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The impact of blood component transfusion practices on patient survival after abdominal aortic aneurysm surgery

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Abstract

Background: The aim of the present study was to investigate the blood transfusion practice in patients operated on for abdominal aortic aneurysm (AAA) with special emphasis on massive transfusion in cases with rupture.

Material and methods: From a database, 504 patients operated on for AAA were stratified into 2 groups; an early transfusion period (1992-1999) and a late transfusion period (2000-2008) to evaluate changes in transfusion practices over the course of time.

Results: Patients operated on for non-ruptured AAA (n=330) showed a decreased mortality rate: from 4% (early transfusion period) to 1% (late transfusion period) without significant changes in transfusion practices. In patients operated on for ruptured AAA (n=174) an unexpected low mortality rate was found compared to the 30-day mortality reported in earlier studies. The transfusion practices in ruptured AAA surgery showed a significant increase in platelet use and change of FFP:RBC ratio from 0.8 to 0.9 between the early and late transfusion period.

Conclusion: The present database study shows that the operating mortality for AAA surgery has decline during the past decades. The cause of the decline in mortality in patients with ruptured AAA was interpreted as partly due to a modern blood component therapy.

Introduction

Abdominal aortic aneurysm (AAA) is a common and often asymptomatic condition until the catastrophic event of hemorrhagic shock due to aneurysm rupture.^{1,2} Despite advances in surgical and anaesthetic techniques the reported perioperative mortality remains high, around 50%, in patients with ruptured AAA.¹ Earlier reports indicate that a major cause of immediate intraoperative death in patients with ruptured AAA is due to coagulopathy related to haemorrhage.³ However, the survival after AAA repair has improved in Sweden since the millennium.⁴ Furthermore, a recent study found that fatal coagulopathy was relatively uncommon instead there was a high incidence of thrombosis related deaths in AAA patients with shock due to rupture.⁵ The transfusion practices have changed in the last three decades with the introduction of blood-component treatment to patients suffering haemorrhagic shock.^{6,7} During the past 30 years the transfusion policy has changed from a combination of RBC, crystalloid and/or colloids to the use of plasma and platelets instead of crystalloids and colloids. Modern management of the patient with haemorrhage due to ruptured AAA includes rapid administration of large amounts of red blood cells (RBC) units, along with sufficient fresh frozen plasma (FFP) and platelets to treat or prevent coagulopathy. For the last 10 years the optimal FFP/RBC ratio in massive bleeding has been a hot topic in medical literature.^{6,7} Most of the studies concerning survival after massive blood transfusion are based on trauma patients and little has been investigated concerning blood transfusion practices in AAA surgery. Hence, based on the above discussion we have examined the blood transfusion practice in patients operated on for AAA between 1992 and 2008 to investigate a change in blood transfusion practice as the possible explanation for the improved survival.

Material and Methods

All vascular surgical procedures (both open and endovascular) for AAA at Sundsvall County Hospital are prospectively registered in the national registry Swedvasc (The Swedish Vascular Registry).^{8,9} To evaluate changes in transfusion practices over the course of time the patients were stratified into an early transfusion period (1992-1999) and a late transfusion period (2000-2008). Total number of transfused units of RBC, FFP and platelets during the hospital stay were extracted from the hospital blood bank data base. The 30-day mortality and complications were obtained from the Swedvasc registry. The study protocol was in accordance with the Declaration of Helsinki and subsequent amendments.

Patients with ruptured abdominal aortic aneurysm are expected to require a massive transfusion (>10 units of RBC in 24 h) and is per se defined as a massive transfusion situation. The routine in our hospital during the study period was to order 4-10 units of RBC and equal numbers of FFP immediately at diagnosis. Platelets were ordered later on demand. No blood transfusions were given before laparotomy and, in accordance with Crawford, no significant attempt was made at blood volume resuscitation until surgery.¹⁰ In obscure cases ultrasound was performed by the surgeon in the emergency department. At diagnosis the patients were promptly transferred to the operating room for open aortic repair by a vascular surgeon. A temporary initial aortic clamping at the supraceliac level was the standard approach at our department in patients operated on for ruptured AAA.¹¹ In an emergency situation O RhD negative RBC was available for immediate delivery. ABO compatible RBC and FFP were delivered as soon as possible. In the initial resuscitation phase plasma was delivered as liquid stored plasma or thawed FFP (stored at +4°C in maximal 7 days).^{12,13} No cryoprecipitate was used, however, factor concentrates were used in selected cases for example acute patients on Warfarin.

In patients with non-ruptured AAA platelet count, activated partial thromboplastin time, and prothrombin time were used as preoperative screening for bleeding risk.¹⁴ Haemoglobin trigger levels were between 80 and 100 g/L due to the cardiopulmonary condition in each individual case.¹⁵ Cell saver was not used because it was not regarded as cost-effective in elective cases.¹⁶ Even in patients with massive haemorrhage due to ruptured AAA cell saver was avoided due to the risk of the emergence of a hyperfibrinolytic state.^{17,18}

Statistical analysis

All analyses were carried out using SPSS[®] statistical software 16.0 for Windows[™] (SPSS, Chicago, Illinois, USA). Median (interquartile range) values were calculated for continuous variables and categorical data was expressed as absolute numbers with percentages. Differences in findings between study groups were assessed by Fisher's exact test (two-tailed) for categorical variables and by Mann-Whitney tests for continuous variables. Results were considered statistically significant when *p*-values were <0.05.

Results

Between January 1992 and December 2008, 504 patients (430 men and 74 women) underwent vascular surgical procedures (both open and endovascular) for AAA at our department. Cases of mycotic aneurysm and second operations were not included. 174 patients with ruptured infrarenal AAA were included. All patients had a confirmed retroperitoneal hematoma and 132 had signs of clinical shock with at least one episode of hypotension (systolic pressure of <80 mm Hg) prior to aortic cross clamping.⁹ The remaining 42 patients were not in clinical shock. 330 patients with an acute or elective operation for non-ruptured infrarenal AAA were also included. All patients underwent conventional open AAA repair through a standard midline laparotomy incision and transperitoneal approach with infrarenal graft repair with the exception of 40 cases with non-ruptured AAA treated by endovascular aortic repair (EVAR) during 2006-2008. The 30-day mortality in all patients with ruptured AAA (n=174) during 1993-2008 was 25%, however, an insignificant decrease in mortality between the early (31%) and late (20%) transfusion periods (Table 1). The use of platelets was significantly higher in the late transfusion period compared to the early (Table 1). The FFP:RBC ratio increased significantly (p=0.001) from 0.8 in the early period (n=62 cases with both RBC and FFP transfusion) to 0.9 in the late period (n=92 cases with both RBC and FFP transfusion). As shown in table 1 there was no proven change in transfusion practices between the early and late transfusion period in patients operated on for non-ruptured AAA. In both transfusion periods approximately one-third of patients operated on for non-ruptured AAA were not transfused. The mortality rates for non-ruptured AAA surgery decrease, however not significantly, from 4% (early transfusion period) to 1% (late transfusion period).

Discussion

In this database analysis, the 30-day mortality in patients operated on for non-ruptured AAA was comparable to other reports.¹ Instead, strikingly low mortality in patients operated on for ruptured AAA was observed compared to the previously reported mortality.^{1,2,19}

However, the low 30-day mortality (25%) in patients with ruptured AAA in the present study was consistent with the improvement in survival shown in a recent report from Sweden.⁶

The improvement in survival has probably many causes. Early diagnosis in obscure cases is crucial in preventing fatal delay to surgery: increased attention to typical signs and symptoms, emergency access to abdominal ultrasound and computer tomographic investigation all facilitate AAA rupture diagnosis. Advances in anaesthetic techniques including aggressive re-warming to prevent hypothermia by warm fluid infusion, forced air warming and the use of warm water on the surgical field to prevent coagulopathy are other possible explanations for the improved survival rate. Furthermore, modern management of patients with haemorrhage due to ruptured AAA with rapid administration of large amounts of RBC, along with sufficient plasma and platelets probably improve the survival rate. In the present study we have evaluated changes in transfusion practices between an early transfusion period (1992-1999) and a late transfusion period (2000-2008). There were no significant changes in transfusion practices between the two periods for non-ruptured AAA surgery. The transfusion practices in ruptured AAA surgery showed a significant increase in platelet use and change of FFP:RBC ratio from 0.8 to 0.9 between the early and late transfusion period. The use of more plasma and platelets in ruptured AAA surgery was consistent with a recent recommendation given by Johansson et al.²⁰ However, the association between the change in transfusion practices and the decrease in mortality rate from 31% to 20% may be due to bias and/or limitations. There are several limitations to the present study. First, the unknown real death of ruptured AAA patients due to a low autopsy rate in the study population casts some doubt on the operative mortality rate. Second, the present study lacks data about the time course of the transfusion and the amount of administered crystalloids and colloids which is perhaps more important than the total amount of blood component units given. Last, absence of data about symptom duration is a limitation as the delay to surgery influence survival.

In conclusion, the operating mortality for AAA surgery has declined. The prominent decline in mortality in patients with ruptured AAA is likely due, in part, to modern blood component therapy. However, the highest priority in hemorrhagic shock and directly related to survival is to stop the bleeding. Hence, we believe that the most important cause of the low mortality in our department is the fact that all emergency cases were operated by a vascular surgeon familiar with elective aneurysm surgery, damage control approach, and temporary supraceliac aortic clamping in cases with ruptured AAA. Further improvement is to be expected with the introduction of EVAR even in cases of ruptured AAA with use of a transfemoral aortic balloon catheter to stop the bleeding.^{21,22} Finally, goal-directed transfusion therapy guided by thromboelastography is likely the optimal solution instead of transfusion with fixed FFP/RBC ratio.^{6,23}

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Table 1. Blood component transfusion and 30-days mortality in patients with surgery for AAA during two time-periods.

	Period 1992-1999	Period 2000-2008	p-value
Ruptured AAA	n=74	n=100	
Age, years	72(67-76)	73(69-77)	0.282
Death	23 (31%)	20 (20%)	0.111
RBC	12 (8-19)	10 (6-20)	0.347
FFP	8 (4-16)	9 (6-19)	0.211
Platelets	0(0-1)	0(0-2)	0.043
Only RBC	12 (16%)	8 (8%)	0.148
RBC+FFP+Platelets	19 (26%)	44 (44%)	0.017
FFP:RBC ratio	0.8(0.5-1.1)	0.9(0.8-1.3)	0.001
Nonruptured AAA	n=128	n=202	
Age, years	70(65-75)	72(65-77)	0.187
Death	5 (4%)	2 (1%)	0.114
RBC	2 (0-4)	2 (0-3)	0.704
FFP	0 (0-2)	0 (0-2)	0.763
No transfusion	40 (31%)	65 (32%)	0.904

The figures indicate number (percentage) or median (interquartile range) of patients/controls. Differences in findings between study groups were assessed by Fisher's exact test (two-tailed) for categorical variables and by Mann-Whitney tests for continuous variables. AAA=Abdominal aortic aneurysm, RBC=red blood cells, FFP=fresh frozen plasma (including liquid stored plasma).