

Revision total hip replacement: predictors of blood loss, transfusion requirements, and length of hospitalisation

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Abstract

Background Revision total hip replacement (THR) is associated with increased blood loss and extended hospitalization.

Materials and methods We reviewed 146 patients who underwent revision THR to identify predictors of blood loss, transfusion requirements, and length of hospitalization.

Results Blood loss was greater with increasing age and in men. Femoral and dual-component revision and revision of cemented hip components were also associated with greater blood loss. Transfusion requirements were greater in patients who had lower preoperative hemoglobin concentration and in patients undergoing dual-component revision. Length of hospitalization was significantly increased in patients who received transfusion but less in patients who underwent isolated acetabular-component hip revision.

Conclusions This study shows significantly greater blood loss in men, older patients, revision surgery of cemented implants, and dual-component revisions. More complex revision surgery and preoperative anemia are clearly associated with increased transfusion requirements and

length of hospitalization. Identification and treatment of patients at higher risk of transfusion may guide likely transfusion requirements, shorten the length of hospitalization, and reduce the overall cost of treatment.

Keywords Revision · Hip replacement · Transfusion · Length of stay · Blood loss

Introduction

Patients undergoing revision total hip replacement (THR) are at greater risk of perioperative blood loss, requiring transfusion [1] and extended length of hospitalization [2], which can have substantial cost implications. Allogenic transfusion carries the risk of disease transmission and immunological reactions and has been shown to increase the length of hospitalization [3]. Identification of patients potentially requiring transfusion is desirable to improve blood use and more accurately identify which patients should receive established pre- and perioperative blood conservation interventions. In this study we examined the influence of variables such as age, gender, preoperative hemoglobin concentration and type of revision surgery on blood loss, transfusion rates, and length of hospitalization following revision THR.

Materials and methods

A retrospective analysis was conducted on 146 patients who underwent elective revision total hip arthroplasty (THA) in our unit over a 5-year period. Operations were performed by four consultant surgeons using various surgical and anesthetic techniques. The analysis did not

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specifically look into the modes of implant failure and excluded cases of revision THA for infection or fractures as well as early revisions for dislocations secondary to implant malposition. Data were grouped according to the type of THR component that was revised (acetabular, femoral, or dual components).

The electronic database was searched, and variables such as pre- and postoperative hemoglobin concentrations, patient demographics such as age and gender, type of revision surgery, transfusion rates, and length of hospitalization were recorded. Blood loss was estimated by measurement of pre- and postoperative hemoglobin concentrations (24 h after surgery); the difference between concentrations was recorded in each case. Anemia was defined as hemoglobin levels <12 g/dl in women and <13 g/dl in men [4].

Data were analyzed using statistical software (SPSS 16.0 for Windows—SPSS Inc., Chicago, IL, USA). Pearson's correlation coefficients were calculated to examine the relationship between blood loss, transfusion requirements, length of hospitalization, age, and preoperative hemoglobin levels. Continuous data were analyzed using the Student's *t* test and categorical data by the Mann–Whitney *U* test. Multiple linear regressions were used to examine the relationship between blood loss, length of stay, and transfusion rates with the variables analyzed. For comparing the percentage of patients receiving blood transfusion in the different subgroups, Fisher's contingency table analysis was performed. A *P* value <0.05 was considered to be significant.

Data were retrieved from case notes and did not involve direct patient participation. No identifiable parameters were investigated or recorded. The regional ethics committee authorised the study and advised that informed consent from patients was not required due to the retrospective nature of the analysis.

Results

One hundred and forty-six patients who underwent elective revision THR surgery were reviewed in this study. Table 1 describes patient characteristics and shows that men ($n = 50$) and women ($n = 96$) were evenly matched for age.

The average drop in hemoglobin concentration following elective revision THR was 4.6 g/dl (32%) in men and 3.5 g/dl (27%) in women ($p = 0.021$). The preoperative hemoglobin concentration was, as expected, significantly higher in male patients. No significant difference was observed in the percentage of cases receiving transfusion or overall transfusion numbers between male and female patients (Table 1).

Table 1 Characteristics of cases of revision total hip replacement

	Male	Female	<i>P</i> value
Number of cases (<i>n</i>)	50	96	–
Age (years)	67.3 ± 12.2	70.2 ± 11.3	0.555
Preoperative hemoglobin concentration (g/dl)	14.2 ± 1.36	12.7 ± 1.25	<0.001*
Blood loss (g/dl)	4.6 ± 1.75	3.5 ± 1.64	0.021*
Length of hospitalization (days)	12.8 ± 9.3	14.9 ± 17.5	0.545
Number of units transfused (<i>n</i>)	71	188	0.295
Number of patients transfused (<i>n</i>)	22 (44%)	51 (53%)	0.258

* Statistically significant

Relationship between blood loss and type of THR component revision

In 23 cases, there was insufficient information in the electronic database about the components that were revised during surgery. Therefore, only 123 patients were analyzed with reference to the type of revised component (Table 2). Dual-component revision in a hybrid THR was classified as cemented, as one of the components by default is cemented.

Blood loss following acetabular-component revision (3.3 g/dl) was significantly less than dual-component (4.7 g/dl) ($P < 0.001$) and femoral-component (4.2 g/dl) ($P = 0.048$) revisions (Table 3). Patients who underwent acetabular-component revisions received less transfusions compared with patients who underwent dual-component revision ($P < 0.001$). Overall, 33% ($n = 21$) of patients who underwent acetabular-component revision received blood transfusions compared with 42% ($n = 5$) in femoral-component revision ($P = 0.124$) and 73% ($n = 35$) in dual-component revision ($P < 0.001$).

Revisions of cemented THR components were associated with increased blood loss but did not lead to higher rates of transfusion (Table 4).

Table 2 Type of total hip replacement components revised

Components revised	Type of implant	
	Cemented	Uncemented
Acetabular component (63)	55	8
Femoral component (12)	11	1
Dual components (48)	43	5

Table 3 Characteristics of patients undergoing revision total hip replacement based on component revision

	Acetabular component (n = 63)	Femoral component (n = 12)	Dual component (n = 48)
Blood loss (g/dl)	3.3 ± 1.29*	4.2 ± 1.29*	4.7 ± 1.92*
Number of cases transfused (n)	21 (33%)	5 (42%)	35 (73%)
Number of transfusions (n)	76	16	123
Length of hospitalization (days)	10.6 ± 6.3	13.7 ± 7.3	13.0 ± 14.3

* Statistically significant

Table 4 Characteristics of patients undergoing revision of cemented and uncemented total hip replacement components

Components revised	Cemented (n = 109)	Uncemented (n = 14)	P value
Blood loss (g/dl)	4.1 ± 1.73	2.6 ± 1.23	0.001*
Number of cases transfused (n)	54 (49.5%)	5 (36%)	0.703
Number of transfusions (n)	204	12	0.174
Length of hospitalization (days)	12.6 ± 10.5	11.3 ± 6.5	0.570

* Statistically significant

Relationship between blood loss (drop in hemoglobin concentration), age, and preoperative hemoglobin concentration

Univariate analysis only revealed a significant relationship between blood loss and preoperative hemoglobin concentration ($P < 0.001$) (Table 5).

However, multivariate regression analysis also identified age ($P = 0.027$) as an independent variable with significant correlation to blood loss (Table 6).

Relationship between blood transfusion and variables

Sixty-eight of the 146 patients who underwent revision THR received blood transfusion. Univariate analysis revealed a significant relationship between the number of blood transfusions and age ($P = 0.002$), preoperative hemoglobin concentration ($P = 0.022$), and blood loss ($P < 0.001$) (Table 7).

After adjustment for potential confounders in a stepwise multivariate linear regression analysis, only preoperative

Table 5 Correlation between blood loss and variables investigated

	Age	Number of transfusions	Preoperative hemoglobin concentration	Length of hospitalization
Blood loss				
Pearson's correlation	0.090	0.346*	0.478*	0.022
Significance (2-tailed)	0.156	0.000	0.000	0.404

* Statistically significant

Table 6 Multivariate regression model for blood loss

Independent variables	Regression coefficient	95% Confidence interval	P value
Age (years)	0.162 (0.011)	0.003–0.046	0.027*
Preoperative hemoglobin concentration (g/dl)	0.540 (0.086)	0.470–0.808	<0.001*

* Statistically significant

Table 7 Correlation between transfusion requirements and variables investigated

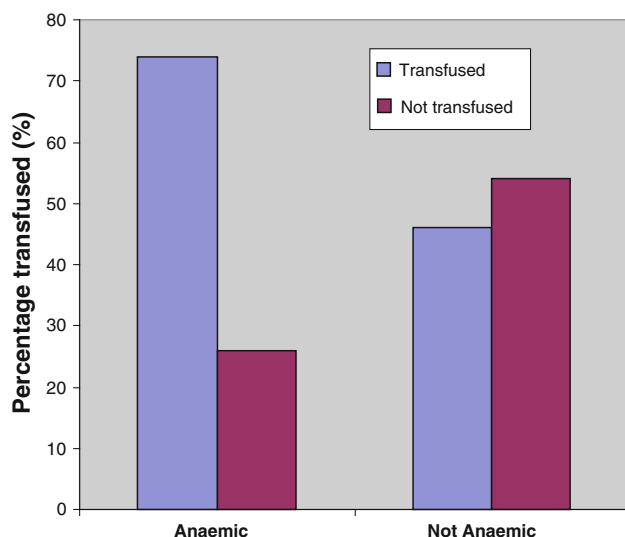
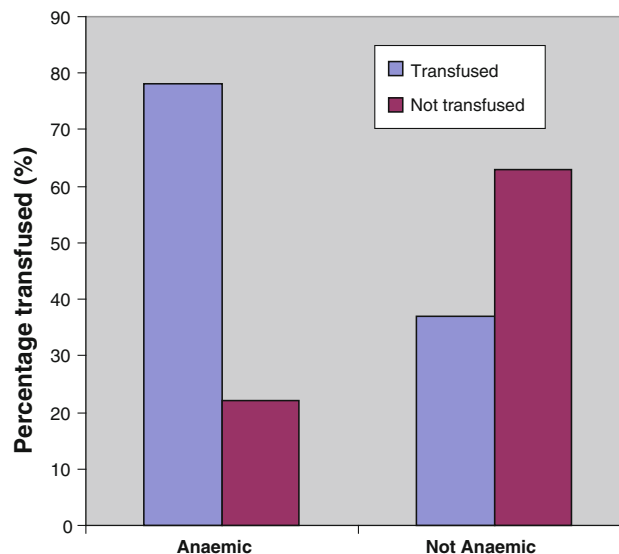
	Age	Preoperative hemoglobin concentration	Blood loss	Length of hospitalization
Number of transfusions				
Pearson correlation	0.256*	−0.178*	0.346*	0.300*
Significance (2-tailed)	0.002	0.022	0.000	0.000

* Statistically significant

Table 8 Multivariate regression model for transfusion requirements

Independent variable	Regression coefficient	95% Confidence interval	<i>P</i> value
Age (years)	0.021 (.017)	−0.13 to 0.054	0.230
Preoperative hemoglobin concentration (g/dl)	−0.642 (0.157)	−0.952 to −0.332	<0.001*
Blood loss (g/dl)	0.752	0.499–1.006	<0.001*

* Statistically significant

**Fig. 1** Proportions of female patients receiving blood transfusion based on preoperative hemoglobin level**Fig. 2** Proportions of male patients receiving blood transfusion based on preoperative hemoglobin level

hemoglobin concentration ($P < 0.001$) and blood loss ($P < 0.001$) remained significant (Table 8).

Twenty-four percent of female patients ($n = 25$) and 20% of male patients ($n = 10$) were anemic preoperatively. Seventy-four percent ($n = 19$) of female patients who were anemic preoperatively required allogenic transfusion compared with only 46% in those who were not anemic ($P = 0.01$) (Fig. 1). The odds ratio (OR) for an anemic female patient to receive transfusion was 3.5 compared with a nonanemic patient. In male patients with preoperative anemia (hemoglobin <13 g/dl), 78% required transfusion compared with 37% in those who were not anemic ($P = 0.02$) (Fig. 2). The OR for an anemic male patient to receive transfusion was 6.1.

Relationship between length of hospitalization and variables

A significant relationship was observed between length of hospitalization and age ($P = 0.028$), number of transfusions ($P < 0.001$), and preoperative hemoglobin levels ($P = 0.029$) (Table 9).

Patients older than 70 years who underwent revision THR spent significantly more days in hospital (16.6 days)

compared with younger patients (11.5 days) ($P < 0.001$) (Fig. 3).

However, multivariate analysis identified a significant relationship only between length of hospitalization and blood transfusion ($P = 0.006$) (Table 10). Transfused patients had an average increased length of hospital stay of 6 days (17.3 versus 11.1 days, $P = 0.006$).

Relationship between length of hospitalization and gender

The average length of hospital stay following elective revision THR was 14.2 days, with male patients averaging 12.8 days compared with 14.9 days in female patients, demonstrating no significant difference ($P = 0.547$) (Table 1).

Relationship between length of hospitalization and type of THR component revision

The length of hospital stay was shorter in patients who underwent acetabular-component revision compared with dual-component revision ($P = 0.006$). No significant difference in the length of hospital stay was observed when

Table 9 Correlation between length of hospitalization and variables investigated

	Age	Number of transfusions	Preoperative hemoglobin concentration	Blood loss
Length of hospitalization				
Pearson's correlation	0.169*	0.300*	-0.167*	0.022
Significance (2-tailed)	0.028	0.000	0.029	0.404

* Statistically significant

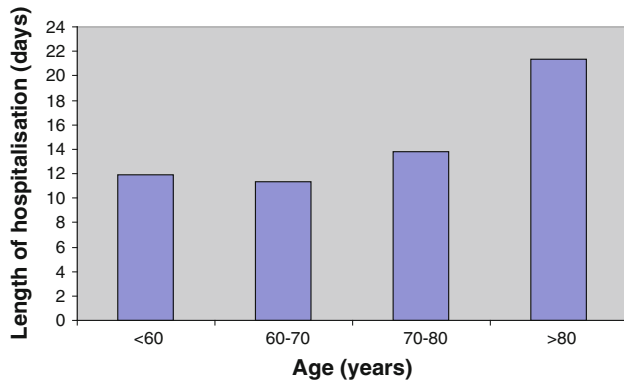


Fig. 3 Length of hospitalization in relation to patient age

comparing femoral-component revisions with dual-component or acetabular-component revisions or between cemented and uncemented implants (Table 3 and 4).

Discussion

This study was undertaken to determine what variables could be predictive of the need for postoperative blood transfusion and prolonged hospitalization following revision THA in order to develop a system that ensures effective use of resources, including blood-conservation techniques and funding.

Overall, 46% of patients who underwent revision THA received blood transfusions, which is consistent with the findings of Sharma et al. [1] (39–56%) but substantially lower than the figures of Phillips et al. [5] of >90%.

Blood loss

In this study, blood loss was significantly greater in men, older patients, revision of cemented implants, and dual-component revisions. Grosflam et al. [6] shown that

male gender was a significant predictor for greater blood loss following THR. Our analysis concurred with their findings, showing that blood loss was significantly greater in men during revision surgery. In revision arthroplasty, cement and implant removal can be challenging, time-consuming, and damaging to the remaining host bone [7]. We postulated that removal of well-fixed cement from bone surfaces at the time of revision surgery was likely to cause more bleeding compared with removal of uncemented components. The postoperative fall in hemoglobin in our analysis supports this hypothesis. We concurred with previous studies that dual-component revision is associated with increased blood loss [8, 9]. Other factors that have been shown to influence blood loss during THA include the use of general anesthesia, American Society of Anesthesiologists (ASA) class [6], and patient positioning [10].

Transfusion requirements

Increased transfusion rates correlated with patient age, preoperative hemoglobin concentration, blood loss, and dual-component revision surgery. Increased blood loss was found in men and revisions of cemented implants, but this did not correspond to higher levels of transfusion.

Increasing age was associated with higher levels of transfusion. These findings support previous studies that identified age as a significant predictive factor for transfusion in patients undergoing elective THA [6, 11, 12]. The increased transfusion levels in older patients was likely to be related to their lower preoperative hemoglobin concentrations, as after adjustment for confounders, only preoperative hemoglobin concentration and blood loss remained significant for transfusion. Preoperative anemia increased the likelihood of allogenic transfusion by up to six times. Our results support Feagan et al. [11] and Salido et al. [13], who investigated transfusion requirements in patients undergoing elective hip and knee arthroplasty.

Table 10 Multivariate regression model for length of hospitalization

Independent variable	Regression coefficient	95% Confidence interval	P value
Age (years)	0.085 (0.117)	-0.122 to 0.342	0.348
Preoperative hemoglobin concentration (g/dl)	-0.115 (0.970)	-3.128 to 0.711	0.215
Number of transfusions (n)	0.282 (0.597)	0.497–2.860	0.006*
Blood loss (g/dl)	-0.047 (0.992)	-2.382 to 1.545	0.674

* Statistically significant

Length of hospitalization

Prolonged length of hospitalization following revision THA was found in patients with lower preoperative hemoglobin concentrations, those receiving blood transfusion, and with increasing patient age. Patients who underwent isolated acetabular-component revision spent fewer days in hospital compared with patients who underwent femoral- or dual-component revision. However, a significant statistical difference was only demonstrated when acetabular-component revisions were compared with dual-component revisions. The small number of cases ($n = 12$) in the femoral-component revision group may have resulted in a failure to observe a true difference (type II error) when statistical analysis was applied. No association was identified between length of hospitalization and gender.

Patients with preoperative anemia have prolonged hospitalization following orthopedic surgery [6, 14–16]. These patients often require blood transfusions, which is an important factor in prolonging hospitalization [4, 17]. In our study, patients who received blood transfusion spent an additional 6 days in hospital. The cost for a 24-h stay on a National Hospital Services (NHS) surgical ward is around £400, increasing to £1,500 per day if surgical complications require the expertise of the intensive care unit [18]. Patients who received blood transfusions following revision THA could cost the NHS at least an additional £2,400 on prolonged hospital stay alone. It appears likely that aggressive treatment of preoperative anemia would reduce transfusion requirements and costs. Patients who receive allogenic blood are not only exposed to the risks of blood transfusion but also spend more days in hospital, which has health and financial implications.

The limitations of this study include the relatively small sample size. We also lacked information on the type of revision undertaken on these failed implants, which may have had a bearing on the results of this study. The estimation of blood loss was calculated using the pre- and postoperative hemoglobin concentration. A more accurate method of estimating blood loss would be using a mathematical model such as the one devised by Brecher et al. which takes into account parameters such as blood volume, hematocrit count, transfusion triggers, and amount of hemodilution performed [19]. However, we did not have sufficient data in our records to undertake these calculations.

This study has shown significantly greater blood loss in men, older patients, revision surgery of cemented implants, and dual-component revisions. More complex revision surgery and preoperative anemia are clearly associated with increased transfusion requirements and length of hospitalization. Identification and treatment of patients at higher risk of transfusion may guide likely transfusion

requirements, shorten the length of hospitalization, and reduce the overall cost of treatment.

Conflict of interest None.

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