

Factors leading to blood transfusion among Chinese patients undergoing total knee replacements: A retrospective study

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ABSTRACT

Purpose. To investigate the risk factors leading to blood transfusion among Chinese patients undergoing total knee replacement.

Methods. From July 2001 to June 2002, a total of 128 primary total knee replacements were performed in 83 Chinese patients (38 unilateral and 45 one-stage sequential bilateral). No pharmaceutical prophylaxis against deep vein thrombosis was used. The risk factors leading to allogenic blood transfusion were analysed.

Results. The important predictive factors for postoperative blood transfusion were preoperative haemoglobin level ($p=0.005$), intra-operative blood loss ($p<0.001$), and bilateral total knee replacements ($p<0.001$).

Conclusion. To reduce the need of allogenic blood transfusion, we suggest administering erythropoietin or iron supplements to increase the haemoglobin

level for patients undergoing total knee replacement. Routine use of intra-operative blood salvage can be considered for patients undergoing one-stage bilateral total knee replacement. Use of a postoperative blood salvage system is recommended for surgeries that may result in major intra-operative blood loss.

Key words: arthroplasty; Asian continental ancestry group; blood transfusion; risk factors

INTRODUCTION

Bleeding is inevitable when total joint replacement is performed. Allogenic blood transfusion carries the risk of transmitting infectious disease. Various methods have been used in order to reduce the incidence of allogenic blood transfusion. These methods include preoperative use of erythropoietin, preoperative autologous blood donation, and the use of blood salvage systems both intra-operatively and post-

operatively. Each method has its own merits and disadvantages; therefore, selecting the most suitable method for each patient is important.

For Caucasian patients, recent papers have suggested that the preoperative haemoglobin (Hb) level is the most important predictive factor for postoperative allogenic blood transfusion.^{1,2} However, among the Chinese population, pharmaceutical prophylaxis (e.g. heparin and warfarin) for deep vein thrombosis prevention is not routinely used, because of the low incidence of deep vein thrombosis and pulmonary embolism. This definitely affects intra-operative bleeding and hence the need for blood transfusion. We aim to investigate the risk factors leading to postoperative allogenic blood transfusion among Chinese patients undergoing total knee replacement (TKR).

MATERIALS AND METHODS

From July 2001 to June 2002, a total of 128 primary TKR were performed in 83 Chinese patients at Queen Mary Hospital in Hong Kong. Each operation was performed by any one of the 4 authors. No patient received preoperative pharmaceutical prophylaxis against deep vein thrombosis. One deep drain was left before wound closure and was removed on day 2 postoperatively. Blood transfusion was considered if the patient's absolute Hb level was below 80 g/l; or if the patient developed symptoms of anaemia; or if there was haemodynamic instability. All the blood transfused was allogenic. No preoperative erythropoietin treatment, preoperative autologous blood donation, or blood salvage system was used.

38 patients underwent unilateral TKRs, whereas 45 patients underwent one-stage sequential bilateral TKRs. All the TKRs were cemented. Patellae were not resurfaced routinely apart from those patients suffering from inflammatory joint disease. Tourniquets were not used at the beginning of the operation. Meticulous haemostasis was achieved throughout the whole procedure. The tourniquet was inflated at the time of cementation of prosthesis to ensure a good cement interdigitation into the bone. The mean duration of applying the tourniquet was approximately 15 to 25 minutes. The operation technique was standardised (midline incision and Insall approach). All the tibial cuts were performed using an extra-medullary alignment guide, and all the femoral cuts were performed using an intra-medullary alignment guide. The hole created for the femoral intra-medullary alignment guide was

Table 1
Characteristics of patients undergoing total knee replacement

	Results
Mean age (SD) [†] [years]	66.2 (8.8)
Sex (male:female)	9:74*
Mean body weight (SD) [kg]	63.7 (11.2)
Mean body height (SD) [cm]	150.0 (8.6)
Mean preoperative haemoglobin level (SD) [g/l]	125 (13)
Mean preoperative platelet count (SD) [$\times 10^9/l$]	270 (94)
Mean duration of operation (SD) [minutes]	173 (65)
Mean intra-operative blood loss (SD) [ml]	606 (370)
Mean postoperative drain output (SD) [ml]	511 (285)
Mean No. of pints of blood transfused (SD) [range]	1.4 (1.6) [0-6]
No. of patients receiving blood transfusion	47*
Presence of inflammatory joint disease	8*
Use of steroid	3*
Use of anticoagulants	31*

* Results are shown in No. of patients

[†] SD standard deviation

routinely sealed with a piece of cancellous bone graft. All the prostheses were put in with cement.

The age, sex, body weight, body height, preoperative Hb level, preoperative platelet count, duration of operation, intra-operative blood loss, postoperative drain output, number of pints of blood transfused, presence of inflammatory joint disease, and use of steroid and anticoagulants (not for deep vein thrombosis prevention) were recorded. Independent Student's *t* test, linear regression test, and Chi squared test were used, and statistical significance was assumed if $p < 0.05$.

RESULTS

The distributions of age, sex, body weight, body height, preoperative Hb level, and preoperative platelet count are shown in Table 1. 47 out of 83 patients required blood transfusion. The mean amount of blood transfused was 1.4 pints (range, 0-6 pints). The need for blood transfusion was significantly correlated to the preoperative Hb level ($p = 0.005$), the duration of operation ($p < 0.001$), intra-operative blood loss ($p < 0.001$), postoperative drain output ($p = 0.001$), and one-stage sequential bilateral TKR ($p < 0.001$)

Table 2
Comparison of risk factors between TKR* patients who received blood transfusion and those who did not

Risk factors	Blood transfusion		p value
	Yes (n=47)	No (n=36)	
Mean age (years)	67	65	NS [†]
Sex (male:female)	3:44	6:30	NS
Mean body weight (kg)	62.2	65.9	NS
Mean body height (cm)	148.1	153	NS
Mean preoperative haemoglobin level (g/l)	121	130	0.005
Mean preoperative platelet count (x10 ⁹ /l)	287	249	NS
Mean duration of operation (minutes)	196	136	<0.001
Mean intra-operative blood loss (ml)	739	409	<0.001
Mean postoperative drain output (ml)	596	392	0.001
Presence of inflammatory joint disease	6	2	NS
Use of steroid	1	2	NS
Use of anticoagulants	18	13	NS
Unilateral: bilateral	12:35	26:10	<0.001
Removal of implant	1	1	NS

* TKR total knee replacement

[†] NS not significant

Table 3
Comparison between patients undergoing unilateral TKR* and one-stage sequential bilateral TKR

Risk factors	Unilateral TKR	Bilateral TKR	p value
Mean age (SD) [†] [years]	66.1 (9.7)	66.2 (8.1)	NS [‡]
Sex (male:female)	4:34	5:40	NS
Mean body weight (SD) [kg]	62.2 (11.2)	64.9 (11.2)	NS
Mean body height (SD) [cm]	152.6 (6.7)	147.9 (9.3)	NS
Mean preoperative haemoglobin level (SD) [g/l]	123 (12)	127 (14)	NS
Mean preoperative platelet count (SD) [x10 ⁹ /l]	266 (95)	274 (94)	NS
Presence of inflammatory joint disease	4	4	NS
Use of steroid	3	0	NS
Use of anticoagulants	14	17	NS
Mean duration of operation (SD) [minutes]	112 (19)	221 (45)	<0.001
Mean intra-operative blood loss (SD) [ml]	333 (176)	837 (333)	<0.001
Mean postoperative drain output (SD) [ml]	338 (165)	657 (285)	<0.001 [§]
No. of patients requiring blood transfusion	12	35	<0.001 [§]
Mean No. of pints of blood transfused (SD)	0.6 (0.9)	2.1 (1.6)	<0.001

* TKR total knee replacement

[†] SD standard deviation

[‡] NS not significant

[§] Chi squared test

[Table 2]. After regression analysis, preoperative Hb level, intra-operative blood loss, and bilateral TKR remained the risk factors that led to blood transfusion. There was a significant correlation between the intra-operative blood loss and postoperative drain output in this group of patients (Pearson correlation=0.423; $p=0.001$).

The characteristics of the patients (age, sex ratio, body weight, body height, preoperative Hb level, preoperative platelet count, disease pattern, and drug use history) who underwent unilateral

TKR versus bilateral TKR are compared in Table 3. The magnitude of the surgery—in terms of operating time, intra-operative blood loss, and postoperative drain output—was a significant factor that led to blood transfusion ($p<0.001$; independent 2 sample *t* test).

DISCUSSION

Although pharmacological prophylaxis against deep vein thrombosis was not used in our patients, the

amount of blood loss (mean, 606 ml; standard deviation [SD], 370 ml) and the amount of postoperative blood transfusion (mean, 1.4 pints; SD, 1.6 pints) were larger than those in Caucasian studies.¹⁻³ Despite a rather strict policy on blood transfusion, 47 of the 83 patients still needed blood transfusion, which is comparable to other studies.^{1,2}

In our study, the most important factors in predicting postoperative blood transfusion in Chinese patients undergoing TKR were the preoperative Hb level ($p=0.005$), intra-operative blood loss ($p<0.001$), and one-stage sequential bilateral TKR ($p<0.001$). These findings also agreed with other studies performed on Caucasian populations.^{1,4}

Comparing with 9318 Caucasian patients who underwent total joint replacements in a large-scale study,² we found that our patients had a significantly lower preoperative Hb level (mean, 125 g/l; SD, 13 g/l vs mean, 138 g/l; SD, 16 g/l) [$p<0.001$; one sample *t* test]. Besides, our patients were lighter (mean body weight, 63.7 kg; SD, 11.2 kg vs mean, 74.5 kg) [$p<0.001$; one sample *t* test] and shorter (mean body height, 150.0 cm; SD, 8.6 cm vs mean, 156 cm) [$p<0.001$; one sample *t* test] than Caucasian patients reported in another study.¹

Preoperative autologous blood donation is one of the approaches to avoid allogenic blood transfusion. However, because of the short lifespan of red blood cells, donation is usually carried out within 3 months before the target operation, which limits the body to replenish the loss of the donated blood, thereby leading to a low preoperative Hb level. This is not desirable for patients undergoing TKRs because low preoperative Hb level was one of the risk factors leading to postoperative transfusion in this study. Bierbaum et al.² reported a 9% incidence of breakthrough transfusion (i.e. patients who need allogenic blood transfusion in addition to preoperative autologous blood donation) in their study on 9318 Caucasian patients. This reflected the undesirable effect of preoperative autologous blood donation, which may lead to postphlebotomy anaemia and exaggerate the incidence of blood replacement postoperatively.³ This further makes the use of preoperative blood donation undesirable.

Whether preoperative autologous blood donation can lessen the financial burden on the health-care system remains controversial.⁵ The most notable criticism is that there is usually a high percentage of wastage of donated blood, which can be as high as 45% in some studies.^{2,3}

Using a blood salvage system, either intra-operatively or postoperatively, can reduce the need for allogenic blood transfusion.⁶ However, routine

use of a blood salvage system in every patient undergoing TKR is not recommended, because of the costly equipment and the fact that only 47 of 83 patients required transfusion in our study. Instead, routine use of intra-operative blood salvaging system is more justified for patients undergoing bilateral TKR because they were prone to having more intra-operative blood loss (28 out of 38 patients) and thus required blood transfusion. In the current study on patients undergoing TKR, the intra-operative blood loss was significantly correlated with postoperative drain output ($p=0.001$). Postoperative blood salvaging system can be used to cut down the need for allogenic transfusion, especially for patients with significant intra-operative blood loss.

The findings in this study agree with others that preoperative Hb level is one of the most important predictive factors of postoperative blood transfusion.^{1,2,4} Our study found that the preoperative Hb level among Chinese patients undergoing total joint replacements was within the lower range, compared to that of a normal population (mean, 125 g/l; SD, 13 g/l). Therefore, we recommend preoperative use of erythropoietin and oral iron supplements to build up the Hb level of these patients before undergoing a major total joint replacement surgery.

For patients undergoing unilateral TKR, if their preoperative Hb level was above 125 g/l, the incidence of requiring blood transfusion was significantly lower than those below ($p=0.002$; odds ratio=0.0349), which is in keeping with patients undergoing bilateral TKR with a preoperative Hb level of above 130 g/l ($p=0.002$; odds ratio=0.612). It is reasonable to project that if the preoperative Hb level reaches a certain level, the need for blood transfusion can be minimised. Five of our patients (one underwent unilateral TKR and 4 underwent bilateral TKR) with a preoperative Hb level at or above 145 g/l required no blood transfusion.

CONCLUSION

To reduce the need for allogenic blood transfusion, we suggest administering erythropoietin or iron supplements to increase the Hb level for patients undergoing TKR. Routine use of intra-operative blood salvage can be considered for patients undergoing one-stage bilateral TKR. Use of a postoperative blood salvage system is recommended for surgeries that may result in major intra-operative blood loss.

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