doi:10.1510/icvts.2009.205930

INTERACTIVE CARDIOVASCULAR AND THORACIC SURGERY

Interactive CardioVascular and Thoracic Surgery 9 (2009) 491–493

www.icvts.org

Follow-up papers - Aortic and aneurysmal

Preoperative haemodynamic parameters and the immediate outcome after open repair of ruptured abdominal aortic aneurysms

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Received 23 February 2009; received in revised form 12 June 2009; accepted 16 June 2009

Abstract

Aim: The aim of this study was to evaluate the impact of preoperative cardiac function and haemodynamic parameters on the immediate outcome after repair of ruptured abdominal aortic aneurysm (RAAA). **Methods:** This is a retrospective review of 68 consecutive patients who underwent emergency repair of RAAA. Baseline pulmonary artery pressure, cardiac index, oxygen saturation and pulse rate were measured and recorded immediately after insertion of a pulmonary artery thermodilution catheter and before anaesthesia induction. **Results:** The in-hospital mortality rate was 39.7%. The area under the receiver operating characteristic (ROC) curve of cardiac index was 0.74 (95% CI 0.61–0.86), of stroke volume index was 0.78 (95% CI 0.67–0.89) and for oxygen delivery 0.72 (95% CI 0.60–0.84) for prediction of in-hospital death. The best cut-off values of cardiac index was 2.7 l/min/m² (18.8% vs. 58.3%, OR 6.07, 95% CI 2.00–18.37), of stroke volume index was 27 ml/m² (23.1% vs. 62.1%, OR 5.46, 95% CI 1.90–15.70) and of oxygen delivery was 370 ml/min/m² (17.9% vs. 56.4%, OR 5.05, 95% CI 1.87–18.91). Multivariate analysis showed that patient's age ($P=0.01$, OR 1.23, 95% CI 1.05–1.44), stroke volume index ($P=0.018$, OR 0.89, 95% CI 0.81–0.98), and shock ($P=0.007$, OR 14.20, 95% CI 2.09–96.67) were independent predictors of in-hospital death. **Conclusions:** This study suggests that impaired cardiac function and suboptimal oxyhaemodynamic parameters are important determinants of death after repair of RAAA.

Keywords: Abdominal aortic aneurysm; Rupture; Cardiac index; Stroke volume; Oxygen delivery; Glasgow aneurysm score

1. Introduction

Rupture of abdominal aortic aneurysm (RAAA) is associated with a mortality rate of about 80% [1]. For those patients undergoing open repair, a postoperative mortality rate ranging from 40 to 50% is expected [2]. Among those patients who survive repair of their RAAA, severe postoperative complications are frequently encountered. Vascular surgeons practice a selective policy of operative intervention for patients with RAAA, but this approach is affected by the difficulty to estimate the realistic chance of survival after emergency operation. Indeed, the existing risk scoring methods are not reasonably accurate to identify those patients who most probably succumb after surgery [3]. Beside intrinsic difficulties in aneurysm repair and anaesthesiologic management of these critical patients, preoperative conditions are major determinants of adverse outcome. In particular, depressed cardiac function is likely to contribute to high postoperative mortality and morbidity. However, there is lack of studies on this issue as the need of emergency repair does not allow any preoperative assessment of the cardiac function.

The aim of this study was to evaluate the relationship between preoperative cardiac and stroke volume indexes and the outcome of patients who underwent repair of RAAA. This would provide further insights regarding the prognostic importance of these factors and their therapeutic relevance.

2. Patients and methods

This is a retrospective review of 68 consecutive patients (57 males and 11 females) who underwent emergency repair of RAAA from January 1992 to January 2008 at the Vaasa Central Hospital. Only patients with infra-renal RAAA were included in the study.

Preoperative and intraoperative clinical data of these patients are summarized in Table 1. The operative risk was estimated by calculating Glasgow aneurysm score (GAS) according to the following formula: risk score = age in years + 17 (for shock) + 7 (for myocardial disease) + 10 (for cerebrovascular disease) + 14 (for renal disease) [4].

Shock was defined as a mean blood pressure <60 mmHg and/or haemodynamic instability.

Baseline pulmonary artery pressure, cardiac index, oxygen saturation and pulse rate were measured and recorded

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Table 1
Pre- and intraoperative characteristics of patients who survived versus those who died after repair of ruptured abdominal aortic aneurysm

Clinical and intraoperative variables*	Survivors 41 patients (%)	Operative deaths 27 patients (%)	*P*-value
Age (years)	71.1±8.5	79.3±5.3	<0.0001
Females	6 (14.6)	5 (18.5)	0.67
Chronic obstructive pulmonary disease	17 (41.5)	8 (29.6)	0.32
Cerebrovascular disease	6 (14.6)	3 (11.1)	1.00
Coronary artery disease	9 (22.0)	4 (14.8)	0.54
Hypertension	32 (78.0)	16 (59.3)	0.11
Diabetes	7 (17.1)	0 (0)	0.51
Renal failure (serum creatinine >150 mmol/l)	5 (12.2)	0 (0)	0.15
Dialysis	2 (4.9)	0 (0)	0.037
Shock	13 (31.7)	22 (81.5)	<0.0001
Glasgow aneurysm score	81±12	95±8	<0.0001
Preoperative haemoglobin (g/l)	110±25	103±19	0.14
Preoperative haematocrit	0.33±0.08	0.31±0.06	0.31
Baseline mean pulmonary artery pressure (mmHg)	25±10	21±4.9	0.053
Baseline cardiac index (l/min/m²)	2.89±0.79	2.38±0.86	0.001
Stroke volume index (ml/m²)	35.1±11.2	25.3±8.4	<0.0001
Baseline oxygen delivery (ml/min/m²)	420±155	310±103	0.002
Baseline oxygen saturation (%)	97.6±2.9	95.6±5.5	0.08
Operative time (min)	205±63	196±104	0.69
Aortic cross-clamping (min)	107.6±51.0	98.7±64.3	0.81
Intraoperative use of inotropes	27 (65.9)	24 (92.3)	0.018
Blood products transfusion			
Red blood cells units	6.6±3.2	9.7±4.7	0.006
Fresh frozen plasma units	3.8±2.9	3.6±2.5	0.98
Platelets units	1.3±1.2	1.9±2.1	0.46

*Continuous variables are reported as the mean±S.D.

immediately after insertion of a pulmonary artery thermodilution catheter and before anaesthesia induction.

2.1. Statistical analysis

Statistical analysis was performed using an SPSS statistical software (SPSS 16.0.1, Chicago, IL, USA). The Pearson's test, the Fisher exact test, and the Mann–Whitney test were used for univariate analysis. Receiver operating characteristic (ROC) curve analysis was used to estimate the area under the curve of continuous variables in predicting immediate outcome. The best cut-off values of continuous variables have been chosen according to the best sensitivity, specificity, accuracy and odds ratio. Logistic regression with the use of backward selection was performed to estimate the impact on preoperative and operative variables on the immediate postoperative outcome. Only variables with a $P<0.20$ have been included into the regression model. A $P<0.05$ was considered statistically significant.

3. Results

The immediate postoperative complications are summarized in Table 2. The in-hospital mortality rate was 39.7% (27/68 patients). Predictors of immediate postoperative death at univariate analysis are listed in Table 1. Of note, inotropes have been used in 65.9% of patients who survived and in 92.3% of patients who died after surgery ($P=0.018$).

The area under the ROC curve of cardiac index was 0.74 (95% CI 0.61–0.86), of stroke volume index was 0.78 (95% CI 0.67–0.89) and of oxygen delivery 0.72 (95% CI 0.599–0.842) for prediction of in-hospital death. The best cut-off value of cardiac index in predicting immediate postoperative death was 2.7 l/min/m² (18.8% vs. 58.3%, OR 6.1, 95% CI 2.00–18.37, sensitivity 78%, specificity 63%, accuracy 69%), of stroke volume index was 27 ml/m² (23.1% vs. 62.1%, OR 5.5, 95% CI 1.90–15.70, sensitivity 67%, specificity 73%, accuracy 71%) and of oxygen delivery was 370 ml/min/m² (17.9% vs. 56.4%, OR 5.0, 95% CI 1.87–18.91, sensitivity 81%, specificity 57%, accuracy 67%).

Table 2
Postoperative complications

	Number (%)
Cardiac low output syndrome	20 (30.3)
Acute renal failure	11 (16.2)
Myocardial infarction	1 (1.5)
Atrial fibrillation	3 (4.4)
Stroke	5 (7.4)
Intestinal occlusion	2 (2.9)
Pneumonia	5 (7.4)
Sepsis	12 (17.6)
Deep wound infection	3 (4.5)
Gastrointestinal complications	4 (5.9)
Re-operation	13 (19.1)
Miscellaneous	22 (27.9)

Multivariate analysis showed that patient's age ($P=0.01$, OR 1.2, 95% CI 1.05–1.44), stroke volume index ($P=0.018$, OR 0.9, 95% CI 0.81–0.98), and shock ($P=0.007$, OR 14.2, 95% CI 2.09–96.67) were independent predictors of in-hospital death.

4. Discussion

RAAA is associated with a very high postoperative mortality. This is due to the co-morbidities commonly associated in this patient population and the profound haemodynamic changes occurring pre- and intraoperatively. However, repair of RAAA is not infrequently technically challenging and surgeon's experience and skills may significantly affect the outcome of these patients. The latter can explain the difficulties in stratifying the operative risk of these patients [3]. Undoubtedly, patients' co-morbidities and preoperative haemodynamic conditions are of major prognostic importance. The former are not often accurately assessed in the emergency setting, whereas haemodynamic parameters may widely vary according to the cardiac function, the extent of bleeding and the resuscitation policy. Indeed, to our knowledge, there is no major study reporting on the impact of cardiac function, other than the study by Peerless and colleagues [5]. They have evaluated cardiac index and oxygen delivery during the first 24 postoperative hours only in survivors after open repair of RAAA. Anyway, oxyhaemodynamic parameters have been shown to have a great impact on the development of multi-organ failure even in patients who survived the operation [5]. This suggests that in these patients with critical conditions, enhancement of cardiac function and oxygen delivery is possibly of key importance to improve the outcome [6–8]. The present study clearly confirmed that patients with depressed cardiac function and suboptimal oxygen delivery are at very high risk to die after surgery. The retrospective nature of this study, along with the lack of serial measurements of oxyhaemodynamic parameters, prevents any conclusion on the value of intraoperative haemodynamic support. However, these findings suggest that peri- and postoperative optimization of cardiac function and oxyhaemodynamic parameters could be important intra- and postoperative therapeutic targets.

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eComment: Ruptured abdominal aortic aneurysms – endovascular treatment and hemodynamic parameters

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doi:10.1510/icvts.2009.205930A

The authors clearly confirmed that patients with depressed cardiac function and suboptimal oxygen delivery preoperatively are at very high risk to die after surgery of ruptured abdominal aortic aneurysm (RAAA) [1]. Despite improvements in treatment algorithms, mortality of RAAA has remained constantly high over the last decades [2]. According to our results in a 10-year period (1999–2009), mortality rates of hemodynamically unstable patients with RAAA are up to 80%. This is in line with our observation in this high-risk subgroup of patients with RAAA. Additionally, preoperatively concomitant cardiac depression and profound hemodynamic changes aggravate diagnostic and therapeutic procedures. In our series, all deaths occurred during emergency surgery in the shock unit. The cause was ongoing blood loss due to aortic free rupture and complications related to cardiac impairment. In the management of hemodynamically RAAA, postponed intervention due to treatment of additional cardiac-life threatening lesions seems to be an advantage. Minor bleeding of the RAAA has a benign course, and preoperative plan for a surgical approach following imaging is valuable. Controversially, major ruptures have an insidious course and require prompt intervention. Until 2000, in our institution, these patients have been treated conventionally by tubular or bifurcated replacement graft or with endovascular (EVAR) technique of the ruptured aortic segment. Over time, EVAR stent-graft placement has evolved as a safe and effective treatment modality for RAAA. As initial results have been encouraging, this new treatment modality has been used more liberally and short-term as well as mid-term results are well documented [3]. Especially in high-risk patients, who are frail and have a diminished physiologic reserve, this minimally invasive technique does not expose these patients to substantial risk.

According to our results in a 10-year period with EVAR, we concluded that preoperative hemodynamic stability, cardiac function as well as a straightforward individual treatment strategy are prerequisites for survival of RAAA. Endovascular stent-graft placement has emerged as an innovative and minimally invasive surgical option in high-risk patients with RAAA, but early postoperative results, in our opinion, are strongly related with perioperative optimization of cardiac function and oxyhemodynamic parameters. The authors suggest similar conclusions, and for this reason, I would like to encourage their future work on this topic.

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