

# Is the ABO Blood Group Associated With Increased Intraoperative Blood Loss in Cervical Surgery? A Cohort Study

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## Research article

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# Abstract

## Objective

To find out if the ABO blood group is associated with increased intraoperative blood loss in cervical surgery.

## Methods

A total of 126 patients who underwent cervical surgery under general anesthesia were included in this comparative study. Types of cervical surgery included anterior cervical corpectomy decompression and fusion (ACCF) and anterior cervical discectomy and fusion (ACDF). According to ABO blood group differences, the patients were divided into O and non-O blood groups. Intraoperative blood loss was assessed by external blood loss (EBL), Drop-Hct (hematocrit), and Drop-Hb (hemoglobin). This study collected indicators such as ABO blood group, preop Hct, preop Hb, postop Hct, postop Hb, history of hypertension, and etiology.

## Results

There were 22 patients in the O blood group and 104 in the non-O group. There were no significant differences in age between the two groups. Patients of blood group O showed a significantly higher Drop-Hb than in the non-O group (15(11.9-20.2) g/L and 8.5(6.5-11.0) g/L,  $p=0.001$ ). Drop-Hct also showed a significant difference between the two groups (4.8 (3.3-6.9) (%) vs. 2.2 (1.6-2.8) (%),  $p=0.001$ ). There was no association between group O and EBL ( $p=0.263$ ). The ACCF subgroup included 54 patients. Patients with O blood had significantly higher Drop-Hct and Drop-Hb ( $p<0.05$ ). In the ACDF subgroup ( $n=72$ ), Drop-Hct and Drop-Hb of O blood patients increased significantly ( $p<0.05$ ).

## Conclusion

The ABO blood group was associated with Drop-Hct and Drop-Hb. Consequently, blood group O may be a risk factor for increased intraoperative blood loss during anterior cervical surgery.

# Introduction

Von Willebrand factor (vWF) plays an important role in hemostasis. It ensures the adhesion of platelets to the subendothelium of damaged blood vessels and promotes aggregation [1]. Jenkins et al. reported ABO was a key determinant of vWF and coagulation factor VIII (FVIII) plasma concentrations [2]. Blood group O patients have lower plasma concentrations of vWF and decreased factor VIII activity than non-O individuals. The reason for lower plasma concentration of vWF is increased vWF clearance [3]. Gallinaro et al. demonstrated that ABO blood groups influenced vWF half-life, people with blood group O had a shorter vWF survival span than those in other blood groups [4]. The ABO blood group, therefore, has a potential influence on hemostasis.

In recent years, there have been several studies of the association between the ABO blood group and bleeding risk. In 2001, Alberth et al. found out that group O was not associated with increasing blood loss in prosthetic hip replacement [5], but surgical blood loss in this study was evaluated visually. Related studies suggested that it was inaccurate to estimate surgical blood loss through vision [6]. In 2013, a meta-analysis showed that blood group O was a potentially important genetic risk factor for bleeding [7]. In 2018, Schack et al. considered no association between transfusion or perioperative changes in hemoglobin with ABO blood group [8]. However, previous study involved many types of surgery, and the potential interference of differences in clinical research results could not be ruled out.

Some literatures have explored the related factors of spinal surgery blood loss [9], such as drugs active on coagulation [10], surgical tips, patient positioning, and general or spinal anesthesia. This study aims to explore the correlation between cervical spine surgery blood loss and ABO blood group.

Our hypothesis is that EBL during cervical surgery is higher in O blood group patients than non-O blood individuals. A secondary hypothesis is that O group patients have greater Drop-Hb and Drop-Hct than non-O patients.

## Materials And Methods

### Study populations

This is a retrospective observational study. It was approved by the hospital ethics committee. We retrieved all available data for anterior cervical corpectomy decompression and fusion (ACCF) and anterior cervical discectomy and fusion (ACDF) surgery. These surgeries were performed between August 1, 2013 and August 31, 2019. The fusion stage was one stage. We abstracted data from the electronic medical records system, including intraoperative external blood loss (EBL), age, sex, operating time, and preoperative and postoperative hemoglobin concentration. All patients upon admission routinely underwent ABO phenotyping by standard serology, as well as blood routine examination (BRE). One hour after the operation all patients routinely underwent a second BRE. General anesthesia was routinely given. These patients completed the operation in the supine position through the anterior approach. All patients had postoperative suction drains for 24–48 hours. The surgeons used monopolar and bipolar electrocoagulation to stop bleeding as thoroughly as possible. Hemostatic drugs were not used during the operation.

Exclusion criteria were revision surgery, operation because of tumor or infection, autotransfusion or transfusion during the operation, and missing ABO blood group or Hb values.

Intraoperative blood loss was estimated from the volume in suction devices. The volume of blood in sterile gauze was estimated by the anesthesiologist. Drop-Hb was calculated by subtracting Postop Hb from Preop Hb. Drop-Hct was calculated by subtracting Postop Hct from Preop Hct. The work has been performed in line with the STROCSS criteria [11].

## Statistical analysis

These patients were divided into two groups according to ABO blood group (O and non-O). Values are given as the mean (standard deviation (SD)) for normally distributed data, and median (95% confidence interval (CI)) as well for skewed data. If normally distributed, the data was compared by t test or Welch test. If not normally distributed, the data was compared using the Mann-Whitney test.  $p$  value  $<0.05$  was considered statistically significant. Analyses were carried out using SPSS software package version 20.0.

## Results

### Study population characteristics

This retrospective comparative study included 126 subjects. These patients were divided based on ABO blood group (Blood group O,  $n=22$ , vs. Blood group non-O,  $n=104$ ). Baseline characteristics of patients are shown in Table 1. We did not find significant differences in population characteristics (sex, age, race, preop Hct, preop Hb, preop platelets, hypertension) between both groups.

### Associations between EBL and ABO blood group

Associations between EBL and potentially influencing clinical variables were tested (Table 2). There was no association between O blood and EBL ( $p=0.263$ ). The mean EBL in patients with blood group O was 80.0 mL ( $\pm 53.1$  mL). In the non-O blood group, the mean EBL was 120 mL ( $\pm 114$  mL). We also explored the relationship between postoperative suction drainage and ABO blood group. We found that the postoperative suction drainage of patients with blood group O was 31.3 (21.3-41.2) mL, while for group non-O it was 38.5 (32.6-44.5) mL. The difference was not statistically significant.

### Association between Drop-Hb/Drop-Hct and ABO blood group

We found Drop-Hb and Drop-Hct during surgery were significantly different between blood groups O and non-O (Table 2). The median Drop-Hb in group O was 15(11.9-20.2) g/L. The median Drop-Hb in non-O patients was 8.5(6.5-11.0) g/L. This difference is statistically significant ( $p=0.001$ ). The median Drop-Hct in blood group O patients was 4.8 (3.3-6.9) %, while for group non-O it was 2.2 (1.6-2.8) %. Drop-Hb and Drop-Hct did not show a significant positive correlation with pathogen, hypertension history, and age (Table 3).

In the ACCF subgroup, patients with blood group O had higher Drop-Hb and Drop-Hct than patients in group non-O, and the difference was statistically significant (Table 4).

In ACDF, Drop-Hb and Drop-Hct in blood group O patients were higher than in group non-O, and the difference was statistically significant (Table 5).

## Discussion

This study shows that the ABO blood group has no relationship with EBL in anterior cervical surgery. Our findings were similar to two previous studies on this issue. Komatsu et al. analyzed 1,054 patients who underwent spine surgeries involving four or more vertebral levels and reported there was no association between O blood group and increased intraoperative blood loss [12]. Choi et al. explored lumbar spine surgery involving three or fewer vertebral levels. The total amount of blood loss and transfusion showed no difference between blood group O and non-O patients [13]. They both estimated blood loss by sight, which was inaccurate [14, 15]. External blood loss was usually underestimated because it was based on volumes on sight at the surface of soft tissue. Blood on gauze and in drains was easily ignored, making the method of visually measuring loss inaccurate.

To find more accurate measurement, some formulas have been used to estimate blood loss. Lopez-Picado et al. assessed it by estimating external blood loss and using some formulas that calculate it, including Bourke, Gross [16], Mercuriali, Camarasa [17], and a new formula [18]. The calculated total blood loss does differ depending on the method used. The differences are sufficiently large to affect clinical decisions. There is no gold standard for accurate measurement of perioperative blood loss volume. Hence, Drop-Hb and Drop-Hct are recommended, avoiding the inaccurate way of estimating only by sight.

This study reveals that the ABO blood group is a potentially influencing factor on Drop-Hct and Drop-Hb. Blood group O is associated with increased risk of Drop-Hct and Drop-Hb. We assume that a lower level of functioning vWF in patients with blood group O is the underlying pathophysiology of this finding. Several studies have reported that the level of vWF was 25-30% lower in blood group O than in other groups, which might increase the risk of hemorrhage [19]. A recent study identified an increased all-cause mortality (adjusted odds ratio (OR) 2.86) in 901 severely injured trauma patients [20]. Blood group O was significantly associated with high mortality in severe trauma patients, and it might have a considerable impact on outcomes. The difference in transfusion volume did not reach statistical significance. There was a tendency toward hemorrhage increasing in blood group O patients. Similarly, increased risk of post-partum hemorrhage with OR 1.14 ((95% CI 1.05–1.23);  $p < 0.001$ ) was observed in O group women in a retrospective study involving 125,768 deliveries [21]. However, many differences in hemostasis mechanisms according to ABO blood group remain unknown. Further basic study is ongoing to reveal the role of blood types in maintaining hemostasis.

As for the shortcomings of this study, we excluded patients who had had transfusions before and after surgeries, which could have caused selection bias. For the next step, our study would be expanded to other surgeries. At the same time, some of the medicines and fluids used were also considered within hemorrhage tendencies/risk in different blood groups.

## Conclusions

In conclusion, the results of this study show that the blood group O is associated with Drop-Hb and Drop-Hct. Consequently, the ABO blood group is associated with increased intraoperative blood loss in anterior

cervical surgery.

## **Abbreviations**

ACCF: Anterior cervical corpectomy decompression and fusion; ACDF: Anterior cervical discectomy and fusion; BRE: Blood routine examination; EBL: External blood loss; Hct: Hematocrit; Hb: Hemoglobin; vWF: Von Willebrand factor; FVIII: Coagulation factor VIII; SD: Standard deviation; CI: Confidence interval; OR: Odds ratio

## **Declarations**

### **Acknowledgements**

None

### **Authors' contributions**

JX Cao and S Cheng designed the study. L Lin and ZY Ke searched the institutional database and collected the clinical data and then reviewed the data. XJ Jia performed the statistical analysis. JX Cao drafted the manuscript. S Cheng and L Lin revised the manuscript. All authors have read and approved the manuscript and ensured that this is the case.

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### **Availability of data and materials**

All data are fully available without restriction.

### **Ethics approval and consent to participate**

This study was approved by the local Ethics Committee of The Second Affiliated Hospital of Chongqing Medical University. Written consent was obtained from all participants.

### **Consent for publication**

Not applicable.

### **Competing interests**

The authors declare that they have no competing interests.

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## Tables

<b>Table 1 Baseline characteristics of patients</b>			
Variable	Blood group O	Blood group non-O	<i>p</i> -value
	(n=22)	n=104	
Male, n (%)	72.7	69.2	0.885
Age (years)	53 ± 11	58 ± 12	0.134
Race			
Han	18	100	0.275
Other	4	4	
Operating time (min)	111.8± 26.9	119.3± 40.6	0.564
Preop Hct (%)	40.7± 6.2	39± 4.9	0.277
Preop Hb (g/L)	136.3 ± 22.2	130.4± 18.4	0.311
preop platelets (x10 <sup>9</sup> /L)	181± 60	184±74	0.915
Hypertension	4	10	0.732

Categorical variables are expressed as numbers (%); continuous variables are presented as mean ± SD or Median (95% CI median). *p*-value <0.05 was considered statistically significant. Preop, preoperative; Hct, hematocrit; Hb, hemoglobin.

<b>Table 2 Association between blood type and related clinical outcomes</b>			
Variable	Blood group O	Blood group non-O	<i>p</i> -value
Postop Hct (%)	36.6±4.0	37.0±4.4	0.799
Postop Hb (g/L)	121.9±15.3	123.6±15.9	0.752
Postop platelets (x10 <sup>9</sup> /L)	171.0[139.9-198.7]	165.5[157.3-187.0]	0.857
Blood loss, operation (ml)	80.0±53.1	120±114	0.263
Drop-Hct (%)	4.8[3.3-6.9]	2.2[1.6-2.8]	0.001
Drop-Hb (g/L)	15 (11.9-20.2)	8.5 (6.5-11.0)	0.001
Drop-platelets (x10 <sup>9</sup> /L)	5[7-13]	5[0.5-10.5]	0.777
Postoperative suction drainage[ml]	31.3 (21.3-41.2)	38.5 (32.6-44.5)	0.255
Categorical variables are expressed as numbers (%); continuous variables are presented as mean ± SD or Median (95% CI median). <i>p</i> -value <0.05 was considered statistically significant. Postop, Postoperative; Hct, hematocrit; Hb, hemoglobin; Drop-Hct, Preop Hct-Postop Hct; Drop-Hb, Preop Hb-Postop Hb; Drop-platelets, Preop platelets-Postop platelets.			

<b>Table 3 Potential clinical risk factors for Drop-Hct and Drop-Hb</b>					
Variable		Drop-Hct (%)	<i>p</i> -value	Drop-Hb (g/L)	<i>p</i> -value
Blood group	Blood group O	4.8 [3.3-6.9]	0.001	15 (11.9-20.2)	0.001
	Blood group non-O	2.2 [1.6-2.8]		8.5 (6.5-11.0)	
Pathogen	Degenerative disease	2.8 [2.1-3.3]	0.495	10.0 [7.0-11.6]	0.580
	Traumatic disease	2.6 [1.3-3.4]		9.0 [7.0-11.0]	
Hypertension history	YES	2.2 (0.1-3.6)	0.43	11.5 [2.0-14.0]	0.925
	NO	2.6 (1.8-3.2)		9.0 [7.0-11.0]	
Age	≤57 years	3.2 (2.0-3.6)	0.084	9.5 [7.0-12.0]	0.197
	>57 years	2.6 (1.7-3.2)		10.6 [5.0-11.0]	
Continuous variables are presented as mean ± SD or Median (95% CI median). <i>p</i> -value ≤0.05 was considered statistically significant.					

<b>Table 4 Association between blood group and related clinical outcomes—ACCF subgroup</b>			
Variable	Blood group O	Blood group non-O	<i>p</i> -value
Preop Hb (g/L)	136±17.3	135.2±3.8	0.886
Postop Hb (g/L)	117.8±15.0	124.7±3.7	0.113
Drop-Hb (g/L)	17.5 [14-24]	11.0 [7.0-11.1]	0.003
Preop Hct (%)	40.9±4.3	39.9±1.0	0.168
Postop Hct (%)	37.7 (28.0-38.4)	37.5 (34.7-38.6)	0.330
Drop-Hct (%)	5.2 [4.2-7.4]	2.3 [1.8-2.8]	0.002
Blood loss, operation (ml)	125.0 [50.0-200.0]	150.0 (100.0-200.0)	0.280
Categorical variables are expressed as numbers (%); continuous variables are presented as mean ± SD or Median (95% CI median). <i>p</i> -value ≤0.05 was considered statistically significant. Postop, Postoperative; Hct, hematocrit; Hb, hemoglobin; Drop-Hct, Preop Hct-Postop Hct; Drop-Hb, Preop Hb-Postop Hb; Drop-platelets, Preop platelets-Postop platelets.			

<b>Table 5 Association between blood type and related clinical outcomesACDF subgroup</b>			
Variable	Blood group O	Blood group non-O	<i>p</i> -value
Preop Hb (g/L)	140.1±11.4	129.0±4.6	0.041
Postop Hb (g/L)	124.3±7.6	122.7±4.9	0.760
Drop-Hb (g/L)	12.0 (9.0-24.0)	7.0 (2.1-9.0)	0.002
Preop Hct (%)	43.4 (36.3-46.2)	39.5 (38.4-40.4)	0.083
Postop Hct (%)	37.3±2.1	36.8±1.3	0.759
Drop-Hct (%)	3.3 (2.6-7.3)	1.9 (0.7-3.2)	0.004
Blood loss, operation (ml)	50.040.0-60.0	150.0 (50.0-83.5)	0.840
Categorical variables are expressed as numbers (%); continuous variables are presented as mean ± SD or Median (95% CI median). <i>p</i> -value0.05 was considered statistically significant. Postop, Postoperative; Hct, hematocrit; Hb, hemoglobin; Drop-Hct, Preop Hct-Postop Hct; Drop-Hb, Preop Hb-Postop Hb; Drop-platelets, Preop platelets-Postop platelets.			