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Risk Factors Influencing the Surgical Outcome in 138 Consecutive Patients with Infrarenal Aortic Aneurysm: The Cluj-Napoca Cardiovascular Surgery Center Experience*

A. Molnar, D. Săcui, T. Scridon

Cardiovascular Surgery Department, Heart Institute, Cluj-Napoca Romania

Rezumat

Factori de risc care au influenţat rezultatele postoperatorii la 138 de pacienţi consecutivi cu anevrism de aortă infrarenală: experienţa centrului de Chirurgie Cardiovasculară Cluj-Napoca

Anevrismele aortei abdominale reprezintă o patologie comună, cu o incidenţă în creştere în ultimele decenii. Din păcate, rata mortalităţii pentru anevrismele abdominale rupte este şi ea crescută. Scopul acestui studiu retrospectiv a fost determinarea factorilor de risc care pot interfera cu rezultatele tratamentului chirurgical, în special cu ratele morbidităţii şi mortalităţii.

Materiale şi metode: În studiu au fost incluşi 138 de pacienţi consecutivi cu anevrism de aortă abdominală infrarenală, care au beneficiat de chirurgie electivă (pentru anevrisme cronice), sau chirurgie de urgenţă (pentru anevrisme rupte), în Clinica de Chirurgie Cardiovasculara Cluj-Napoca în perioada Ianuarie 2003 - Decembrie 2011. Am luat în considerare bolile cardiovasculare asociate şi cele mai frecvente complicaţii post-operatorii apărute la pacienţii luaţi în studiu. S-au practicat trei tipuri de intervenţii: interpoziţie de graft tubular, bypass aorto-biiliac şi bypass aorto-bifemural.

Rezultate: Mortalitatea perioperatorie în cazul intervenţiilor elective a fost de 5.68% (5 / 88), iar pentru intervenţiile urgente a fost de 46% (23 / 50).

Concluzii: Anevrismul aortic abdominal rupt continuă să reprezinte o patologie asociată cu riscuri substanţiale şi mortalitate ridicată. De aceea, considerăm oportun screening-ul selectiv şi intervenţiile programate pentru îmbunătăţirea ratei de supravieţuire a pacienţilor cu anevrism aortic infrarenal.

Cuvinte cheie: factori de risc, anevrism, aortă infrarenală, ruptură, perioperator, mortalitate

Abstract

Abdominal aortic aneurysms represent a common pathologic condition, with an increasing incidence in the last decades. Unfortunately, the mortality rate in ruptured abdominal aortic aneurysms has also increased. The aim of this retrospective study was to determine the risk factors that could interfere with the surgical outcome of these patients, especially with the perioperative morbidity and mortality rates.

Materials and methods: In this study we included 138 consecutive patients with infrarenal aortic aneurysm, who underwent elective repair (for chronic aortic aneurysm) or emergency repair (for ruptured aortic aneurysm), in the Cluj-Napoca Cardiovascular Surgery Clinic between January 2003 and December 2011. We noted the most frequently associated diseases and perioperative complications among the studied population. Three types of interventions were performed: tubular graft interposition, aortobiiliac bypass and aorto-bifemoral bypass.

Results: The perioperative mortality in the elective repair group was 5.68% (5 / 88), while in the emergency repair group it was 46% (23 / 50).

Corresponding author: Adrian Molnar, MD
Heart Institute, Cardiovascular Surgery Clinic no. 2-4, Clinicilor Street, Cluj-Napoca, Romania
E-mail: adimolnar45@yahoo.com

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Conclusions: Ruptured abdominal aortic aneurysm continues to represent a condition associated with substantial risks and high mortality. Selective screening and elective repair are therefore necessary for the improvement of the survival rate for patients with infrarenal aortic aneurysm.

Key words: risk factors, aneurysm, infrarenal aorta, rupture, perioperative, mortality

Introduction

Infrarenal abdominal aortic aneurysms (AAAs) represent the most frequent arterial aneurysms, with a multifactorial etiology in which the degenerative alterations of the arterial wall seems to have the predominant role (1). Abdominal aortic aneurysm (AAA) affects approximately 5% of men and 1% of women over 60 years of age (2). They affect mostly the patients with a history of smoking and hypertension. Although the prevalence of infrarenal AAA is high, the risk of rupture and the consequent mortality rate is underestimated. AAA related mortality is an important cause of death in ageing populations in the Western World. Approximately 15,000 deaths are attributed to AAA annually in the USA (2).

The present management options for AAA are either surveillance or surgical repair (open or endovascular). Patients are selected for surgery when the risk of AAA rupture is estimated to outweigh the risk of surgical repair. Currently patients are selected for surgery based mainly on aortic diameter thresholds of 50–55 mm, depending on centre (2). Open infrarenal abdominal aortic aneurysm (AAA) repair is performed without event in most cases (3). However, some patients suffer major morbidities such as renal failure, myocardial infarction, paraplegia, acute respiratory distress syndrome, or hepatic dysfunction (3). Predicting what kinds of patient populations are more prone to develop such complications may keep the clinicians more attentive to the patients, possibly leading to better prognosis (3).

The main objective of our study was to quantify the connection degree between the presence of cardiovascular risk factors and comorbidities, and the postoperative complications respectively, with the perioperative mortality risk. We also compared the early postoperative outcomes and mortality rates in patients who underwent elective repair with those who underwent emergency repair.

Materials and Methods

Our aim was to determine the factors that influence the early postoperative outcomes in infrarenal AAAs and the perioperative morbidity and mortality rates: the demographics of the patients (age, gender), the cardiovascular risk factors (smoking, hypercholesterolemia, hypertension, diabetes), the associated diseases (cardiac diseases, peripheral arterial diseases), the medical treatment before admission, the clinical signs at presentation (abdominal or lumbar pain, hypovolemic shock, pulsatile abdominal mass), the aneurysm diameter, and the serum creatinine levels at presentation. The preoperative imaging studies were abdominal US, CT scanning, and angiography (in elective cases associated with renal disease or peripheral occlusive arterial disease). The operative treatment (tubular graft interposition, aorto-biiliac or aorto-bifemoral bypass) was accomplished mainly by transperitoneal approach of the infrarenal aorta and was evaluated by the perioperative complications and mortality rates.

This retrospective study was undertaken on all the 138 patients with infrarenal AAA, who underwent elective repair or emergency repair for ruptured AAA, in the Cluj-Napoca Cardiovascular Surgery Clinic between January 2003 and December 2011. The data were collected from the electronic health records and the operative registers.

Elective repair

Approximately sixty-four percent (n=88) of the study population had elective infrarenal AAA repair. The mean age was 68 ± 5.04 years (range 49 - 84 years), by which 85.2% (75/88) were males. The mean hospital stay was 15.6 ± 4.24 days (range 6 - 45 days). From the cardiovascular risk factors, hypertension was present in 67 patients (76.14%) – 62.7% stage I and 37.3% stage II, diabetes in 8 patients (9.09%), and hypercholesterolemia in 21 patients (23.86%); also, 39 patients (44.32%) were smokers. We evaluated that the medical treatment taken prior to admission was efficient in 70 patients (79.54%). The clinical signs at presentation most frequently encountered were pulsatile abdominal mass (63.6%) and abdominal pain (61.4%), while the most frequent comorbidities were cardiac diseases (54.55%), and peripheral arterial disease (30.68%). The serum creatinine level at presentation varied between 0.59 and 3.14 mg/dl, with a mean of 1.14 mg/dl, and the mean aneurysm diameter was 7.0 ± 1.21 cm (range 4 - 13 cm) (*Table 1*). The operative management was by conventional open repair, using the transperitoneal approach: tubular graft interposition (61.4%), aorto-biiliac bypass (15.9%), and aorto-bifemoral bypass (22.7%). Postoperatively most patients had no complications (74/88), but in the other 14 patients the main complications were at the surgical wound level (7/88), and only 0.8% of patients presented cardiac or respiratory failure (*Fig. 1*). The most frequent cause of perioperative mortality in this populational group was cardiac failure (3/88), followed by renal failure and mesenteric ischemia, each encountered in 1 case (*Fig. 2*). The perioperative mortality rate was almost six percent of the patients (5/88).

Emergency repair

Approximately thirty-six percent (n=50) of the study population patients had emergency repair. Only 9 of these patients (18%) were previously known and followed up for AAA, and all had initial emergent presentation. Their mean age was 68.6 ± 5.88 years (range 51 - 83 years), by which 90% (45/50) were males. The mean hospital length of stay was 11.6 ± 6.8 days (range 0.3 - 39 days). From the cardiovascular risk factors, hypertension was present in 29 patients (58%) – 10.35% stage

Table 1. *Patient characteristics*

Characteristic	Elective repair (n=88)	Emergency repair (n=50)
Mean Age (years)	68 ± 5.04	68.5 ± 5.88
Males	75 (85.2%)	45 (90%)
Mean Hospital Length of Stay (days)	15.6 ± 4.2	11.6 ± 6.8
Mean AAA Diameter (cm)	7.02 ± 1.21	8.14 ± 1.40
Mean Serum Creatinine (mg/dl)	1.14	2.15
Hypertension (patient no.)	67 (76.14%)	29 (58%)
Diabetes (patient no.)	8 (9.09%)	4 (8%)
Hypercholesterolemia (patient no.)	21 (23.86%)	7 (14%)
Smoking (patient no.)	39 (44.32%)	10 (20%)
Effective medical treatment (patient no.)	70 (79.54%)	15 (30%)
Comorbidities (patient no.)	48 (54.55%)	9 (18%)
Postoperative Complications (patient no.)	14 (15.91%)	38 (76%)
Perioperative Mortality (patient no.)	5 (5.68%)	23 (46%)

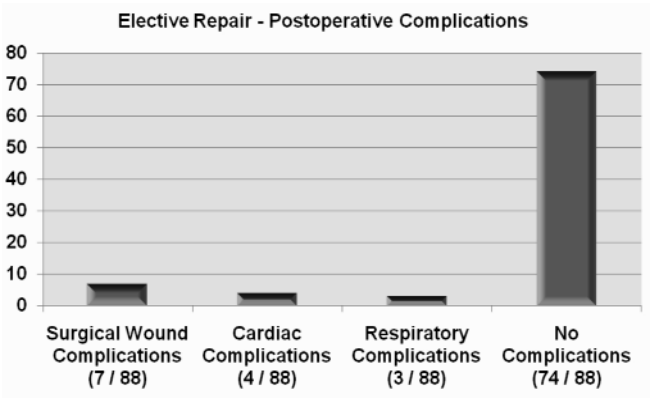


Figure 1. *Postoperative complications in the elective repair group*

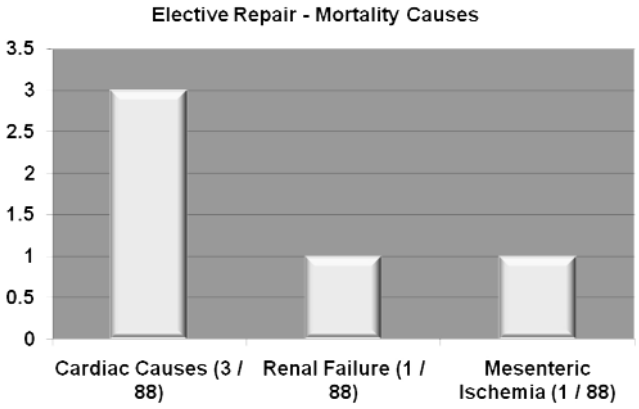


Figure 2. *Perioperative mortality in the elective repair group*

I and 89.65% stage II, diabetes in 4 patients (8%), and hypercholesterolemia in 7 patients (14%); also, 10 patients (20%) were smokers. We evaluated that the medical treatment taken prior to admission was efficient in 15 patients (30%). The most frequent clinical signs at presentation were abdominal pain (70%) and hypovolemic shock (hypotension) (64%), the abdominal pulsatile mass being detected in 44% of patients, while the most frequent comorbidities were peripheral arterial disease (18%), and other cardiac diseases (16%). The serum creatinine level at presentation varied between 0.73 and 8.78 mg/dl, with a mean of 2.15 mg/dl, and the mean AAA diameter was 8.14 ± 1.4 cm (range 4.5 - 13 cm) (*Table 1*). The operative management was by conventional open repair, using the transperitoneal approach: tubular graft interposition (82%), aorto-biiliac bypass (2%), and aorto-bifemoral bypass (16%). Post-operatively the main complications were the cardiac complications (10/50) and mesenteric ischemia (9/50), followed by complications at the surgical wound level (7/50); other 10 patients presented renal dysfunction and/or respiratory failure; also, sepsis occurred in 4% of patients

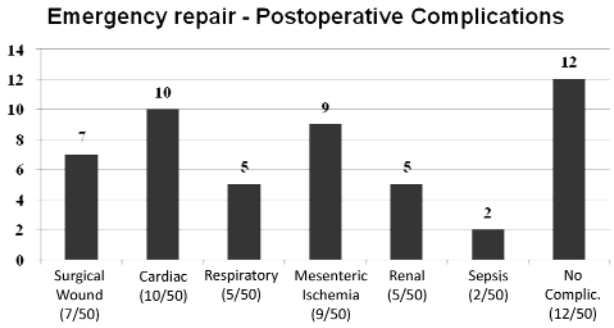


Figure 3. *Postoperative complications in the emergency repair group*

(*Fig. 3*). The most frequent causes of perioperative mortality in this populational group were cardiac failure (8 patients) and mesenteric ischemia (6 patients), followed by MSOF (5 patients) and renal failure in 4 cases (*Fig. 4*). The perioperative mortality rate was forty-six percent (23/50).

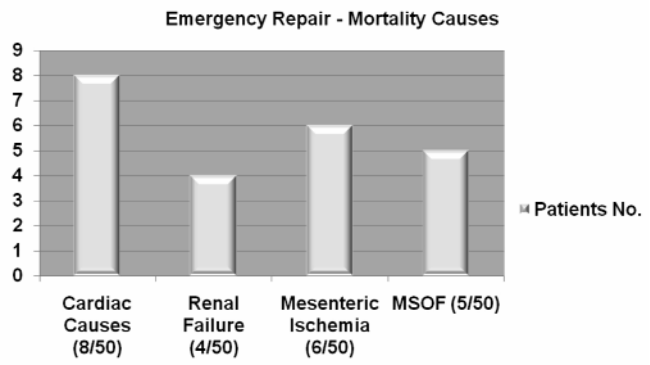


Figure 4. *Perioperative mortality in the emergency repair group*

Statistical analysis

Statistical analysis was done using the Chi-square and the Student t-test for qualitative variables, and the correlation coefficient between numerical data. Statistical significance was taken as $p < 0.05$.

Results

Patient characteristics

The mean hospital length of stay for emergency repair was statistically significantly shorter than for the elective repair group (t-Test), with a p value of 0.01. In the emergency repair group the mean serum creatinine level at admission was significantly higher than in the elective group (t-Test: $p = 0.00004$).

There was a significant statistical difference in mean aneurysm diameter between the elective repair and the emergency repair group ($p = 0.0003$).

Comorbidities

The connection between the frequency of comorbidities and the postoperative complications and the mortality rate respectively (Chi-square test) in the emergency repair group showed no statistical difference ($p = 0.192$ and 0.507 respectively).

Postoperative complications

In the emergency repair group there was a significant statistical difference in the correlation between the perioperative mortality rate and the presence of postoperative complications (Chi-square test), with a p value of 0.000011.

Also, in the emergency repair group the correlation between the frequency of postoperative complications per patient and patient age was statistically moderate, with $Cs = 0.39$, while the correlation with the length of stay was very weak ($Cs = -0.19$); also the $Cs = -0.14$ between the presence of postoperative complications and aneurysm diameter showed no statistical significance; there was no significant correlation between the hospital stay and the patients age ($Cp = 0.075$).

Perioperative (30-Day) mortality

The 30-day mortality in the emergency operative group (46%) was almost eight-times higher than in the elective operative group (6%) ($p = 1.51E-08$), showing a very high statistically significant difference between the two patient populations.

Discussion

Many studies have determined that some preoperative, intraoperative, and postoperative patient variables could predict mortality for AAA open repair (3). Some of the most commonly cited variables include age, gender, elevated serum creatinine, congestive heart failure, chronic pulmonary obstructive disease, hypotension, cardiac arrest, and syncope (4).

The choice of repair method is between open and endovascular repair. The initial outcome of endovascular repair is more favourable than that of open surgery but up to 20% of patients require re-intervention within 5 years and a proportion of patients suffer late terminal complications such as aortic rupture. As a result, careful long-term follow-up is required after endovascular AAA repair; this reduces cost effectiveness and is not always possible (2).

Elderly patients with AAA in emergency presentation with hypovolemic shock status or cardiorespiratory arrest present an increased risk for perioperative morbidity and mortality and should be evaluated in order to establish the indication for endovascular repair (5). The endovascular repair has been widely accepted for the elective treatment of AAA. There is also a growing body of evidence supporting the successful application of this technique to patients with ruptured AAA(4), but our center has very little experience in applying it, especially to patients with ruptured AAA. This is due to numerous reasons, including surgeon preference and the speed of open repair with acceptable results.

Between the two groups of patients we found significant difference in serum creatinine levels at admission (higher for emergency repair group - $p = 0.00004$); also the mean hospital stay was lower for the patients presenting with ruptured AAA, maybe due to the higher frequency of major postoperative complications which lead to higher mortality rates. Other recent studies assessed glomerular filtration as a predictor of surgical outcome in patients with infrarenal AAA. Estimated glomerular filtration rate (eGFR) can be readily calculated from serum creatinine values (6). It is a more sensitive prognostic indicator than serum creatinine alone in patients undergoing thoracoabdominal or endovascular abdominal aortic aneurysm repair. The preoperative eGFR was calculated for patients undergoing elective open infrarenal aortic aneurysm repair. Postoperative complications, perioperative mortality, and long-term survival were compared across eGFR and serum creatinine quartiles. The eGFR identified preoperative renal dysfunction in 33% of patients, whereas serum creatinine identified renal impairment in only 11% (6). Serum creatinine did not correlate with perioperative mortality or long-term survival. However, it did correlate with

postoperative morbidity (6). The eGFR is a more sensitive index of preoperative renal function than serum creatinine and correlates with survival. It should replace serum creatinine as the standard index of renal function before open abdominal aortic aneurysm repair (6).

The study showed an increased incidence of associated cardiac diseases and hypertension both in the elective repair group (54.55% and 76.14%) and in the emergency repair group (16% and 58%); still there was no evidence of a significant correlation with the frequency of preoperative comorbidities or 30-day mortality rate (p = 0.192 and 0.507).

Postoperative complications were predominantly cardiac (20%), ischemic – especially mesenteric ischemia (18%), renal failure (10%) and at the surgical wound level (14%) in the emergency repair group while in the elective repair group the most frequent complication was at the surgical wound level (7.95%). There is a statistically moderate correlation between the postoperative complications frequency and the patients' age (Cs = 0.39) but we found no significant correlation with the aneurysm diameter and hospital length of stay respectively (Cs = -0.14 and - 0.19).

In previous reports, mortality rates for elective infrarenal AAA repair were 0% (7), 2.5% (8), and 3.1% (9). If emergency cases were included, as in ours, the mortality rate was 7.3 % (10,11). Morbidity rates were reported as 37% (9,12) and 40% (7,13,14). Although relatively high, the overall perioperative mortality rate in the elective repair group was significantly lower (5.68%) than in the emergency repair group (46%) (p = 1.51E-08), with a statistically significant connection with the presence of postoperative complications in the emergency repair for ruptured AAA (p value = 0.000011). In light of decreasing elective operative mortality rates, early recognition of likely rupture might further identify those patients for whom the surgical management of AAA would be beneficial (15,16,17,18,19). Among the variables potentially linked with rupture are gender, aneurysm size, and preexisting cardiovascular disease (especially hypertension) (19,20).

The conventional thinking is that the risk of rupture is most related with the maximum AAA diameter (2,21). Although aortic diameter is a useful predictor of subsequent AAA expansion, it has some limitations: rates of expansion are highly variable, both for and between individuals; measurement errors of 1–3 mm are not uncommon with ultrasound; and the final diameter at which rupture occurs in an individual patient is highly variable (2,22,23). Comparing the average aneurysm size in the elective group with that of the aneurysms of the emergency group we found that there is a significant difference in the average size (p = 0.0003). Thus, selective screening and elective surgical repair is necessary in order to improve the survival rate for the patients with infrarenal AAA (24,25,26).

The study limits are mainly represented by the size of the population studied, which could lead to statistical biases (the software we used did not allow the specific adjustment of some statistical tests for small numbers of subjects), and the lack of long-term follow-up, due in part to deficient patient compliance, and also, in many cases, to the difficult access to the health system.

Conclusion

We believe that the ruptured AAA continues to represent a condition associated with considerable risks and high mortality rates, even if those are decreasing in the past decades, especially due to an increase in professional performances. The decision of when, or whether to electively operate on high-risk patients will ultimately depend on the risk of surgery compared with the risk of non-operative management or alternative procedures (27,28,29). However, to estimate the risk of elective AAA repair it is necessary not only to identify what constitutes "high risk" but also to understand the natural postoperative history with short-term outcomes (30,31).

Also, as mentioned in other studies, the EVAR technique, if the criteria of an endograft are met, is a method to be chosen because of its minimal invasive characteristics, especially for the patient with multiple comorbidity factors (32).

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