomes including discharge times and LOS have been addressed, and we should be able to analyze as to how these variables have been affected in upcoming studies.

Past studies have shown that more postoperative pain and intraoperative blood loss (and therefore increased blood transfusion) are correlated directly with an increased LOS.<sup>18,19</sup> The introduction of multimodal postoperative analgesia, identification of risk factors contributing to postoperative blood transfusion, and an optimum physiotherapy regime would serve as an effective 3-pronged approach in minimizing LOS.

One study suggested that one such explanation for our findings could be due to large variance present in the experience level and credentials of hospital staff between regular working hours and on the weekends.<sup>8</sup> A lower operating room workload would also lead to more postoperative care staff available for the patient that would allow for expedited and quick postoperative management and care.

A study on hip fractures by Foss et al and Kehlet<sup>20</sup> showed that there is a significantly reduced percentage of perioperative care and physiotherapy staff during holidays, such as weekends, and this is directly correlated with an increased 5- and 30-day mortality when compared with weekdays. Our study, however, found no significant association between surgeries performed on weekdays and postoperative complications and 30-day complications ( $P > .05$ ).

Another couple of interesting past studies have shown that anxiety levels and psychiatric comorbidities of the patient preoperatively have a significant effect on the LOS and perioperative outcomes.<sup>21,22</sup> Whether our patients operated over the weekend had low levels of anxiety at that time is something that can be explored in future studies.

One of the major limitations of this study is the retrospective nature and inability to control for numerous confounding variables. Another limitation of the study is that the results were based on one hospital only and may not reflect findings of other hospitals. That being said, our hospital is the major tertiary care referral hospital of Pakistan and follows numerous clinical guidelines and health policies to maintain accreditation by the Joint Commission. However, it is possible that poor staffing levels among other reasons may be the major cause of such a phenomenon and indicates a flaw at the hospital level. Another important limitation is that surgeon experience was not accounted for in our study. Although only few past studies have kept this as variable when investigating the impact of the DOS on the LOS, studies have shown that surgeon experience may affect patient outcomes. However, with that being said, we have seen that in our hospital there is a significant overlap in

the daily schedule of consultants due to a large backlog of waiting patients and scarcity of operating rooms, thus making analysis of data difficult. Future studies investigating the effect of DOS should cater toward including the surgeon experience as a confounding variable.

## Conclusions

Based on our findings, we conclude that unilateral TKAs performed earlier during the week and later on the weekend were associated with a significantly lower LOS. However, these findings are based on data from one tertiary care hospital, and further research involving multiple tertiary care centers are required before reaching to a conclusion. With the advent of service lines in our hospital to enhance patient care and outcomes, further studies are currently under way to see whether these changes have favorably affected patient outcomes including LOS.

## Author Contributions

ATM was involved in conception of idea, study design, data collection, analysis and manuscript writing. SK, AA and SHM were involved in data collection. SN was involved in supervision of study and critical review of manuscript.

## Availability of Data and Materials

The data sets used and/or analyzed during this study are available from the corresponding author on reasonable request.

## Disclosures and Ethics

The authors declare that there is no conflict of interest. Because this study was a retrospective study, exemption for ethical approval was granted by the institutional review board of the Aga Khan University.

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