Effect of patellar resurfacing surgery on bleeding in total knee arthroplasty

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INTRODUCTION

Background
One of the important factors affecting the clinical and functional results of patients after total knee arthroplasty (TKA) operation is the amount of postoperative bleeding. Blood loss after TKA can lead to postoperative anemia, need for transfusion and its related systemic complications, as well as complications affecting functional outcomes such as delayed mobilization and decreased knee flexion. The number of studies on the reduction of postoperative bleeding after TKA is gradually increasing. Considering all types of arthroplasty, the number of articles examining postoperative bleeding and published in PubMed was 19 in 2010, while this number increased to 454 in 2020. The main ones of these studies are those on the use of tourniquets, hypotensive anesthesia, as well as agents such as systemic or local tranexamic acid (TXA) and lidocaine-containing epinephrine.

Another factor affecting the functional results after the operation is the patellar resurfacing performed in TKA. However, there is still no consensus on whether patellar resurfacing should be routinely performed in every patient. In this regard, surgeons are divided into three groups: routinely performing patellar resurfacing, not performing it routinely, and performing it in a selected patient group. Although resurfacing has advantages such as reduction in anterior knee pain and reoperation rates, it has main disadvantages such as patellar fracture that may occur during the operation and loosening of the patellar component. While there are articles stating that patellar resurfacing reduces revision surgery rates and has better results, there are articles claiming that complication rates increase by 10% due to patellar resurfacing alone.

Although the factors related to the attachment of the implant to the bone tissue come to the fore while evaluating the complications related to the use of the patellar component, the additional bleeding that will occur should also be considered. It is expected that patellar resurfacing will not cause significant bleeding, but we could find very few studies investigating the effect of patellar resurfacing on bleeding. We think that these studies do not provide sufficient evidence. Therefore, we planned our study with the hypothesis that patellar resurfacing does not change the blood loss of the patients.

METHODS

Study design and setting
We started the study after receiving ethics committee approval. Patients who had undergone total knee replacement (TKR) due to primary osteoarthritis were included in the study. Patellar resurfacing was performed in 30 patients, while 39 patients did not undergo patellar resurfacing. Demographic data, amount of transfusion, preoperative and postoperative hemoglobin and hematocrit values, and total, visible, and hidden blood loss values were recorded.
for primary knee osteoarthritis between June 2015 and June 2021 were included. A total of 103 patients operated by a single orthopedic surgeon using the same standard surgical procedures were included in this study. Thirty-four patients with a history of deep vein thrombosis (DVT) or pulmonary embolism (PE), bleeding diathesis, a history of renal failure, cardiovascular disease, a history of TXA allergy, a history of malignancy, hemorrhagic diathesis and coagulopathy, receiving anticoagulant therapy, preoperative hemoglobin values below 10 g/dl, traumatic osteoarthritis or inflammatory arthritis, peripheral vascular disease, liver failure, and a history of stroke were excluded from this study according to the exclusion criteria. Comparison was made between 30 patients who had undergone patellar resurfacing during the operation and 39 patients who had not.

First-generation cephalosporins reportedly had been given to all patients as 1 g just before the operation and 1 g every 8 h for every 24 h. Operations had been performed under spinal/epidural and general anesthesia. Cemented femoral component and cemented tibial component had been used in all patients. The cemented patellar component was additionally used in patients who underwent polyethylene insert patellar resurfacing. Notably, 10 mg/kg intraoperative TXA was administered intravenously to all patients, and the same dose was repeated at the third postoperative hour. At the end of the operation, a 10-gauge drain was placed intra-articularly. Surgical folds passed through the incision were closed in order anatomically. At the 24th postoperative hour, the drain was removed. The amount of blood accumulated in the drain reservoir was measured and recorded. Intraoperative blood loss was calculated as zero because tourniquets were used in all patients. Of note, 4,000 IU low-molecular-weight heparin (Oksapar; Kocak Farma, Turkey) was administered subcutaneously to all patients daily for thrombosis prophylaxis, and it was continued for 4 weeks. On the first postoperative day, they were mobilized with as much weight as they tolerated.

Patients’ age, surgical side, body mass index (BMI, kg/m²), the amount of transfusion, preoperative and postoperative hemoglobin (Hgb), hematocrit (Hct) values on the first, second, and third days, and the amount of blood from the postoperative drain were recorded. Total blood volume (TBV) was calculated as described by Nadler et al. Total blood loss (TBL) was calculated using the Gross formula as follows:

\[ TBL = TBV \times \frac{ \text{preoperative Hct} - \text{postoperative day 3 Hct} }{ \text{Mean Hct} } \]

The amount of erythrocyte suspension (200 mL each) given to the patients in the postoperative period was added to the amount of TBL. Hidden blood loss (HBL) volume was obtained by subtracting the visible blood loss (VBL) volume from the TBL volume (Figure 1). Iron or

![Figure 1. Flowchart of the movement of blood between compartments and calculation of blood loss parameters.](image-url)
erythropoietin preparations were not used in any of the patients. In case of hemoglobin (Hgb) values being <8.5 g/dl in the follow-up of the patients or in clinical cases showing symptoms of tachycardia, hypotension, or anemia, blood transfusion was performed in consultation with the anesthesia team.

**Statistical analysis**
The Gpower (G*Power version 3.1.9.6; Germany) software was used for the adequacy test of the sample size. For calculation, data from a recently published similar article about bleeding⁶ were used. In the 95% power and effect size range of 1.15, a minimum of 18 patients from both groups was calculated as a sufficient value (the number of patients in the groups in our study was 30 and 39). Statistical analysis was performed using IBM SPSS for Windows 23.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistics for numerical variables were expressed as mean and standard deviation. Parametric test procedures on normal distribution were used in the Kolmogorov-Smirnov test. Independent two-sample t-tests were used to determine the relationships between parameters. Chi-square analysis was used to determine the relationship between categorical data. The correlation analysis between TBL and VBL and postoperative drainage volume was evaluated using the Pearson correlation coefficient. The results were evaluated within the 95% confidence interval, and p<0.05 was considered statistically significant.

**RESULTS**
Demographic data of the patients included in this study are given in Table 1. There was no statistically significant difference between the groups with and without patellar resurfacing in terms of age, operation side, BMI, TBV, preoperative Hgb values, and the type of anesthesia administered. There was no statistically significant difference between the hemoglobin values of the groups in the mean hemogram values on the first, second, and third postoperative days (Table 1). There was no statistically significant difference between the groups in terms of the amount of blood in the drain, TBL, and VBL of the patients participating in this study. There was no statistically significant difference between the groups in terms of blood transfusion (Table 2). When the correlation between postoperative drainage volume and VBL was evaluated, there was no significant correlation (r=0.025, p=0.837), but a positive significant correlation was found between postoperative drainage volume and TBL (r=0.262, p=0.029).

**DISCUSSION**
The most important finding of our study is that no significant effect of patellar component change on TBL, VBL, and HBL was observed in patients who had undergone TKA. In the current literature, there are very few studies investigating the effect of patellar resurfacing on bleeding, and their results are inconsistent. In a comparative study investigating the effect of patellar resurface surgery on bleeding in patients undergoing TKA, no

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**Table 1. Demographic data and postoperative Hgb values of study patients.**

|                      | Resurfaced 30 patients | Not resurfaced 39 patients | p     |
|----------------------|------------------------|----------------------------|-------|
| **Age**              | 66.77±6.393            | 67.33±6.276                | 0.713 |
| **Gender**           | 0.345                  |                            |       |
| Female               | 21                     | 23                         |       |
| Male                 | 9                      | 16                         |       |
| **BMI (kg/m²)**      | 31.53                  | 31.20                      | 0.701 |
| **Side**             | 0.387                  |                            |       |
| Right                | 13                     | 21                         |       |
| Left                 | 17                     | 18                         |       |
| **Pre-op Hgb**       | 13.24±0.79             | 13.50±0.82                 | 0.195 |
| **Pre-op Hct**       | 39.63±2.29             | 40.34±2.44                 | 0.220 |
| **TBL (mL)**         | 4891.18±585.96         | 4935.95±462.08             | 0.728 |
| **Post-op day 1 Hgb (g/dl)** | 11.93±0.76             | 12.04±0.81                | 0.499 |
| **Post-op day 2 Hgb (g/dl)** | 10.53±0.77             | 10.65±0.89                | 0.561 |
| **Post-op day 3 Hgb (g/dl)** | 9.04±0.78              | 9.16±0.89                 | 0.561 |

Hgb: hemoglobin; SD: standard deviation; BMI: body mass index; Hct: hematocrit value; TBL: total blood volume.
significant effect of patellar resurface surgery on bleeding was demonstrated. However, in this study, it was stated that there was no difference in bleeding by evaluating only the Hct levels of the patients, whereas the methods calculated in the evaluation of bleeding were not used in the current literature. In another study comparing patients with and without patellar resurfacing, only the difference in intraoperative bleeding was examined in terms of bleeding, and it was stated that there was no difference. However, this information is not useful for many surgeons who use tourniquets during the operation, as in our clinic. Another study, which not only focusing on patellar resurfacing but also investigating the effect of many factors on bleeding, has stated that patellar resurfacing increases the amount of bleeding, but not the amount of transfusion.

Another important finding of our study is that there was no significant difference in the amount of blood transfused between the groups with and without patellar resurfacing. Expected TBL in patients who had undergone total joint arthroplasty ranges between 590 and 1,800 mL. This situation should be taken into account when planning patellar resurfacing in elderly patients undergoing TKA and having various comorbidities. There may also be medical conditions where blood transfusion may be contraindicated or patients who refuse blood transfusion for religious reasons, such as Jehovah’s witnesses, or patients who cannot be transfused. In such cases, if the surgeon prefers the patellar component, they should provide sufficient evidence to the patients that it will not increase bleeding and require additional transfusion. However, there are very limited studies on this subject in the current literature, and the results of the studies are contradictory. Therefore, we think that the results of our study will be beneficial for surgeons considering patellar resurfacing in patients who cannot receive blood transfusion.

In our study, we evaluated the relationship between postoperative drainage volume and HBL or TBL. A positive correlation was found between postoperative drainage volume and TBL. The reason for this positive correlation may be that TBL plays a major role in postoperative drainage volume. However, we did not find a significant correlation between postoperative drainage volume and HBL. In a study investigating the effect of TXA on bleeding in patients undergoing TKA, a positive correlation between HBL and postoperative drainage volume was found, the finding inconsistent with our study. In contrast, while TXA was used in only some of the patients in the mentioned study, TXA was used in all patients in our study.

The main limitation of our study is that it is retrospective and single centered. Moreover, the postoperative drainage volumes of the patients were obtained from the data in the patient file recorded by the clinical nurse on duty. Another limitation may be that the same person did not measure the postoperative drainage volumes. However, the homogeneity of the demographic data of the groups compared and the application of standard surgical procedures by a single orthopedic surgeon to the patients can be ranked among the strengths of our study.

**CONCLUSION**

Patellar component application in patients who underwent TKA does not change the blood loss of the patients.

**AUTHORS’ CONTRIBUTIONS**

SA: Conceptualization, Data curation, Formal Analysis, Writing – original draft. DC: Data curation, Writing – review & editing. SK: Formal Analysis, Writing – original draft. ZO: Data curation, Writing – review & editing. HO: Writing – review & editing. OB: Writing – review & editing.
REFERENCES

1. Grosso MJ, Trofa DP, Danoff JR, Hickernell TR, Murtaugh T, Lakra A, et al. Tranexamic acid increases early perioperative functional outcomes after total knee arthroplasty. Arthroplast Today. 2017;4(1):74-7. https://doi.org/10.1016/j.arotd.2017.05.009

2. Kornuijt A, de Kort GJL, Das D, Lenssen AF, van der Weegen W. Recovery of knee range of motion after total knee arthroplasty in the first postoperative weeks: poor recovery can be detected early. Musculoskelet Surg. 2019;103(3):289-97. https://doi.org/10.1007/s12306-019-00588-0

3. Search data of blood loss. PubMed [Internet]. Available from: https://pubmed.ncbi.nlm.nih.gov/?term=blood+loss

4. Cankaya D, Dasar U, Satilmis AB, Basaran SH, Akkaya M, Bozkurt M. The combined use of oral and topical tranexamic acid is a safe, efficient and low-cost method in reducing blood loss and transfusion rates in total knee arthroplasty. J Orthop Surg (Hong Kong). 2017;25(1):2309499016684725. https://doi.org/10.1177/2309499016684725

5. Turan S, Bingöl O. Is tranexamic acid effective on hidden blood loss in patients during total knee arthroplasty? Jt Dis Relat Surg. 2020;31(3):488-93. https://doi.org/10.1097/BTO.0000000000000328

6. Girdler SJ, Glezos CD. Does patella resurfacing affect postoperative blood loss in patients undergoing total knee replacement? Tech Orthop. 2020;35(2):154-6. https://doi.org/10.1097/BTO.0000000000001377

7. He JY, Jiang LS, Dai LY. Is patellar resurfacing superior than non-resurfacing in total knee arthroplasty? J Orthop Surg Res. 2019;10(3):289-97. https://doi.org/10.1007/s12306-019-00588-0

8. Maney AJ, Koh CK, Frampton CM, Young SW. Usually, selectively, or rarely resurfacing the patella during primary total knee arthroplasty: determining the best strategy. J Bone Joint Surg Am. 2019;101(5):412-20. https://doi.org/10.2106/JBJS.18.00389

9. Fraser JF, Spangenhel MJ. International rates of patellar resurfacing in primary total knee arthroplasty. 2004–2014. J Arthroplasty. 2017;32(1):83-6. https://doi.org/10.1016/j.arth.2016.06.010

10. Putman S, Boureau F, Girard J, Migaud H, Pasquier G. Patellar complications after total knee arthroplasty. Orthop Traumatol Surg Res. 2019;105(1S):S43–S51. https://doi.org/10.1016/j.otsr.2018.04.028

11. Healy WL, Wasilewski SA, Takei R, Oberlander M. Patellofemoral complications following total knee arthroplasty. Correlation with implant design and patient risk factors. J Arthroplasty. 1995;10(2):197-201. https://doi.org/10.1016/0883-5403(95)80127-5

12. Jia C, N M, Fu J, Li X, Li X. Chai W, et al. A comparative study on effectiveness of patellar resurfacing against non-resurfacing in total knee arthroplasty. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2018;32(4):394-9. https://doi.org/10.7507/1002-1892.201708128

13. Saengjumrut P, Suwanjutah T, Ingkutanonta P, Sopakhayang W, Chaluy S, Benchasiriluck P, et al. Factors related to blood loss in total knee arthroplasty. J Southeast Asian Med Res. 2018;2(2):85-91. https://doi.org/10.55374/jseamed.v2i2.13

14. Nadler SB, Hidalgo JH, Bloch T. Prediction of blood volume in normal human adults. Surgery. 1962;51(2):224-32. PMID: 21936146

15. Groso JB. Estimating allowable blood loss: corrected for dilution. Anesthesiology. 1983;58(3):277-80. https://doi.org/10.1097/00000542-198312000-00006

16. Sehat KR, Evans R, Newman JH. How much blood is really lost in total knee arthroplasty?: Correct blood loss management should take hidden loss into account. Knee. 2000;7(3):151-5. https://doi.org/10.1016/s0968-0160(00)00047-8

17. Hu Y, Li Q, Wei BG, Zhang XS, Torsha TT, Xiao J, et al. Blood loss of total knee arthroplasty in osteoarthritis: an analysis of influential factors. J Orthop Surg Res. 2018;13(1):225. https://doi.org/10.1186/s13018-018-1038-0

18. Dong Q, Zhang Y, Sun X, Hu F. The effectiveness and safety of aminocaproic acid for reducing blood loss in total knee and hip arthroplasty: a meta-analysis. Int J Surg. 2018;52:156-63. https://doi.org/10.1016/j.ijsu.2018.02.035

19. Issa K, Banerjee S, Rifi A, Kapadia BH, Harvin SF, McInerney VK, et al. Blood management strategies in primary and revision total knee arthroplasty for Jehovah’s Witness patients. J Knee Surg. 2013;26(6):401-4. https://doi.org/10.1055/s-0033-1353994