İstanbul Med J 2025; 26(1): 42-6
DOI: 10.4274/imj.galenos.2025.60963

Impact of Drain Use and Tourniquet Release Timing on Blood Loss, Operative Time, and Wound Complications in Total Knee Arthroplasty

Emre Özmen[1], Alican Barış[1], Fahri Erdi Malkoç[1], Süha Ahmet Aktaş[1], Muhammed Yunus Gazaioğlu[1], Kevser Yamen Karaca[2], Bilge Aslan[2], Serdar Yüksel[1]

[1]University of Health Sciences Türkiye, İstanbul Physical Therapy and Rehabilitation Training and Research Hospital, Clinic of Orthopedics and Traumatology, İstanbul, Türkiye
[2]University of Health Sciences Türkiye, İstanbul Physical Therapy and Rehabilitation Training and Research Hospital, Clinic of Anesthesiology, İstanbul, Türkiye

ABSTRACT

Introduction: This study aimed to investigate the effects of different practices regarding tourniquet release timing and drain usage in primary total knee arthroplasty (TKA) on intraoperative and post-operative blood loss, operative time, and post-operative complications.

Methods: A retrospective review was conducted on the records of patients who underwent TKA by one of four authors (E.Ö., S.Y., F.E.M., S.A.A.) from 01.09.2023 to 01.11.2024. Patients were divided into three groups: group A, early tourniquet release without drain use (E.Ö.); group B, early tourniquet release with drain use (F.E.M.); group C, late tourniquet release with drain use (S.A.A. and S.Y.). Patients with revision TKAs or use of constrained prosthesis, or removal of hardware were excluded. A total of 102 patients were identified. Demographic, blood loss, and operative time data were collected. The groups were compared regarding changes in pre- and post-operative hemoglobin (Hb) levels, operative times, and post-operative complications.

Results: No significant differences in age, gender distribution, or pre-operative and post-operative Hb levels were observed between the groups ($p>0.05$). All groups showed a significant decrease in post-operative Hb levels compared with pre-operative values ($p<0.05$), but the Hb change was not statistically different between groups ($p>0.05$). The operative time was significantly longer in group B (122.0±18.6 minutes) than in groups A (101.0±14.3 minutes) and C (97.6±21.5 minutes) ($p<0.05$). Wound complications included prolonged wound drainage in group A, acute infection in group B, and superficial infection in group C, with no significant differences in complication rates between groups ($p>0.05$).

Conclusion: Our results showed that different tourniquet release timings and drain use did not significantly impact perioperative blood loss but may affect the operative time. Specifically, drain use and early tourniquet release were associated with longer operation times. These findings suggest that late tourniquet release minimizes the operative time while maintaining comparable blood loss. This approach may be particularly beneficial in busy surgical settings where reducing operative time is a priority, without compromising patient safety or clinical outcomes.

Keywords: Arthroplasty, drainage, tourniquet, blood loss

Introduction

Osteoarthritis (OA) is a common disability that affects millions of people around the world (1). Severe OA of the knee is treated with total knee arthroplasty (TKA), which is a frequently performed procedure. More than 700,000 TKAs are performed each year worldwide (2). Although the technique is mostly standard and well-established, there are differences in practice exist between surgeons regarding various aspects of the pre-, per-, and post-operative applications.

Drain use is a routine practice in primary TKA (3). In fact, all orthopedic surgeons in the present study were trained in institutions where drain use was the routine practice in all TKAs.

Address for Correspondence: Emre Özmen MD, University of Health Sciences Türkiye, İstanbul Physical Therapy and Rehabilitation Training and Research Hospital, Clinic of Orthopedics and Traumatology, İstanbul, Türkiye
E-mail: emreozmen@istanbul.edu.tr **ORCID ID:** orcid.org/0000-0002-8384-5468

Received: 10.11.2024
Accepted: 12.01.2025
Publication Date: 19.02.2025

Cite this article as: Özmen E, Barış A, Malkoç FE, Aktaş SA, Gazaioğlu MY, Yamen Karaca K, Aslan B, Yüksel S. Impact of drain use and tourniquet release timing on blood loss, operative time, and wound complications in total knee arthroplasty. İstanbul Med J. 2025; 26(1): 42-6

©Copyright 2025 by the University of Health Sciences Türkiye, İstanbul Training and Research Hospital/İstanbul Medical Journal published by Galenos Publishing House. Licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 (CC BY-NC-ND) International License

Another controversial topic in primary TKA is the early release of tourniquets. Early release refers to obtaining hemostatic control before closing the fascial incision by releasing a tourniquet after hardening of the cement. Late release refers to the release of the tourniquet after skin closure.

In our institution, the authors of the present study follow different practices. EO practices early tourniquet release without drain use, F.E.M. practices early tourniquet release with drain use, and S.A.A. and S.Y. practice late tourniquet release with drain use. A considerable number of studies have compared tourniquet and drain practices (4). However, to our knowledge, no studies have compared combinations of these practices side by side. Understanding this issue may help optimize surgical protocols, especially in busy hospitals where efficiency and patient outcomes are crucial. By comparing these combinations side by side, this study aims to fill a critical gap in the existing literature. The present study investigated the effect of drain use and hemostasis on intra- and post-operative blood loss, operation time, and wound complications.

Methods

The University of Health Sciences Türkiye, İstanbul Physical Therapy and Rehabilitation Training and Research Hospital, Ethical Committee approved the study (approval number: 2024-64, date: 08.10.2024). Records of patients who had TKA by one of the four authors (E.Ö., S.Y., F.E.M., and S.A.A.) between 01.09.2023 and 01.11.2024 were retrospectively reviewed. Revision TKAs, primary TKAs in which a condylar constrained prosthesis was used, and primary TKAs involving the removal of previous hardware were excluded. A total of 102 patients were identified. All authors used tourniquet and 1 g of intraoperative intravenous tranexamic acid (TXA). Demographic information was obtained from the hospital records system, whereas blood loss and operation time data were obtained from the anesthesia records. The baseline characteristics and surgical details of the study population are summarized in Table 1.

Group A consisted of patients who were operated solely by one of the authors (E.Ö.), who practices early tourniquet release without drain use.

Tablo 1. Baseline characteristics and surgical details of the study population

	Minimum-maximum	Median	Average ± SD/(n, %)
Age	53.0-81.0	69.0	68.9±6.6
Sex			
Male			16 (15.6%)
Female			86 (84.3%)
Hemoglobin	10.3-16.6	13.1	13.0±1.2
Operation time	65.0-150.0	105.0	104.9±20.6
Groups			
A			32 (31.3%)
B			24 (23.6%)
C			46 (45.1%)

SD: Standard deviation

Group B consisted of patients who were operated solely by another author (F.E.M.), who practices early tourniquet release with drain use. Group C consisted of patients operated by S.A.A. and S.Y., who practice late tourniquet release with drain use.

Surgical Pocedure

All patients underwent cemented TKA using TIPMED primary total knee implants (TIPMED, İzmir, Türkiye) (Figure 1). All patients received combined spinal and epidural anesthesia. TKA was performed by midline skin incision and medial parapatellar arthrotomy under a pneumatic tourniquet. For bony resection, an intramedullary alignment system was used for the femur, with an extramedullary device for the tibia. None of the patients underwent patellar resurfacing. The intramedullary guide holes in the distal femur were plugged with autologous bone grafts from distal femoral cuts in each patient before inserting the components.

In group A, the tourniquet was deflated when the cement had hardened; then, homeostasis was attempted. No drains were used. In group B, the tourniquet was deflated when the cement had hardened; then, homeostasis was attempted. Drains were used in each case. In group C, drains were used for each patient. The fascial layer, subcutaneous tissue, and skin were then closed, the tourniquet was deflated after closing the wound, and a compressive dressing was applied. A compressive bandage was applied using a layer of cotton wool and two layers of elastic bandage in all groups.

Statistical Analysis

The mean, standard deviation, median lowest, highest, frequency, and ratio values were used in the descriptive statistics of the data. The distribution of variables was measured using the Kolmogorov-Simirnov and Shapiro-Wilk tests. ANOVA (Tukey's test) was used in the analysis of quantitatively independent data with normal distribution. The Kruskal-Wallis and Mann-Whitney U tests were used in the analysis of quantitative independent data with abnormal distribution. The Paired Samples t-test was used in the analysis of dependent quantitative data. The chi-square test was used in the analysis of qualitatively independent data, and the Fisher's exact test was used when the chi-square test conditions were not met. The Spearman Correlation Analysis was used in the correlation analysis, and the SPSS 27.0 (IBM, Chicago, IL, USA) program was used in the analysis.

Results

There were no significant differences in the age of patients between groups A, B, and C (69.6±6.6, 70.4±8.4, and 68.0±5.9 years, respectively; p=0.346, Table 2). Similarly, there was no significant difference in gender distribution across the groups (p=0.465, Table 2). Males accounted for 9.4%, 16.7%, and 19.6% of groups A, B, and C, respectively, whereas females accounted for 90.6%, 83.3%, and 80.4%.

There were no significant differences between groups A, B, and C in terms of pre-operative hemoglobin (Hb) levels (12.8±1.0 g/dL, 12.9±1.0 g/dL, and 13.2±1.3 g/dL, respectively; p=0.255, Table 2). Post-operative Hb levels also did not differ significantly between the groups (11.6±1.0 g/dL, 11.0±1.2 g/dL, and 12.0±1.4 g/dL, respectively; p=0.078, Table 2). However, within each group, post-operative Hb values decreased

Tablo 2. Statistical comparison of demographic and clinical parameters among groups A, B, and C

			Group A (n=32)[1]	Group B (n=24)[2]	Group C (n=46)[3]	p
Age	Average ± SD		69.6±6.6	70.4±8.4	68.0±5.9	0.346[K]
	Median		69.5	74.5	69.0	
Sex	Male	n, %	3 (9.4%)	4 (16.7%)	9 (19.6%)	0.465X^2
	Female	n, %	29 (90.6%)	20 (83.3%)	37 (80.4%)	
Hemoglobin						
Pre-op	Average ± SD		12.8±1.0	12.9±1.0	13.2±1.3	0.255[A]
	Median		12.6	12.7	13.3	
Post-op	Average ± SD		11.6±1.0	11.0±1.2	12.0±1.4	0.078[A]
	Median		11.6	11.2	12.3	
Pre-op/post-op değişim	Average ± SD		-1.2±0.5	-1.8±0.8	-1.3±0.7	0.094[A]
	Median		-1.2	-1.9	-1.2	
Intra-group change p-value			**<0.001[E]**	**0.001[E]**	**<0.001[E]**	
Operation time	Average ± SD		101.0±14.3	122.0±18.6	97.6±21.5	**<0.001[K]**
	Median		102.5[2]	124.5	91.0[2,1]	

[A]ANOVA, [K]Kruskal-Wallis (Mann-Whitney U test), [E]Paired t-test, X^2Chi-square test (Fisher); [1]Difference with group A p>0.05; [2]Difference with group B p<0.05, SD: Standard deviation, Pre-op: Pre-operative, Post-op: Post-operative

significantly compared with pre-operative values: in group A, from 12.8±1.0 to 11.6±1.0 g/dL (p<0.001); in group B, from 12.9±1.0 to 11.0±1.2 g/dL (p=0.001); and in group C, from 13.2±1.3 to 12.0±1.4 g/dL (p<0.001). Despite these decreases, the magnitude of pre-operative-to-post-operative Hb changes did not differ significantly among the groups (-1.2±0.5 g/dL, -1.8±0.8 g/dL, and -1.3±0.7 g/dL for groups A, B, and C, respectively; p=0.094, Table 2).

The duration of operation was significantly different between the groups (p<0.001, Table 2). Group B had the longest mean duration (122.0±18.6 minutes), followed by group A (101.0±14.3 minutes) and group C (97.6±21.5 minutes). Pairwise comparisons showed that the operation time in group B was significantly higher than that in groups A (p<0.05) and C (p<0.05), while the operation time in group A was not significantly higher than in group C (p>0.05). Results are visualized in Figure 2.

No significant correlations were observed between the magnitude of Hb changes and patient age or the duration of surgery (p>0.05, Table 3).

Wound complications included one case of prolonged wound drainage in group A, treated with wound care, one case of acute periprosthetic infection in group B requiring debridement, antibiotics, and polyethylene exchange (Figure 3), and one case of superficial wound infection in group C requiring surgical debridement. The results did not significantly differ between the groups (p>0.05). There were no cases of deep vein thrombosis.

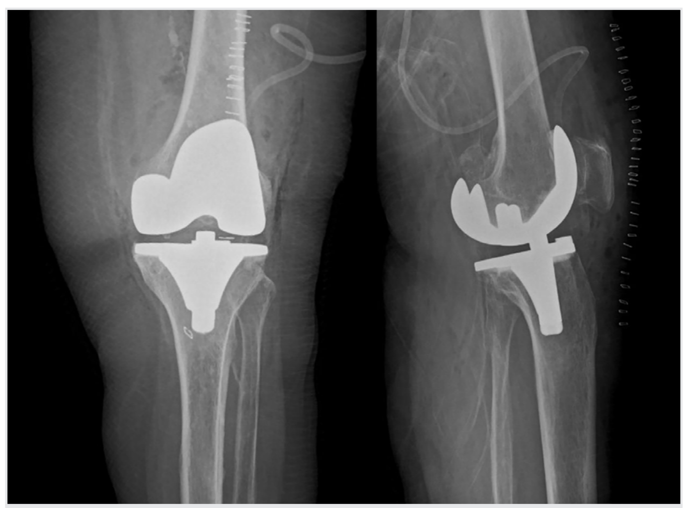

Figure 1. Anteroposterior and lateral X-rays of a TIPMED primary cruciate-retaining total knee arthroplasty

Tablo 3. Spearman correlation between hemoglobin change, age, and operation time

		Age	Operation time
Hemoglobin change	r*	-0.198	0.050
	p**	0.065	0.644

*Correlation coefficient, **p-value

Discussion

Literature suggests that while drains are traditionally used to manage post-operative hematoma, they may contribute to a significant decrease in hematocrit (Hct) levels, increased blood loss, and a higher need for transfusions, without substantial benefits. Madan et al. (5) conducted a retrospective review of 152 patients and found that drain use was linked to greater Hct reductions (p=0.002) and higher transfusion needs (p=0.044). Similarly, Albasha et al. (6) observed that patients with drains had more pronounced Hct drops and longer hospital stays (p<0.05), and Ares et al. (7) reported that drained volume correlated with further reductions in Hct, suggesting ongoing blood loss related to drain placement. There are also studies, such as one by Manta et al. (8), who found that while use of drains did not increase blood loss or transfusion rates, no difference in knee swelling was found between groups, questioning the benefit of using drains at all.

One theoretical benefit of drain use is preventing hematoma formation, resulting in decreased wound complications, which in turn translate to lower infection rates. However, previous studies have found no difference in infection rates between patients with or without drain use (9,10). In a 2016 meta-analysis by Si et al. (11), 12 randomized controlled trials consisting of 889 TKAs examined the effects of closed drainage compared with non-drainage after TKA. The analysis found no notable difference in infection rates between the groups, although drain use was linked to an increased need for blood transfusions and extended hospital stays (11). This raises the question of whether avoiding or modifying drain usage might be beneficial for patients undergoing TKA.

The use of tourniquets is another controversial topic in TKA, as previous studies have reported mixed outcomes. Although tourniquets reduce intraoperative blood loss, they do not significantly impact total blood loss. Meta-analyses by Tai et al. (12) and Zhang et al. (13) showed that tourniquets lower measured blood loss during surgery but not overall, with associated increases in complications like thrombosis. Research by Tan et al. (14) and others found no significant benefits in blood loss, stability, or pain relief with tourniquets, and Migliorini et al. (15) observed better functional outcomes and fewer DVTs without them. Some studies, such as Smith and Hing (16), highlight the advantage of shorter operative times with tourniquets, but this is offset by higher risks of complications, such as DVT and early joint impairment.

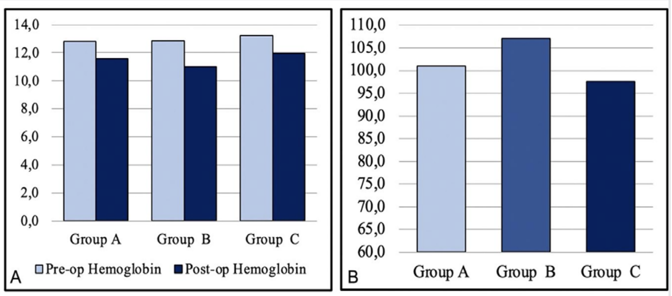

Figure 2. (A) Pre- and post-operative hemoglobin levels of groups. (B) Operation time (minutes) across groups

Figure 3. Persistent wound draining in a patient at post-operative week 2. The patient later underwent debridement and polyethylene exchange. Informed consent was obtained from the patient to use the image for scientific purposes

All authors in the present study used tourniquets for all patients; however, the timing of tourniquet release and hemostasis control were different. The literature is also controversial on this matter as well. Two meta-analyses by Huang et al. (17) and Rama et al. (18) have provided evidence that early tourniquet release can lead to significantly higher blood loss in TKA procedures, whereas late release post-wound closure, particularly with controlled pressure and limited duration, may mitigate this effect. Huang et al.'s (17) analysis of 14 RCTs found that late tourniquet release reduces blood loss without increasing the risk of complications, and Rama et al.'s (18) meta-analysis of 893 TKAs similarly noted a substantial increase in blood loss with early release. Our findings are consistent with the results of these studies.

Additional studies, including those by Velyvis (19), Yildiz et al. (20), and Demirkale et al. (21), support the strategic combination of tourniquet timing with hemostatic measures to optimize outcomes. Yildiz et al. (20) conducted a retrospective analysis and found that tourniquet release after skin closure, paired with drain clamping, effectively reduced blood loss without added complications, whereas Demirkale et al. (21) noted reduced infection rates with late release in non-drainage protocols. Chang et al. (22) further illustrated that releasing the tourniquet post-arthrotomy closure decreased ischemia time, improved early recovery, and had no adverse effects on complications. Collectively, these findings suggest that late tourniquet release, particularly when paired with additional hemostatic strategies, may provide a safer and more effective approach in TKA.

Prolonged procedures may increase surgical complications (23). The shortest possible operative time should be planned without compromising the technical quality and exposing the patient to unnecessary risks. Our results indicate that there are no differences between drain use and early tourniquet release in terms of peroperative blood loss, whereas both contribute to increased operation times. The present study's findings regarding drain use in TKA align with other research, suggesting limited benefits and potential drawbacks. For example, Albasha et al. (6) found that drains were associated with longer hospital stays, increased blood loss, and higher transfusion rates compared with cases without drains. Similar to the current study, their results suggest that although drains may theoretically control hematoma formation, they may actually increase blood loss due to continued post-operative bleeding. Furthermore, unlike other studies that emphasize higher transfusion requirements with drain use, our study did not show significant differences in perioperative blood loss across groups, regardless of drain usage or tourniquet timing. This finding could be attributed to the standardized use of TXA, a factor that Albasha et al. (6) highlighted as significantly improving post-operative outcomes when used with or without drains.

Study Limitations

The study has several limitations. First, the retrospective study design inherently limits the ability to control for confounding factors, which may impact the results. Second, the sample size is relatively small, particularly in group B, which could affect the statistical power of the findings and the generalizability of the results. Another limitation of the present study was that only early post-operative Hb levels were assessed. Post-operative Hb levels were not routinely monitored because this is not standard practice in our institution. This limitation restricts the ability to fully evaluate long-term trends in blood loss or potential delayed anemia, which could provide additional insights into the effects of different tourniquet and drain practices over time. Other factors not included in this study, such as body mass index, patient comorbidities, and surgeon variability, may have also influenced the results.

Conclusion

Our results indicate that although there were no significant differences in perioperative blood loss between the groups, the use of drains and early tourniquet release were associated with longer operative times. Late tourniquet release resulted in shorter operation times without compromising perioperative blood loss or increasing wound complications. These findings suggest that adopting late tourniquet release as a standard practice in TKA may improve surgical efficiency, particularly in high-volume surgical centers, while maintaining patient safety and clinical outcomes.

Ethics

Ethics Committee Approval: The University of Health Sciences Türkiye, İstanbul Physical Therapy and Rehabilitation Training and Research Hospital, Ethical Committee approved the study (approval number: 2024-64, date: 08.10.2024).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions: Surgical and Medical Practices - E.Ö., F.E.M., S.A.A., K.Y.K., B.A., S.Y.; Concept - E.Ö., A.B., B.A., K.Y.K., S.Y.; Design - E.Ö., M.Y.G., K.Y.K., B.A., S.Y.; Data Collection or Processing - E.Ö., M.Y.G.; Analysis or Interpretation - E.Ö., A.B., F.E.M., S.A.A.; Literature Search - E.Ö., A.B., F.E.M., S.A.A.; Writing - E.Ö., M.Y.G.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Mahomed NN, Barrett J, Katz JN, Baron JA, Wright J, Losina E. Epidemiology of total knee replacement in the United States Medicare population. J Bone Joint Surg Am. 2005; 87: 1222-8.
2. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am. 2007; 89: 780-5.
3. Waugh TR, Stinchfield FE. Suction drainage of orthopaedic wounds. J Bone Joint Surg Am. 1961; 43: 939-46.
4. Quinn M, Bowe A, Galvin R, Dawson P, O'Byrne J. The use of postoperative suction drainage in total knee arthroplasty: a systematic review. Int Orthop. 2015; 39: 653-8.
5. Madan FH, Khamis E, Alhassan MA, Alrashid M, Saleh A, Rahma M. Hemoglobin drop and the need for transfusion in primary knee arthroplasty. Cureus. 2022; 14: 27659.
6. Albasha A, Salman LA, Elramadi A, Abudalou A, Mustafa A, Hejleh HAA, et al. Outcomes of drain versus no drain in total knee arthroplasty: a retrospective cohort study. Int Orthop. 2023; 47: 2985-9.
7. Ares O, Seijas R, Sallent A, Popescu D, Lozano L. Bleeding in knee arthroplasty: age, drained volume, and ischemia time. J Knee Surg. 2015; 28: 329-34.
8. Manta N, Mangiavini L, Balbino C, Colombo A, Pandini EG, Pironti P, et al. The role of suction drainage in the management of peri-operative bleeding in total and unicompartmental knee arthroplasty: a retrospective comparative study. BMC Musculoskelet Disord. 2021; 22: 1031.
9. Parker MJ, Livingstone V, Clifton R, McKee A. Closed suction surgical wound drainage after orthopaedic surgery. Cochrane Database Syst Rev. 2007; 2007: 001825.
10. Dubin JA, Hameed D, Bains SS, Board T, Nunley R, Mont MA. Effect of various ancillary operating room techniques on wound healing outcomes after total knee arthroplasty. Surg Technol Int. 2022; 43: 279-88.
11. Si H, Yang T, Zeng Y, Shen B. No clear benefit or drawback to the use of closed drainage after primary total knee arthroplasty: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2016; 17: 183.
12. Tai TW, Lin CJ, Jou IM, Chang CW, Lai KA, Yang CY. Tourniquet use in total knee arthroplasty: a meta-analysis. Knee Surg Sports Traumatol Arthrosc. 2011; 19: 1121-30.
13. Zhang W, Li N, Chen S, Tan Y, Al-Aidaros M, Chen L. The effects of a tourniquet used in total knee arthroplasty: a meta-analysis. J Orthop Surg Res. 2014; 9: 13.
14. Tan Y, Guo S, Wang H, Tie K, Qin J, Zhao X, et al. The effects of tourniquet use on blood loss and perioperative complications in total knee arthroplasty. BMC Musculoskelet Disord. 2023; 24: 847.
15. Migliorini F, Maffulli N, Eschweiler J, Knobe M, Tingart M, Betsch M. Tourniquet use during knee arthroplasty: a bayesian network meta-analysis on pain, function, and thromboembolism. Surgeon. 2022; 20: 241-51.
16. Smith TO, Hing CB. Is a tourniquet beneficial in total knee replacement surgery? A meta-analysis and systematic review. Knee. 2010; 17: 141-7.
17. Huang Z, Ma J, Zhu Y, Pei F, Yang J, Zhou Z, et al. Timing of tourniquet release in total knee arthroplasty. Orthopedics. 2015; 38: 445-51.
18. Rama KRBS, Apsingi S, Poovali S, Jetti A. Timing of tourniquet release in knee arthroplasty: meta-analysis of randomized, controlled trials. J Bone Joint Surg Am. 2007; 89: 699-705.
19. Velyvis JH. Gelatin matrix use reduces postoperative bleeding after total knee arthroplasty. Orthopedics. 2015; 38: 118-23.
20. Yildiz C, Koca K, Kocak N, Tunay S, Basbozkurt M. Late tourniquet release and drain clamping reduces postoperative blood loss in total knee arthroplasty. HSS Journal. 2014; 10: 2-5.
21. Demirkale I, Tecimel O, Sesen H, Kilicarslan K, Altay M, Dogan M. Nondrainage decreases blood transfusion need and infection rate in bilateral total knee arthroplasty. J Arthroplasty. 2014; 29: 993-7.
22. Chang CW, Lan SM, Tai TW, Lai KA, Yang CY. An effective method to reduce ischemia time during total knee arthroplasty. J Formos Med Assoc. 2012; 111: 19-23.
23. Horlocker TT, Hebl JR, Gali B, Jankowski CJ, Burkle CM, Berry DJ, et al. Anesthetic, patient, and surgical risk factors for neurologic complications after prolonged total tourniquet time during total knee arthroplasty. Anesth Analg. 2006; 102: 950-5.