Association Between Operation Duration of Total Knee Arthroplasty and Risk of Blood Transfusion Events: A Secondary Analysis Based on Cohort Study in Singapore

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Abstract

Background

The purpose of our research is to explore the association between operation duration and the risk of blood transfusion in the patients undergoing TKA.

Methods

This study was a secondary analysis based on the data of a single-center retrospective cohort study in Singapore. The independent variable was the operation duration, and the dependent variable was the risk of blood transfusion events in the perioperation. we analyzed the risk factors of blood transfusion in the Perioperative period by univariate logistic regression, then, multivariable logistic regression analysis was performed adjusting for variables that might affect the operation duration of TKA and the risk of blood transfusion events. Additional analyses examined this association by the subgroup analysis by using stratified multivariate logistic regression models.

Results

Among 2,622 patients, 153 (5.8%) had blood transfusion in perioperative period. The older (OR=1.051 ,95% CI:1.030, 1.073), the lower BMI (OR=0.939,95% CI: 0.903,0.976),the lower Hb (OR=0.603,95% CI: 0.541 6.132), the DM on insulin (OR=2.542,95%CI:1.054, 6.132), the Bilateral TKA(OR=3.202, 95%CI:2.087, 4.913), the within CHF (OR=4.600, 95% CI :1.685, 12.563), the Cr≥2mg/dl (OR=7.246, 95% CI:2.739, 19.166), the higher ASA status (OR=6.439, 95% CI:2.403, 17.249), the higher risk of blood transfusion ($P<0.05$).The operation duration was positively correlated with perioperative blood transfusion. We demonstrated that the risk of blood transfusion increased by 1.1% for 1-minute increase in operation duration (OR = 1.011,95% CI: 1.004,1.018).

Conclusion

Our research shows that the longer the TKA operation duration, the higher the incidence of blood transfusion. The risk of blood transfusion events increases by 66% for every 1-hour increase in operation duration. Compared with patients with operation duration 100 minutes, patients with operation duration more than 100 minutes have an increased risk of blood transfusion events by 56.8%.

Introduction

Total knee arthroplasty (TKA) is an effective method for the treatment of end-stage knee osteoarthritis, which can significantly relieve patients' pain and promote functional recovery[1, 2]. Patients receiving TKA often need blood transfusion due to excessive blood loss, large joint cavity, joint swelling and other reasons[3, 4], while blood transfusion will increase the risk of postoperative adverse reactions in patients receiving TKA, such as perioperative sepsis, pneumonia, venous thromboembolism and even death[5–8]. Studies have shown that the incidence of blood transfusion in TKA is approximately 3.5%-18.5%[9].

Reducing blood transfusion not only mitigates adverse reactions after TKA, but also lowers the risk of complications such as infection and body fluid overload [10]. In addition, lowering the incidence of blood transfusion can also effectively decrease the treatment cost of patients [11]. Therefore, it is necessary to minimize the risk of perioperative blood transfusion in TKA patients.

There are many factors related to perioperative blood transfusion in TKA patients, such as Hb level[12], length of hospital stay[13, 14], anesthesia method during operation, etc. [11]. The speed of operation completion has long been considered as a way to evaluate the surgeon's ability. The surgeon Robert Liston has been highly praised for being able to complete the amputation above the knee in less than 2.5 minutes. Although the development of modern anesthesiology avoids the requirement that surgeons must complete the operation as quickly as possible, they still bear the pressure of reducing the operation duration. Another reason behind this is to increase the number of hospital admissions [15].

At present, the association between the operation duration of TKA and the risk of blood transfusion is controversial. It is generally believed that shorter operation duration can reduce the risk of infection and blood transfusion, thus improving the prognosis. The research of Young et al.[16] have shown that longer operation duration is significantly related to higher revision rate and poor prognosis. However, there is no study to evaluate the influence of operation duration on the risk of blood transfusion. Hence, based on the data of single-center retrospective cohort study in Singapore, we conducted a secondary analysis to explore the association between TKA operation duration and blood transfusion.

Methods

Data Sources

The original data has been uploaded to "DATADRYAD" website (www. datadryad.org) by Abdullah et al., who have authorized DataDryad website to own the original data; Therefore, we can use these data to make a secondary analysis of different hypotheses without infringing the author's rights.

This study was a secondary analysis based on single-center retrospective cohort study in Singapore. A total of 2,622 patients underwent TKA. The demographic characteristics (age, gender, race, BMI), preoperative Hb level, anesthesia method, comorbidity, Cr in the past 60 days > 2mg/dl (177 umol/L), knee replacement mode, operation duration, operation date were collected. The measurement window period of Hb level was determined to be a maximum of 14 days and a minimum of 1 day before operation. Perioperative blood transfusion was defined as blood transfusion from 2 weeks before operation to 2 weeks after operation. We further divided the duration of the operation into groups by 100 minutes.

The study was approved by the Ethics Committee of the Affiliated Hospital of Qingdao University. The Ethics Committee particularly approved that informed consent was not required because of being approved by the“DATADRYAD”Web site (www.datadryad.org) and data were analyzed anonymously.The ethics committee waived the requirement for informed consent from all patients.

Study Variables

The independent variable was the operation duration (minutes), and the dependent variable was whether patients had blood transfusion during the perioperative period. Perioperative blood transfusion was defined as 2 weeks before operation and 2 weeks after operation. The covariates included gender, age, race, BMI, smoking status, preoperative Hb level, ASA-status, DM, IHD, CHF, CVA, anesthesia method, Cr in the past 60 days≥2mg/dl (177 umol/L), operation mode, operation duration and operation date. Except aspirin, all antiplatelet drugs were routinely stopped for a period of time before operation. On the first day after operation, 40mg of low molecular weight heparin (Sanofi, France, Paris) was used for chemoprevention of thromboembolism until discharge. In the original study, the blood transfusion was defined as the Hb level of blood serum lower than 8.0g/dL. For patients with anemia symptoms or any anemia-related organ dysfunction, the Hb level of blood serum lower than 10.0g/dL was considered as a trigger factor for blood transfusion. The measurement and evaluation of anesthesia method, blood transfusion and other covariates were described in detail in the original study.

Statistical Analyses

For the demographic characteristics of patients, we displayed the continuous variables in the form of mean and standard deviation, and further tested the differences between groups by single-factor ANOVA or Kruskal-Wallis's Htest (continuous variables of normal or skewed distribution). If the variables were classified data (percentage), we employed chi-square test. Through single-factor logistic regression analysis, We preliminarily explored the influencing factors of perioperative blood transfusion, and further analyzed the association between them by subgroup analysis to study whether there were differences between different subgroups and find out whether there were special people.

Finally, we constructed three logistics regression models: 1. Unadjusted model; 2. Partially adjusted model; 3. Completely adjusted model. Among them, age, gender, BMI and ethnicity were adjusted in the partially adjusted model. In the completely adjusted model, all the co-variables were adjusted, and the operation duration was divided into groups by 100 minutes. Further, the trend test was carried out to identify whether the association between them was stable, and P<0.05 was considered statistically significant.Statistical packages R, version 3.4.3 (http://www.r-project.org) and EmpowerStats software (http://www.empowerstats.com, X&Y Solutions, Inc.) were used for statistical analyses.

Results

The Baseline characteristics of participants

Finally, a total of 2,622 patients underwent TKA. 153 patients (5.8%) had perioperative blood transfusion, and 2,469 patients (94.2%) had no perioperative blood transfusion (Table 1). Compared with the age of patients who had no perioperative blood transfusion (66.066±8.094), the age of patients who had perioperative blood transfusion was larger (69.373±9.642), and the difference was statistically significant (p<0.001) (Table 1). There was no significant difference (P > 0.05) (Table 1) between the two groups in

gender, race, smoking status, DM, DM on insulin, IHD, CVA, operation date, while there was significant difference ($P < 0.05$) (Table 1) in BMI, preoperative Hb level, ASA status, OSA, CHF, Cr in the past 60 days> 2mg/dl (177 umol/L), operation mode, operation duration and anesthesia method.

Table 1 Baseline characteristics of selected participants

Whether blood transfusion in the perioperation?	No (2469)	Yes (153)	P-value	P-value*
Gender			0.437	-
Male	601 (24.342%)	33 (21.569%)		
Female	1868 (75.658%)	120 (78.431%)		
Age(Years)	66.066 ± 8.094	69.373 ± 9.642	<0.001	<0.001
Race			0.364	-
Chinese	2079 (84.204%)	127 (83.007%)		
Indian	141 (5.711%)	9 (5.882%)		
Malay	179 (7.250%)	9 (5.882%)		
Others	70 (2.835%)	8 (5.229%)		
BMI	27.886 ± 5.587	26.592 ± 4.956	0.005	<0.001
Hb(g/dL)	13.160 ± 1.394	12.013 ± 1.796	<0.001	<0.001
ASA Status			<0.001	-
1	179 (7.250%)	5 (3.268%)		
2	2151 (87.120%)	123 (80.392%)		
3	139 (5.630%)	25 (16.340%)		
Type of Anaesthesia			<0.001	-
GA	884 (35.804%)	77 (50.327%)		
RA	1585 (64.196%)	76 (49.673%)		
Procedure Description			<0.001	-
Unilateral	2273 (92.062%)	121 (79.085%)		
Bilateral	176 (7.128%)	30 (19.608%)		
Revision	20 (0.810%)	2 (1.307%)		
Smoking			0.119	-

No	2230 (90.320%)	144 (94.118%)		
Yes	239 (9.680%)	9 (5.882%)		
DM			0.420	-
No	2017 (81.693%)	121 (79.085%)		
Yes	452 (18.307%)	32 (20.915%)		
IHD			0.108	-
No	2348 (95.099%)	141 (92.157%)		
Yes	121 (4.901%)	12 (7.843%)		
CHF			0.001	-
No	2451 (99.271%)	148 (96.732%)		
Yes	18 (0.729%)	5 (3.268%)		
CVA			0.872	-
No	2425 (98.218%)	150 (98.039%)		
Yes	44 (1.782%)	3 (1.961%)		
Creatinine > 2mg/dl (177 umol/L) (Past 60 days)			<0.001	-
No	2181 (88.335%)	129 (84.314%)		
Yes	14 (0.567%)	6 (3.922%)		
Missing	274 (11.098%)	18 (11.765%)		
DM on insulin			0.096	-
No	1834 (74.281%)	111 (72.549%)		
Yes	39 (1.580%)	6 (3.922%)		
Missing	596 (24.139%)	36 (23.529%)		
which Day of doing operation in a week?			0.215	-
Mon	408 (16.525%)	27 (17.647%)		
Tue	548 (22.195%)	41 (26.797%)		
Wed	428 (17.335%)	20 (13.072%)		

Thu	571 (23.127%)	29 (18.954%)
Fri	386 (15.634%)	31 (20.261%)
Sat	128 (5.184%)	5 (3.268%)

Results in the table: mean + SD / N (%)

P value *: if it is a continuous variable, it shall be obtained by Kruskal Wallis rank sum test. If the theoretical number of counting variables is less than 10, it shall be obtained by Fisher exact probability test.

The Single-factor analysis and subgroup analysis of operation duration and blood transfusion

We analyzed the association between the operation duration and perioperative blood transfusion by single-factor logistics regression. The results showed that the older age (OR = 1.051, 95% CI: 1.030,1.073), the lower BMI index (OR = 0.939,95% CI: 0.903,0.976), the higher ASA status (OR=6.439, 95% CI: 2.403, 17.249), the lower Hb level (OR=0.603, 95% CI:0.541, 0.671),the general anesthesia(OR=0.550, 95% CI:0.397, 0.764), the Bilateral KA (OR=3.202,95%CI:2.087, 4.913), within CHF (OR=4.600, 95%CI: 1.685, 2.563), the Cr in past 60 days>2mg/dL(OR=7.246,95% CI: 2.739, 19.166), the DM insulin-dependent (OR=2.542,95% CI: 1.054, 6.132) ,the higher risk factors for perioperative blood transfusion of TKA (P<0.05) (Table 2). On the contrary, gender, race, operation method, smoking status, DM, IHD, CVA, operation date were not associated with perioperative blood transfusion (P > 0.05) (Table 2).

Table 2
Univariate analysis of Each variable and Risk of Blood Transfusion Events in the Perioperation

	Total	OR (95%CI)	P-value
Gender			
MALE	634 (24.180%)	Ref	
FEMALE	1988 (75.820%)	1.170 (0.787, 1.738)	0.43732
Age(Years)	66.259 ± 8.227	1.051 (1.030, 1.073)	**<0.001**
Race			
Chinese	2206 (84.134%)	Ref	
Indian	150 (5.721%)	1.045 (0.520, 2.098)	0.90174
Malay	188 (7.170%)	0.823 (0.412, 1.646)	0.58188
Others	78 (2.975%)	1.871 (0.881, 3.973)	0.10305
BMI	27.811 ± 5.560	0.939 (0.903, 0.976)	**0.00148**
ASA Status			
1	184 (7.018%)	Ref	
2	2274 (86.728%)	2.047 (0.826, 5.071)	0.12160
3	164 (6.255%)	6.439 (2.403, 17.249)	**0.00021**
Hb (g/dL)	13.093 ± 1.446	0.603 (0.541, 0.671)	**<0.001**
Type of Anaesthesia			
GA	961 (36.651%)	Ref	
RA	1661 (63.349%)	0.550 (0.397, 0.764)	**0.00035**
Operation Duration (mins)	84.875 ± 27.492	1.014 (1.009, 1.019)	**<0.00001**
Procedure Description			
Unilateral	2394 (91.304%)	Ref	

Data in the table: OR (95%CI) Pvalue
Result variable: what blood transfusion in the period?
Exposure variables:Race; Gender; BMI; Age(Years); ASA Status; Hb(g/dL); Type of Anaesthesia; Operation Duration (mins); Procedure Description; Smoking; OSA; DM; IHD; CHF; CVA; Creatinine > 2mg/dl ; DM on insulin; which Day of doing operation in a week?
Adjust variables:None

	Total	OR (95%CI)	P-value
Bilateral	206 (7.857%)	3.202 (2.087, 4.913)	**<0.00001**
Revision	22 (0.839%)	1.879 (0.434, 8.130)	0.39895
Smoking			
No	2374 (90.542%)	Ref	
Yes	248 (9.458%)	0.583 (0.294, 1.158)	0.12347
DM			
No	2138 (81.541%)	Ref	
Yes	484 (18.459%)	1.180 (0.789, 1.765)	0.42021
IHD			
No	2489 (94.928%)	Ref	
Yes	133 (5.072%)	1.651 (0.891, 3.061)	0.11105
CHF			
No	2599 (99.123%)	Ref	
Yes	23 (0.877%)	4.600 (1.685, 12.563)	**0.00291**
CVA			
No	2575 (98.207%)	Ref	
Yes	47 (1.793%)	1.102 (0.338, 3.591)	0.87163
Creatinine > 2mg/dl			
No	2310 (88.101%)	Ref	
Yes	20 (0.763%)	7.246 (2.739, 19.166)	**0.00007**
NA	292 (11.137%)	1.111 (0.668, 1.848)	0.68600
DM on insulin			
No	1945 (74.180%)	Ref	
Data in the table: OR (95%CI) Pvalue			
Result variable: what blood transfusion in the period?			
Exposure variables:Race; Gender; BMI; Age(Years); ASA Status; Hb(g/dL); Type of Anaesthesia; Operation Duration (mins); Procedure Description; Smoking; OSA; DM; IHD; CHF; CVA; Creatinine > 2mg/dl ; DM on insulin; which Day of doing operation in a week?			
Adjust variables:None			

	Total	OR (95%CI)	P-value
Yes	45 (1.716%)	2.542 (1.054, 6.132)	**0.03785**
NA	632 (24.104%)	0.998 (0.678, 1.470)	0.99193
Day of doing operation in a week?			
Mon	435 (16.590%)	Ref	
Tue	589 (22.464%)	1.131 (0.684, 1.868)	0.63208
Wed	448 (17.086%)	0.706 (0.390, 1.279)	0.25081
Thu	600 (22.883%)	0.767 (0.448, 1.316)	0.33614
Fri	417 (15.904%)	1.214 (0.711, 2.071)	0.47770
Sat	133 (5.072%)	0.590 (0.223, 1.564)	0.28896
Data in the table: OR (95%CI) Pvalue			
Result variable: what blood transfusion in the period?			
Exposure variables:Race; Gender; BMI; Age(Years); ASA Status; Hb(g/dL); Type of Anaesthesia; Operation Duration (mins); Procedure Description; Smoking; OSA; DM; IHD; CHF; CVA; Creatinine > 2mg/dl ; DM on insulin; which Day of doing operation in a week?			
Adjust variables:None			

We further conducted stratification analysis on the age, BMI group, ASA status and Hb group. We observed that the incidence of perioperative blood transfusion was higher ($P<0.05$) (Table 3) when the BMI of patients was less than 29 kg/m^2. Moreover, in the stratified analysis of age, ASA status and Hb, we found that the older the patients, the higher the ASA status and the lower the preoperative hemoglobin Hb value, and the higher the incidence of perioperative blood transfusion (Table 3).

Table 3
Subgroup Analysis of Operation Duration (mins) and Blood Transfusion in the Perioperation

	N	Blood Transfusion	P-value
		OR (95%CI)	
BMI group			
14.6 - 25.4	862	1.019 (1.011, 1.027)	**<0.0001**
25.5 - 29	884	1.014 (1.005, 1.022)	**0.0022**
29.1 - 183.3	876	1.007 (0.996, 1.019)	0.1915
Age(Years) group			
20 - 62	853	1.011 (1.001, 1.021)	**0.034**
63 - 69	833	1.016 (1.007, 1.025)	**0.0005**
70 - 92	936	1.016 (1.008, 1.024)	**<0.0001**
ASA Status			
1	184	1.005 (0.974, 1.038)	0.7429
2	2274	1.015 (1.009, 1.020)	**<0.0001**
3	164	1.012 (0.997, 1.027)	0.1234
Hb(g/dL) group			
6.8 - 12.5	820	1.010 (1.003, 1.016)	**0.0062**
12.6 - 13.6	920	1.024 (1.014, 1.035)	**<0.0001**
13.7 - 18.1	882	1.013 (1.001, 1.025)	**0.0288**

Data in the table: OR (95%CI) Pvalue; Result variable: Whether blood transfusion in the perioperation?; Exposure variables: Operation Duration (mins); Adjust variables: None

Table 4
Univariate and multivariate analysis of Operation Duration (mins) and Blood Transfusion in the perioperation

Exposure	Non-adjusted Model OR (95%CI) P-value	Adjust I Model OR (95%CI) P-value	Adjust II Model OR (95%CI) P-value
Operation Duration (mins)	1.014 (1.009, 1.019) <0.00001	1.016 (1.011, 1.021) <0.00001	1.011 (1.004, 1.018) 0.00096
Group			
<100	**Ref**	**Ref**	**Ref**
>=100	1.947 (1.393, 2.722) 0.00010	2.161 (1.537, 3.039) <0.00001	1.568 (1.034, 2.378) 0.03442
P for trend	0.00010	<0.00001	0.03442
Result variable: what blood transfusion in the period?			
Exposure variables:Operation Duration (mins); Operation Duration (mins) ▯▯; Operation Duration (mins) ▯▯			
Non-adjusted model adjust for: None			
Adjust I model adjust for: Race; Gender; BMI; Age(Years)			
Adjust II model adjust for: Race; Gender; BMI; Age(Years); ASA Status; Hb(g/dL); Type of Anaesthesia; Procedure Description; Smoking; OSA; DM; IHD; CHF; CVA; Creatinine > 2mg/dl (177 umol/L) (Past 60 days); DM on insulin; which Day of doing operation in a week?			

The Multiple Logistics Regression Operation Duration And Blood Transfusion

Finally, we explored the independent influence of operation duration and perioperative blood transfusion by multi-factor logistics regression. It was found there was a positive association between operation duration and perioperative blood transfusion in the three models, and the relationship was stable. In the unadjusted model, the risk of blood transfusion would increase by 1.4% for each 1-minute increase in operative duration (OR = 1.014,95% CI: 1.009,1.019). In the partially adjusted model, the risk of blood transfusion would increase by 1.6% for each 1-minute increase in operative duration (OR = 1.016,95% CI: 1.011,1.021). In the fully adjusted model, the risk of blood transfusion would increase by 1.1% for each 1-minute increase in operative duration(OR = 1.011,95% CI: 1.004, 1.018).

Compared with patients with operation duration less than 100 minutes, the incidence of perioperative blood transfusion in patients with operation duration equal to and over 100 minutes was 56.8% higher

(OR = 1.568,95% CI: 1.034, 2.378), and the trend test showed that the P value was below 0.05, which indicated that the positive association between the two was stable.

Discussions

Our research demonstrated that the average operation duration of patients receiving TKA was 84.875±27.492 minutes. After adjusting the potential risk factors of blood transfusion, patients with operation duration equal to and over 100 minutes had significantly higher risk of blood transfusion compared with patients with TKA operation duration less than 100 minutes. This was consistent with the previous research results of Kevin et al.[15]. The revision rate of TKA for more than 150 minutes was significantly higher than that of the operation lasting 120-150 minutes. Studies demonstrated that the operation duration was directly proportional to the risk of blood transfusion. In this regard, measures to shorten the operation duration as much as possible would be beneficial to reduce the blood loss and the risk of blood transfusion in keen operation [17]. On the contrary, the study of Zhong et al. [11] proved that patients with operation duration equal to and over 90 minutes had a lower risk of blood transfusion than those with the operation duration of 60-89 minutes, possibly due to differences in the target group and the surgeon's skills.

Our research results showed that each 1-minute increase in operation duration increased the risk of blood transfusion by 1.1%, which indicated that operation duration was one of the most important independent predictors of perioperative blood transfusion. Similarly, other studies found that longer operation duration was significantly related to higher revision rate and poor prognosis, which might be associated with complications (such as bleeding, large joint cavity, Infection, etc.)[18–22]. The complexity of the operation extended the duration of the operation, and the risk of postoperative complications increased with the high incidence of massive blood loss and transfusion. The results of a study on the operation duration and the risk of blood loss and blood transfusion in hip revision arthroplasty presented that the operation duration was the sole significant variable affecting the blood loss. The incidence of intraoperative bleeding exceeding 2000ml increased by 3% for each 1-minute increase in operation duration [17]. However, a co-enrolled study of 58,009 TKA patients in New Zealand found that for TKA with operation duration less than 120 minutes, further shortening the operation duration could not improve the prognosis. Meanwhile, when the operation duration was less than 40 minutes, it might in turn increase the risk of bleeding and other complications[16]. In this respect, how to shorten the operation duration has become a key control strategy for perioperative blood transfusion, requiring surgeons to control the operation duration in accordance with patient's individual situation, take measures to reduce the risk of bleeding and anemia, and minimize the risk of perioperative blood transfusion in order to obtain the ideal prognosis.

Previous research showed that the prolonged operation duration might be related to the complexity of operation, the lack of experience or operating habits of surgeons and other factors[23, 24]. In hip replacement where the operation duration exceeded 140 minutes, more than 50% of them were complex cases requiring more professional surgical skills[25]. Jonathan et al [17] discovered that the operation

duration was related to the surgeon's experience. The average operation duration of doctor with over two years' experience would be reduced by 40 minutes, but the risk of blood loss and blood transfusion would be increased by three times. In addition, the operation duration might also be related to the obesity of patients[26–28]. Obese patients (BMI≥40 kg/m2) receiving TKA had a longer average operation duration and more intraoperative blood loss, thus increasing the incidence of blood transfusion.

This research found that gender was an independent factor affecting perioperative blood transfusion. Compared with female patients receiving TKA, the operation duration of male patients was closely related to the risk of perioperative blood transfusion, which was contrary to the results of previous studies[11].Nevertheless, no study discussed the reason why gender was associated with the risk of blood transfusion. In addition, our results were consistent with those of other studies in that the older patients had higher risk of blood transfusion[29–32]. Older people tend to be in poor health and are more likely to experience heavy bleeding, increasing the incidence of perioperative blood transfusion.

Perioperative blood transfusion will lead to a series of potential complications, such as blood transfusion reaction, management errors, infection risks (blood transmission and periprosthetic infection)[33, 34], increasing costs, etc. It is our future research direction to significantly reduce patients' demand for blood transfusion. Some studies on the use of closed drainage in hip or knee replacement have shown that the use of drainage tube has a high risk of blood transfusion, which is of no help to the operation[35, 36]. Previous studies have put forward a variety of blood protection strategies, such as preoperative autologous donation, isovolumetric blood dilution, intraoperative blood recovery, etc. [28, 37], to minimize perioperative blood loss, avoid allogeneic blood transfusion and reduce various complications caused by blood transfusion.

Meanwhile, there are some limitations in our study. First, due to geographical restrictions, the target group of this study is all patients receiving TKA in Singapore, which may affect the universality of the results. Second, this study is based on the secondary analysis of observational study, so we can not adjust the variables not included in the data. In the meantime, we don't have any data about other complications affected by the operation duration, such as thromboembolism and wound complications. Furthermore, it is not clear whether the operation duration in this data only refers to the operation duration of surgeons or the combined time including anesthesia time. Finally, the blood transfusion judgment of different doctors and anesthesiologists is also a potential confounding factor.

Conclusion

Our research shows that the longer the TKA operation duration, the higher the incidence of perioperative blood transfusion. The incidence of perioperative blood transfusion increases by 66% for every 1-hour increase in operation duration. Compared with patients with operation duration less than 100 minutes, patients with operation duration equal to and over100 minutes have an increased risk of blood transfusion by 56.8%.

Abbreviations

TKA:Total knee arthroplasty; BMI: body mass index□Hb:hemoglobin□ASA-PS:American Society of Anesthesiologist Physical Status ; CCF:congestive cardiac failure; CVA□cerebrovascular accidents; DM:diabetes mellitus; GA: general anaesthesia; IHD: ischaemic heart disease; LOS: length of stay; RA: regional anaesthesia;

Declarations

Data availability statement

Availability of Data and Materials: Data can be down-loaded from “DATADRYAD” database. Dryad data package:Abdullah HR, Sim E, Hao Y, Lin G, Liew GHC, Lamoureux EL,Tan MH (2017). Data from: Association between preoperative anemia with length of hospital stay among patients undergoing primary total knee arthroplasty in Singapore:a single-center retrospective study. Dryad Digital Repository. https://doi.org/10.5061/dryad.73250.

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Author contributions

BL performed the data analysis. YH wrote the manuscript. JP P contributed to the manuscript revise. YH contributed to literature search and extraction. BL, and ZJ W conceived and designed the study. All authors have read and approved the final version of the manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Affiliated Hospital of Qingdao University. The Ethics Committee particularly approved that informed consent was not required because of being approved by the DRYAD and data were analyzed anonymously.The ethics committee waived the requirement for informed consent from all patients.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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