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Blood transfusion rates following shoulder arthroplasty in a high volume UK centre and analysis of risk factors associated with transfusion

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Abstract

Aims

To determine the blood transfusion rates following shoulder arthroplasty and to establish risk factors associated with increased risk of transfusion.

Materials and Methods

All shoulder arthroplasty cases performed between January 2012 – March 2017 in a tertiary upper limb unit were identified. Patients who received peri-operative tranexamic acid were excluded. Retrospective review of case notes was completed to identify transfusion rate and risk factors. Univariate and multi-variate analysis was performed to analyse the association between risk factors and transfusion rate.

Results

537 shoulder arthroplasties performed in 474 patients were included. Peri- or post-operative transfusion was required in 21 cases (3.9%). Univariate analysis suggested significant association with age (p=0.005), female sex (0.015), pre-operative haemoglobin / haematocrit (p<0.001), peri-operative drop in haemoglobin (p<0.001) ASA grade (p<0.001) and transfusion rate. Only peri-operative drop in haemoglobin (p<0.001) and ASA grade (p=0.039) retained significance on multi-variable analysis.

Conclusions

The blood transfusion rate following shoulder arthoplasty was 3.9%. Greater peri-operative drop in haemoglobin and higher ASA grade were associated with increased risk of transfusion on multivariate analysis.

Keywords

Shoulder, arthroplasty, transfusion, outcome, complication

Take Home Message

- Low blood transfusion rate following shoulder arthroplasty compared to previous studies in literature
- Increased peri-operative drop in haemoglobin and higher ASA grade associated with increased risk of transfusion

Level of evidence – 2b Individual cohort study

Introduction

Rates of shoulder arthroplasty are rapidly increasing in the UK with 5221 cases recorded on the National Joint Registry in 2015, a rise of greater than 100% since 2012. (1,2) As the volume of procedures increases, more attention is focused on improving peri-operative care to optimise patient outcomes and limit complications. Several large studies from the USA have examined the transfusion rate following shoulder arthroplasty, but at present no data has been published from a UK centre and data from the USA may not be generalisable to the population and healthcare setting in the UK.

The reported rate of blood transfusion following shoulder arthroplasty varies from 4.5%-43%, with more recent work reporting rates at the lower end of this range. (3-9) This compares favourably to transfusion rates of 16%-58% following hip and knee arthroplasty. (10-13) Transfusion in patients undergoing shoulder arthroplasty has been shown to be associated with a higher risk of medical complications, including myocardial infarction, pneumonia, thrombo-embolic event, as well has higher rates of local complication including peri-prosthetic infection. (1,4)

Previous studies have attempted to identify risk factors for transfusion in shoulder arthroplasty patients. Padegimas et al reported that pre-operative haematocrit and surgery for post-traumatic arthritis were both significantly associated with an increased transfusion risk, with other studies suggesting that age, female sex, ischaemic heart disease and the use of cement were all implicated. (4,5,7,8)

Padegimas also reported that pre-operative haematocrit of 0.396 or lower has a sensitivity of 90% in predicting transfusion following shoulder arthoplasty. (4,9)

The purpose of this study was to examine the transfusion rate following shoulder arthoplasty in a high volume UK centre, which does not routinely use tranexamic acid for these cases, and to identify risk factors for transfusion.

Materials and Methods

A consecutive series of shoulder arthroplasties performed at the host institution, a tertiary referral upper limb unit, between January 2012-March 2017 was identified. Patients were included if they underwent any form of shoulder arthroplasty, including anatomic total shoulder replacement, reverse total shoulder replacement, hemiarthroplasty and revision procedures for all indications. Patients were excluded if they received tranexamic acid during the peri-operative period (n=16).

A review of case notes, online patient records, operation note and relevant anaesthetic charts was made to collect patient demographic data, details of co-morbidities, pre-operative / post-operative blood results and details regarding timing and quantity of any transfusion given. Local blood transfusion protocols state that a transfusion trigger of 70g/L should be used if patients are asymptomatic, or 80g/L if patients are symptomatic or have a history of ischaemic heart disease.

Univariable analysis (unpaired T-test for continuous variables, Chi squared or Fisher's Exact Test for categorical data based on size of expected values) was used to evaluate the significance of all measured variables. Multi-variable regression analysis was performed using GraphPad InStat and Prism (GraphPad Software Inc, La Jolla, CA, USA). Significance was determined when $p < 0.05$. No cases had missing data, therefore multiple regression analysis was performed on all cases. The dependent variable was whether transfusion was received or not, the independent variables were the age at intervention, procedure type, indication for intervention, gender, pre-

operative haemoglobin, post-operative haemoglobin, change between pre and post-operative haemoglobin, pre-operative haematocrit, post-operative haematocrit, ASA grade and laterality. The R2 values were inspected to determine if multicollinearity was a problem in the model, if the R2 value was >0.9 then the included values were rationalised. This led to the exclusion of the post-operative haemoglobin and post-operative haematocrit (with the pre-operative values and the haemoglobin drop being retained).

This study was performed under the jurisdiction of the HRA and their decision making tool indicates that ethical approval is not required for the current study or study design.

Results

During the period January 2012 – March 2017, 553 arthroplasties were carried out in 490 patients. Of these 16 patients were given peri-operative tranexamic acid and therefore excluded, leaving 537 arthroplasties in 474 patients eligible for analysis. There were 382 procedures carried out in female patients (71%) and 155 in males (29%), overall the mean age was 71.6 years (24-93). 21 of 537 shoulder arthroplasties required a peri-operative transfusion (4%). Demographic details for all patients included are provided in table 1.

The most common procedure was a primary anatomic total shoulder replacement, representing 235 (44%) of the cases, followed by reverse total shoulder replacement (224 cases; 42%), hemiarthoplasty (30 cases; 6%) and there were 48 revision procedures (9%). Of the 537 procedures undertaken, 258 were for osteoarthritis (48%), 136 for rotator cuff arthropathy (25%), 46 for trauma or trauma sequlae (9%), 33 for rheumatoid arthritis (6%) and 16 for avascular necrosis (3%).

A total of 39 units of packed red cells were transfused in 21 patients at a mean of 3 days post-op. One transfusion was given intra-operatively. Univariate analysis suggested an association between increasing age, pre-operative haemoglobin, pre-operative haematocrit, the peri-operative drop in haemoglobin and ASA with the risk of receiving a transfusion. Pre-operative haematocrit was analysed both as a continuous variable, and as a categorical variable of either less or greater than 0.396 based on the work by Padegimas et al. (4) Using pre-operative haematocrit of less than

0.396 as an independent predictor of transfusion would have identified 18/21 transfusions, a sensitivity of 86%. Many of these variables were not found to be significant on multi-variable analysis.

Table 1. Demographic data of 474 patients undergoing 537 procedures

Variable	All Procedures	Transfusion	No Transfusion	P Value
No. of cases	537	21	516	
Age	71.6	77.4	71.3	0.005
Gender				0.015
Male	155	3	152	
Female	382	18	364	
Pre-op Hb (g/L)	132	119	132	<0.001
Mean Hb Drop (g/L)	23	38	22	<0.001
Pre-op Hct	0.4	0.36	0.4	<0.001
Pre-op Hct				<0.001
<0.396	235	18	217	
>0.396	302	3	299	
Laterality				0.65
Right	300	13	287	
Left	237	8	229	
Procedure				0.13
Anatomic	235	6	229	
Reverse	224	14	210	
Hemiarthroplasty	30	0	30	
Revision	48	1	47	
Indication				0.14
OA	258	4	254	
Cuff arthropathy	136	8	128	
AVN	16	2	15	
Acute trauma	6	0	6	
Post trauma	40	4	36	
RA	33	2	31	
Revision	48	1	46	
ASA				P<0.001
1	52	0	52	
2	259	4	255	
3	217	13	204	
4	9	4	5	

The multiple regression model for whether patients required transfusion or not showed a significant relationship ($p<0.0001$). The change between pre and post-operative haemoglobin ($p<0.0001$) and the ASA grade ($p<0.039$) were significantly associated with the risk of transfusion. The other variables included (age at intervention, procedure type, indication for intervention, gender, pre-operative haemoglobin, pre-operative haematocrit, and laterality) did not ($p=0.07$-0.53).

Table 2: Multiple regression models investigating the risk of transfusion

Variable	Coefficient	95% Confidence Interval	t ratio	p value
Age at operation	0.0007	-0.001 to 0.002	0.767	0.444
Procedure type	-0.0194	-0.043 to 0.004	1.618	0.106
Indication for surgery	0.0038	-0.007 to 0.015	0.699	0.485
Gender	-0.0240	-0.061 to 0.013	1.256	0.210
Pre-operative haemoglobin	-0.0012	-0.004 to 0.002	0.753	0.452
Change from pre to post-operative haemoglobin	0.0063	0.005 to 0.008	8.166	<0.0001
Pre-operative haematocrit	-1.050	-2.185 to 0.084	1.814	0.070
ASA grade	0.0266	0.001 to 0.052	2.075	0.039
Laterality	0.010	-0.021 to 0.040	0.622	0.534

Discussion

This study reports an overall transfusion rate of 3.9% following 537 shoulder arthoplasty procedures. The demographic characteristics of the population studied are comparable both to previous published work and to the data reported by the National Joint Registry of England, Wales and Northern Ireland (NJR). Univariate analysis suggested that increasing age, female sex, lower pre-operative hameoglobin and haematocrit, higher peri-operative drop in hameoglobin and higher ASA grade were all significantly associated with transfusion risk. On multivariate analysis only the peri-operative drop in haemoglobin and the ASA grade remained significant predictors of peri-operative transfusion.

Historical studies have shown very high rates of transfusion following shoulder arthroplasty, with Gruson et al. reporting a transfusion rate of 43%. (9) More recent work has shown greatly decreased rates of transfusion with Padegimas et al., Kandil et al. and Hardy et al. reporting rates of 4.5%, 6.1% and 7.4% respectively. (4,5,9) The transfusion rate of 3.9% reported here is lower than previously recorded rates, but in keeping with the more recent publications. The low transfusion rate reported could be influenced by several factors. Firstly institutional protocols determining when patients require a transfusion may vary, our institution advises transfusion when the haemoglobin is less than 70g/L, or when the value is less than 80g/L and the patient is symptomatic or has a history of ischaemic heart disease. Patients who are found to be anaemic at pre-operative assessment are referred for further investigation, with surgery often delayed in these cases whilst pre-operative optimization is carried out.

This occasionally leads to pre-operative iron supplementation either orally or via intra-venous infusion.

In hip and knee arthroplasty, the use of peri-operative tranexamic acid is commonplace, and in recent years consideration has been given to its use in shoulder arthroplasty. Multiple randomised controlled trials have found that tranexamic acid use during shoulder arthroplasty decreases intra-operative blood loss, drop in haemoglobin and transfusion requirement. (3,6) A meta-analysis on the subject concluded that tranexamic acid use was associated with a lower transfusion requirement and no increase in thrombotic events. (10) With transfusion rates as low as 3.9% surgeons could question the case for blanket use of tranexamic acid. However given the increased complication risk associated with transfusion (1), it's confirmed role in reducing peri-operative blood loss and favourable side effect profile (10) there is clearly a role for peri-operative tranexamic acid in shoulder arthroplasty.

A key step in the prevention of transfusion is identifying the patients most at risk. Padegimas et al. reported that pre-operative haematocrit and surgery for post-traumatic arthritis were both independent risk factors for transfusion, going on to state that a pre-operative haematocrit threshold of <0.396 had a 90% sensitivity for identifying patients who would require a transfusion. (4) In this analysis pre-operative haematocrit appeared to show a significant association with transfusion in univariate analysis, but no significant association was demonstrated between transfusion and either pre-operative haematocrit or indication for surgery on multi-variable analysis.

Using a pre-operative Haematocrit threshold of <0.396 identified 18 out 21 (86%) of transfusions in this study, patients with a pre-operative haematocrit of >0.396 had a 3/302 (1%) risk of transfusion.

Analysis of risk factors for transfusion by Kandil et al., Ahmadi et al. and Hardey et al. identified increasing age, female sex, low pre-operative haemoglobin, increased surgical blood loss and patient co-morbidities to be significantly associated with transfusion risk. (5,7,8) Whilst univariate analysis suggested a positive association with age, gender and pre-operative haemoglobin, no association was demonstrated on multiple variable analysis. The only positive predictors of transfusion risk on multi-variable analysis were the peri-operative drop in haemoglobin, and the patients ASA grade.

The strengths of this paper are that it is a large comprehensive, consecutive series of shoulder arthoplasty cases from a single UK centre with a low rate of case exclusion. It must be stated that the numbers are small when compared to national population level studies from the USA. It is also a strength that this is the only work of this nature to have been done on a UK shoulder arthoplasty population. The limitations are that this was a retrospective study based on case note review, and the number of cases may have been too small to detect significant associations on multi-variate analysis. These cases were performed in a high volume UK centre so results may not be generalisable to all UK centres performing shoulder arthroplasty. The study design

used here is able to demonstrate an association between the considered variables and the risk of receiving a transfusion but is not able to definitively prove causation.

Conclusions

This study reports a low transfusion rate following shoulder arthroplasty of 3.9% in a UK population. Peri-operative drop in haemoglobin and a patient's ASA grade were both independent predictors of transfusion. This study did not confirm previous findings that age, gender, pre-operative haemoglobin, pre-operative haematocrit, procedure and indication for shoulder arthroplasty are predictors of transfusion.

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