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The influence of the approach for blood loss and transfusion in total knee arthroplasty: Medial parapatellar vs. subvastus

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Abstract

The medial parapatellar (MP) and subvastus (SV) approaches are the most common approaches used in total knee arthroplasty (TKA). Blood loss and transfusion requirements during these approaches varies in different studies. This study compared the MP and SV techniques in terms of blood loss and transfusion needs. Sixty-four patients were enrolled for this retrospective, single-centre and single-surgeon study. Patients were allocated into two groups of 32 patients each: TKA utilizing a MP approach (MP group) and TKA utilizing a SV approach (SV group). The calculated blood loss, determined using the Gross method, was the study's primary outcome. Additionally, the amounts of haemoglobin and haematocrit decrease from preoperative to postoperative 3rd day as well as the need for blood transfusions were compared. The mean calculated blood loss was lower in the SV group compared to the MP group (953±362 mL vs. 1245±404 mL, p=0.003). The haematocrit decrease from preoperative to postoperative 3rd day was in favour of the SV group (7.0±2.9 % vs. 9.5±3.0 %, p=0.005). The mean units of packed red cells transfused in the MP and SV groups were 0.28±0.45 and 0.19±0.4, respectively (p>0.05). Although lower blood loss was observed in the SV approach, the postoperative transfusion rates were not affected. When selecting the approach to use in TKA, surgeons should consider that SV approach is efficient in reducing blood loss without any change in transfusion requirement.

Keywords: Total knee arthroplasty, approach, blood loss, transfusion, subvastus, medial parapatellar

Introduction

For patients with advanced knee osteoarthritis, total knee arthroplasty (TKA) is a successful major orthopaedic procedure. The medial parapatellar approach (MP), despite there are other surgical methods for the knee, continues to be the most used one [1,2].

Despite excellent exposure, the quadriceps tendon is incised and the peripatellar blood supply is compromised, which could lead to extensor mechanism complications such as avascular necrosis, patella fracture, and anterior knee pain [1,2]. Therefore, less invasive approaches such as subvastus and midvastus approaches have been investigated in comparative studies over the last few decades.

The subvastus (SV) approach was first introduced by Erkes

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in 1929 and popularized by Hoffman in 1991 [2]. As it avoids disruption of the quadriceps tendon and the insertion point of the vastus medialis, it is considered a less invasive approach that can provide better quadriceps strength, improved patellar tracking and conservation of the patella blood supply, resulting in reduced postoperative pain and shorter hospital stays [1,2]. In terms of blood loss, a significant amount may occur during TKA. The average blood loss values in different studies have been reported as up to 3030 mL [3]. This wide range depends on several factors, such as the surgical approach and technique, the use of a tourniquet and drainage, several pharmacological agents, and implant design [4].

The surgical approach is one of the main factors influencing the blood loss and transfusion requirement during or after any surgical operation, so these parameters must be considered by the surgeon when selecting the approach to be used. Several studies comparing the SV and MP approaches have revealed conflicting results and controversy remains about which approach results in lower blood loss [1,2,5-11]. The hypothesis of the current study was that the SV approach would decrease blood loss and transfusion requirements as the less invasive nature.

Material and Methods

This retrospective, single-centre and single-surgeon study was carried out in accordance with the Helsinki Declaration (as revised in 2013) and approved by the local ethics committee (Gulhane Ethics Committee, approval number 2020-525). The study's inclusion and exclusion criteria are shown in the Table 1. The patients who received unilateral TKA for primary knee osteoarthritis between January 2016 and August 2020 utilizing either the SV or MP approach were analysed from the database of the senior surgeon.

Table 1. Inclusion and exclusion criteria for the study

Inclusion and Exclusion Criteria
Inclusion
Patients who undergone unilateral total knee arthroplasty with medial parapatellar or subvastus approach
Patients aged 55-80 years
Patients within the normal range of preoperative haemoglobin, haematocrit, platelet and prothrombin time (INR, international normalized ratio) levels
Exclusion
Previous knee surgery
Patients with post-traumatic osteoarthritis or rheumatoid conditions
Patients with coagulation disorders or chronic hepatic disease
History of malignancy
Pre-operative ongoing anticoagulant therapy
Metabolic bone disease

During this period, 32 patients underwent TKA using the SV approach. A match-paired group by age, gender, the American Society of Anaesthesiologists (ASA) Physical Status Classification System score, body mass index (BMI) of 32 patients who underwent TKA using the MP approach were selected from the same database. The patients were divided into two groups of 32 patients each, according to the surgical approach used: MP approach utilized TKA (MP group) and SV approach utilized TKA (SV group).

The following data were retrieved from the medical records of the patients: age, gender, weight, height, BMI, ASA score, the side of the surgery, operation time, preoperative and postoperative first, second and third day haemoglobin and haematocrit levels, amount of intraoperative and postoperative blood transfusions, the decrease in haemoglobin and haematocrit from preoperative to postoperative day 3, and the volume of blood coming from the surgical drain.

All patients received a daily subcutaneous injection of low-molecular-weight heparin (40 mg of enoxaparin sodium; Clexane, Aventis Intercontinental, France) starting 12 hours before to surgery and continuing for 4 weeks following the procedure. All operations were performed under combined spinal and epidural anaesthesia. A posterior-cruciate-ligament-stabilized (PS) implant (Zimmer, NexGen) was used for all patients. Entry with a midline skin incision was followed by a standard MP or SV arthrotomy for exposure. The tourniquet was inflated to a pressure of 300 mmHg after sterile preparation, draping, and exsanguination. The tibial and femoral components were implanted with bone cement in each case, and no patient received patellar resurfacing. After implantation, a suction drain was placed and clamped, then the surgical layers were closed in a routine fashion. No cell saver system, bipolar sealer, or pharmacological agent such as tranexamic acid (TXA) was used in any patient.

The suction drain clamp was activated at the postoperative 8th hour. Active and passive knee range of motion and straight leg raise exercises were encouraged immediately postoperatively as tolerated after weaning from the anaesthesia. The drain and the Jones bandage were removed, and the patients were mobilized in the first postoperative day. No continuous passive motion machine was used. The same standardized postoperative rehabilitation protocol was applied to both groups. All patients' postoperative blood drainage from the drain was measured on the container scale after removing the drain.

Blood transfusions were given to patients who had haemoglobin levels below 8 g/dL or who had clinical conditions that were impaired as shown by symptoms of anaemia, tachycardia, or hypotension. Up to three days after surgery, all transfusions administered were tracked. On the first, second, and third days following surgery, the haematocrit and postoperative haemoglobin values were noted. Blood loss was calculated using the Gross formula based on patient gender, height, weight, and haematocrit values [12].

The study's data were statistically analysed using the SPSS program (IBM SPSS Statistics for Windows, Version 24.0). The mean, standard deviation, median, minimum, and maximum values were used to express continuous data, while frequency and percentage were used to express categorical variables. The Shapiro-Wilk test was used to determine if continuous variables conformed to the normal distribution, and the Student's t-test and Mann-Whitney U-test were applied to compare two independent groups. The Pearson Chi-Square test was applied to the comparisons of categorical variables. In all the statistical analyses, a value of $p < 0.05$ was accepted as statistically significant.

Results

Evaluation was made of a total of 64 patients, and no significant difference was determined between the two groups in terms of the demographic data. There was no significant difference between the two groups in terms of the operation side, operation time and ASA Score. The mean calculated blood loss was lower in the SV group compared to the MP group (953±362 mL vs. 1245±404 mL, p=0.003). The mean units of packed red cells transfused in the MP and SV groups were 0.28±0.45 and 0.19±0.4, respectively (p>0.05). The mean postoperative drainage volume within 24 h after surgery was 459±39 mL in the SV group and 471±31 mL in the MP group. Regarding the postoperative transfusion rates and drainage volumes, there was no statistically significant difference between the two groups (Table 2).

The preoperative platelet and prothrombin time (INR, international normalized ratio) levels were within the normal range for all the patients (range for platelet: 150.000-450.000/ microliter, range for INR: <1.1). No significant difference was detected in the haemoglobin values recorded preoperatively and on postoperative days 1, 2, and 3, the preoperative to postoperative third-day haemoglobin decrease, and the postoperative first-day

Table 2. Patient demographic data and the data on the surgical side, ASA Score, postoperative drainage, calculated blood loss, transfusion and operation time

	Subvastus Group	**Medial Parapatellar Group**	**P-value**
Gender (n)-Female/Male	31 (96.9%)/1 (3.1%)	28 (87.5%)/4 (12.5%)	n.s.
Age (years) #	68.5±8.2	69.8±6	n.s.
Body mass index# (kg/m2)	30±2.8	29.2±3.8	n.s.
Side (right/left)	20/12	19/13	n.s.
ASA Score (II/III)	22/10	24/8	n.s.
Postoperative Drainage (ml) #	459±39	471±31	n.s.
Calculated Blood Loss (ml) #	953±362	1245±404	0.003*
Transfusion# (packed red cells/patient)	0.19±0.4	0.28±0.45	n.s.
Operation time (minutes)	90.5±7.25	85.5±6.25	n.s.

The values are given as mean±standard deviation. *Student's t-test

Table 3. Preoperative and postoperative haemoglobin and haematocrit values

Haemoglobin (g/dl)	**Subvastus Group**	**Medial Parapatellar Group**	**P-value**
Preoperative	12.9±1.1	13±1.2	n.s.
Day 1	11±1.3	11.3±1.1	n.s.
Day 2	10.5±0.9	10.3±0.9	n.s.
Day 3	10.3±0.7	10±1.0	n.s.
Hb Decrease (Pre to postop 3rd day)	2.6±1.0	3.0±1.0	n.s.
Haematocrit (%)			
Preoperative	38.8±3.0	39.5±3.6	n.s.
Day 1	33.5±3.7	34±3.6	n.s.
Day 2	32.2±2.7	30.1±2.7	0.039**
Day 3	31.7±2.2	30±2.7	0.01*
Htc Decrease (Pre to postop 3rd day)	7.0±2.9	9.5±3.0	0.005**

The values are given as mean±standard deviation. *Student's t-test, **Mann Whitney U test haematocrit levels. Comparisons made between two groups were at the same time intervals (e.g., postoperative first-day haematocrit levels of the MP group were compared to the postoperative first-day haematocrit levels of the SV group) and a difference was detected in the haematocrit values on postoperative days 2 and 3 in favour of the SV group (p=0.039, p=0.01, respectively). The decrease in haematocrit level from preoperative to postoperative day 3 was lower in the SV group (7.0±2.9 % vs. 9.5±3.0 %, p=0.005) (Table 3).

The number of patients in both groups provided sufficient power for the comparison of the groups of the calculated blood loss (effect size, 0.7612856; α err prob, 0.05; post-hoc power, 0.914; p=0.003) and the preoperative to postoperative 3rd day haematocrit decrease (effect size, 0.8473359; α err prob, 0.05; post-hoc power, 0.915; p=0.005), according to the post-hoc power analysis.

Discussion

The main finding of this study was that the SV approach provides a lower calculated blood loss, but does not affect the postoperative transfusion rates. TKA is a successful major orthopaedic procedure for patients, however it frequently results in substantial blood loss and a high blood transfusion rate. Total knee and hip arthroplasty, as well as fracture surgeries, are the most common causes of transfusion in surgical patients, accounting for 9.8% of all transfused red blood cell units, according to Shortt et al. [13]. Following TKA, transfusion rates have been estimated to range from 20 to 40 percent [14,15].

Average blood loss reported in the current literature varies widely between 400 to 3030 mL [2,3,16,17]. This wide range depends on several factors, such as the patient demographics, surgical approach and technique, use of a tourniquet and drainage, application of several pharmacological agents, implant design, and the method used to calculate blood loss [4]. In the current study, the calculated blood loss in both groups (SV: 953 mL, MP: 1245 mL) was higher than the amounts reported in several studies but was comparable to the current literature. This could be attributed to the routine use of a tourniquet and drainage and non-usage of tranexamic acid.

Allogeneic blood transfusion rates for TKA patients reported in the literature vary greatly from 12% to as high as 87% [16-18]. Complications of allogeneic blood transfusion include haemolytic and allergic reactions, coagulopathy, fluid overload, acute lung injury, disease transmission, immunomodulation which could increase susceptibility to postoperative infections including in the surgical site, increased length of hospitalization, cost, and mortality [14,15,19]. Therefore, minimizing blood loss and consequent blood transfusions during TKA is crucial to avoid increased complications. In the present study, the postoperative transfusion rates were lower in the SV group (0.19±0.4 versus 0.28±0.45 units of packed red cells), although the difference was not statistically significant.

The haemoglobin loss in routine TKA has been reported to be between 2.8-3.8 g/dL [17,20,21]. The current study data revealed a haemoglobin drop of mean 2.6 and 3.0 g/dL in the SV and MP groups, respectively (p>0.05), which was consistent with the literature. Studies comparing the SV and MP approaches have revealed conflicting results concerning blood loss. Several studies have reported no difference [1,5-8], whereas others have reported less blood loss [2,9-11,22] using the SV approach. Higher blood loss is attributed to prolonged surgical times due to difficulty in obtaining adequate exposure. These studies concluded that further high-quality studies are needed to clarify this controversial issue. Nonetheless, in our study, there were no significant difference between the groups in terms of the operation time.

The SV method has been shown to have benefits in numerous studies, including quicker recovery, improved quadriceps strength, less lateral release, enhanced patellar tracking, preservation of the patellar blood supply, and less postoperative pain, which leads to shorter hospital stays. [1,2,7]. Despite the advantages, the long learning curve, longer surgical time, difficulties in obtaining adequate exposure, and consequent prosthesis component malalignment reported in several studies [23,24] have discouraged surgeons. The NJR (National Joint Registry for England, Wales, and Northern Ireland) 11th Annual report revealed that the SV approach was used in only 1% of TKA surgeries between 2004 and 2014 [25]. It can be considered that surgeons are reluctant to use the SV approach due to the above-mentioned difficulties.

Strengths of this study were that the operations were performed by the same senior surgeon with experience beyond the learning curves of both approaches, strict exclusion criteria (including preoperative ongoing anticoagulant therapy and hypertension, which is frequent in this age population), the same anaesthesia technique and implant utilization, and that factors related to increased blood loss were minimized in all patients. The retrospective nature of this study was its principal drawback. In addition, no conclusion can be drawn from the results in respect of cementless application, cruciate retaining design, robotic surgery, patients with rheumatoid disorders and younger patient groups. Lastly, this study did not assess the outcomes of TKA performed without a tourniquet or while using one at various pressures.

Conclusion

The SV approach yielded lower blood loss, higher haematocrit values on postoperative days 2 and 3, and lower preoperative to postoperative third-day haematocrit decrease compared to the MP approach, and the postoperative transfusion rates were not affected. The clinical relevance of this study is that when selecting the approach to be used in TKA, surgeons should take into consideration that the SV approach is efficient in reducing blood loss without any change in transfusion requirement

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compared to the MP approach.

Conflict of interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

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Ethical approval

This study was approved by Gulhane Ethics Committee (approval no 2020-525)

References

1. Teng Y, Du W, Jiang J, et al. Subvastus versus medial parapatellar approach in total knee arthroplasty: meta-analysis. Orthopedics. 2012;35:e1722-e31.

2. Berstock JR, Murray JR, Whitehouse MR, et al. Medial subvastus versus the medial parapatellar approach for total knee replacement: A systematic review and meta-analysis of randomized controlled trials. EFORT Open Rev. 2018;3:78-84.

3. Kalairajah Y, Simpson D, Cossey AJ, et al. Blood loss after total knee replacement: effects of computer-assisted surgery. J Bone Joint Surg Br. 2005;87:1480-2.

4. Cankaya D, Ozkurt B, Aydin C, Tabak AY. No difference in blood loss between posterior-cruciate-ligament-retaining and posterior-cruciate-ligament-stabilized total knee arthroplasties. Knee Surg Sports Traumatol Arthrosc. 2014;22:1865-69.

5. Peng X, Zhang X, Cheng T, et al. Comparison of the quadriceps-sparing and subvastus approaches versus the standard parapatellar approach in total knee arthroplasty: a meta-analysis of randomized controlled trials. BMC Musculoskelet Disord. 2015;16:327.

6. Curtin B, Yakkanti M, Malkani A. Postoperative pain and contracture following total knee arthroplasty comparing parapatellar and subvastus approaches. J Arthroplasty. 2014;29:33-6.

7. Li Z, Cheng W, Sun L, et al. Mini-subvastus versus medial parapatellar approach for total knee arthroplasty: a prospective randomized controlled study. Int Orthop. 2018;42:543-9.

8. Xu SZ, Lin XJ, Tong X, Wang XW. Minimally invasive midvastus versus standard parapatellar approach in total knee arthroplasty: a meta-analysis of randomized controlled trials. PLoS One. 2014;9:e95311.

9. Wu Y, Zeng Y, Bao X, et al. Comparison of mini-subvastus approach versus medial parapatellar approach in primary total knee arthroplasty. Int J Surg. 2018;57:15-21.

10. Liu Z, Yang H. Comparison of the minimally invasive and standard medial parapatellar approaches for total knee arthroplasty: systematic review and meta-analysis. J Int Med Res. 2011;39:1607-17.

11. Boerger TO, Aglietti P, Mondanelli N, Sensi L. Mini-subvastus versus medial parapatellar approach in total knee arthroplasty. Clin Orthop Relat Res. 2005;440:82-7.

12. Gross JB. Estimating allowable blood loss: corrected for dilution. Anesthesiology. 1983;58:277-80.

13. Shortt J, Polizzotto MN, Waters N, et al. Assessment of the urgency and deferability of transfusion to inform emergency blood planning and triage: the Bloodhound prospective audit of red blood cell use. Transfusion. 2009;49:2296-303.

14. Liu D, Dan M, Martinez Martos S, Beller E. Blood Management Strategies in Total Knee Arthroplasty. Knee Surg Relat Res. 2016;28:179-87.

15. Lu Q, Peng H, Zhou GJ, Yin D. Perioperative Blood Management Strategies for Total Knee Arthroplasty. Orthop Surg. 2018;10:8-16.

16. Hu Y, Li Q, Wei BG, et al. Blood loss of total knee arthroplasty in osteoarthritis: an analysis of influential factors. J Orthop Surg Res. 2018;13:325.

17. Park JH, Rasouli MR, Mortazavi SM, et al. Predictors of perioperative blood loss in total joint arthroplasty. J Bone Joint Surg Am. 2013;95:1777-83.

18. Gombotz H, Rehak PH, Shander A, Hofmann A. Blood use in elective surgery: the Austrian benchmark study. Transfusion. 2007;47:1468-80.

19. 19.Palmer A, Chen A, Matsumoto T, et al. Blood management in total knee arthroplasty: State-of-the-art review. J ISAKOS. 2018;3:358–66.

20. Pierson JL, Hannon TJ, Earles DR. A blood-conservation algorithm to reduce blood transfusions after total hip and knee arthroplasty. J Bone Joint Surg Am. 2004;86:1512-8.

21. Rosencher N, Kerkkamp HE, Macheras G, et al. Orthopedic Surgery Transfusion Hemoglobin European Overview (OSTHEO) study: blood management in elective knee and hip arthroplasty in Europe. Transfusion. 2003;43:459-69.

22. Gore DR, Sellinger DS, Gassner KJ, Glaeser ST. Subvastus approach for total knee arthroplasty. Orthopedics. 2003;26:33-5.

23. Thiengwittayaporn S, Fusakul Y, Kangkano N, et al. Hand-held navigation may improve accuracy in minimally invasive total knee arthroplasty: a prospective randomized controlled trial. Int Orthop. 2016;40:51-7.

24. Lin SY, Chen CH, Fu YC, et al. Comparison of the clinical and radiological outcomes of three minimally invasive techniques for total knee replacement at two years. Bone Joint J. 2013;95-B:906-10.

25. 25.Borroff M, Green M, Gregg P, et al. 11th Annual Report, National Joint Registry for England, Wales and Northern Ireland. The NJR Editorial Board, 2014.