Original Article

Prospective Study of Early and Late Morbidity and Mortality in the Abdominal Aortic Aneurysm Surgical Repair

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Objective

To prospectively assess early and late morbidity and mortality of patients undergoing elective surgical repair of abdominal infrarenal aortic aneurysms and to determine the independent predictors of cardiac events.

Methods

For 6 consecutive years, this study analyzed 130 patients, who underwent routine standardized preoperative assessment always with the same clinical, surgical, and anesthesia teams.

Results

In-hospital mortality was 3.1% (4 patients), and the major cause of death was mesenteric ischemia, which occurred in 3 patients. Forty-eight (37%) nonsurgical complications occurred as follows: 8.5% were cardiac complications and 28.5% were noncardiac complications. The most common complications were the pulmonary ones, which occurred in 14 (10.8%) patients. Survivals in the first, third, and sixth postoperative years were 95%, 87%, and 76%, respectively. The variables that significantly correlated with morbidity and mortality were clinical predictors, mean age of 70.5 years, and presence of heart failure and chronic renal failure. No predictor of late morbidity and mortality was identified.

Conclusion

Although this is considered a highly complex surgery, mortality is low, the cardiac complications are not very significant, and the patients have a good long-term evolution.

Key words

abdominal aorta, aneurysm, surgery

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Received for publication: 02/02/2004
Accepted for publication: 07/05/2004
English version by Stela Maris Costalonga

Abdominal aortic aneurysms affects 4% of men and 1% of women in the age group between 60 and 70 years. It is the 13th cause of death in the United States of America[1].

Surgical repair of the abdominal aortic aneurysm is indicated when its diameter reaches or exceeds 5.5 cm, or when expansion of its cross-sectional diameter is ≥ 5 mm in one year[2]. In addition, surgical indication should be based on considerations about the risk of aneurysm rupture, which should be compared with the surgical risk and the patient's life expectancy.

Mortality of the surgical repair of abdominal infrarenal aortic aneurysm has ranged from 1.6 to 12%[3-7], acute myocardial infarction being considered the major cause of postoperative death, accounting for 40% of all deaths[8]. Thus, the emphasis given to cardiac assessment in the preoperative preparation of those patients. Identification and treatment of cardiac disease aim at reducing its impact on the morbidity and mortality of patients undergoing complex surgeries, such as the repair of abdominal aortic aneurysms.

This study aimed at assessing the clinical and cardiological morbidity and mortality of the elective surgery for abdominal aortic aneurysms and to determine the independent predictors of cardiac events.

Methods

From January 1994 to November 2000, 237 patients underwent elective surgical repair of abdominal infrarenal aortic aneurysms. Of them, 130 patients were prospectively selected. The same protocol was used for preoperative assessment, performed by the same cardiologist, and of early and late postoperative follow-up. The study sample comprised 115 (88.5%) men and 15 (11.5%) women, with a mean age of 67±8.05 years. The other patients could not be included in the protocol because they came from other clinics and services of the hospital. All patients had the same surgical and anesthesia teams.

The patients underwent the following preoperative examinations: laboratory tests (hemogram, coagulogram, renal function, electrolytes, lipid profile, arterial blood gas analysis, total proteins and fractions, hepatic enzymes, and glycemia); electrocardiography; chest X-ray; and echocardiography.

The following patients were considered as having clinical evidence of obstructive coronary heart disease: symptomatic patients from the coronary viewpoint, ie, patients with a history of typical

angina pectoris, myocardial infarction, myocardial revascularization, or previous coronary angioplasty, or both; asymptomatic patients with an electrocardiographic finding suggestive of a necrotic area (Q wave ≥ 0.03 s or amputation of the R wave in at least 2 leads, or both).

The symptomatic patient or the patient using antiarrhythmic medication was considered to have cardiac arrhythmia. Patients with heart failure were characterized according to NYHA functional class [9].

In addition, chronic obstructive pulmonary disease and chronic renal failure were considered comorbidities.

The following were considered risk factors for atherosclerosis: 1) systemic arterial hypertension: previous history of arterial hypertension and use of antihypertensive medication or blood pressure > 140/90 mmHg in at least 2 measurements taken on different days; 2) diabetes mellitus: a previous history of diabetes, controlled with diet, oral antidiabetic drug or insulin; 3) smoking: current or within the past 5 years; 4) dyslipidemia: total cholesterol > 200 mg/dL, LDL-cholesterol > 130 mg/dL, and the association of triglycerides > 200 mg/dL with HDL-cholesterol < 35 mg/dL.

At the beginning of the study, all patients underwent cardiac catheterization on preoperative assessment. Since the publication of the ACC/AHA guidelines[10] for cardiovascular evaluation in noncardiac surgery, a progressive change in attitude has been observed, and, since 1997, a new protocol has been used for assessing surgical risk. That protocol is based on the evaluation of clinical predictors (major, intermediate, and minor), on the functional capacity expressed in metabolic equivalents (> 4 METs and < 4 METs), which was analyzed through an adaptation of the Duke activity scale by the AHA, and on the type of surgery according to the algorithm of the ACC/AHA task force[10].

The following were considered cardiac complications: fatal acute myocardial infarction; nonfatal acute myocardial infarction; cardiac decompensation, with worsening of functional class; acute atrial fibrillation; and ventricular or supraventricular arrhythmias that required intravenous medication.

The use of acetylsalicylic acid in the preoperative period of patients with coronary heart disease or cerebral disease was not interrupted.

The following grafts were performed: 84 (64.6%) aorto-aortic grafts and 46 (35.5%) aorto-bifurcated grafts.

All patients underwent electrocardiography in the immediate postoperative period, and on the first and second postoperative days. Serial cardiac enzyme measurements were taken in the case of intra- or postoperative clinical instability or in the presence of electrocardiographic changes suggestive of acute ischemia. In-hospital mortality was considered death occurring within 30 days after surgery, even when the patient was already at home. Some patients continued their clinical follow-up on an outpatient care basis. Others had their late survival assessed through telephone contact, and, if the patient had died, the cause of death written down on the death certificate was asked for.

The following variables were analyzed: sex, age, evidence of obstructive coronary heart disease, preoperative cardiac procedure, risk factors, functional capacity, chronic obstructive pulmonary disease, chronic renal failure, electrocardiography, left ventricular ejection fraction, myocardial scintigraphy, 1-vessel, 2-vessel or 3-vessel coronary artery disease, and NYHA heart failure classification[9].

The major risk factors affecting the patients are shown in table I. Forty-one (31.5%) patients had evidence of obstructive coronary heart disease, and electrocardiography was the diagnostic examination in 31 (75.7%) of them (P<0.001). Of the 41 patients with obstructive coronary heart disease, 32 (79%) had changes in contractility on echocardiography. Sixty-three patients underwent myocardial scintigraphy, and the result was normal in 49. Of the 14 patients with an abnormal result, scintigraphy was the only evidence of coronary heart disease in 4.

Seventy-five patients underwent cardiac catheterization. In 2 patients, the results were not available, and, of the 73 remaining patients, only 20 (27.4%) were normal (tab. II). Single-vessel disease was diagnosed in 16 (22%) patients; 2-vessel disease in 21 (28.2%); and 3-vessel disease in 16 (22%) patients. This shows the elevated association between abdominal aortic aneurysm and coronary heart disease (53 patients, 72.8%).

It is worth stressing that of the 34 patients with no evidence of coronary heart disease on anamnesis, electrocardiography, or echocardiography, 17 (50%) had significant coronary lesions on cardiac catheterization.

Of all patients, 10 (7.7%) had undergone a previous cardiac intervention as follows: myocardial revascularization, 7 (5.4%) patients; and coronary angioplasty, 3 (2.3%) patients. Cardiac intervention was indicated before the aortic aneurysm surgery in 16 (12.3%) patients, surgical revascularization was indicated in 10 (7.7%) patients, and angioplasty in 6 (4.6%) patients.

Only 2 (1.6%) patients had a major clinical predictor, both in the form of unstable angina. One patient underwent coronary angioplasty and the other underwent myocardial revascularization in the preoperative period, and evolved uneventfully.

Statistical analysis was performed by using the Student *t* test

Table I - Major risk factors of patients undergoing abdominal aortic aneurysm repair

Risk factors	Number of patients	%
Systemic arterial hypertension	83	63.8
Smoking	70	53.8
Dyslipidemia	68	52.3
Coronary heart disease	41	31.5
COPD*	34	26.2
FC < 4 Mets †	16	17.4
Renal failure	13	10
Diabetes mellitus	13	10
Heart failure	7	5.4
Atrial fibrillation	6	4.6

* Chronic obstructive pulmonary disease; †FC - functional capacity; METs - metabolic milliequivalents. Note: several patients had more than one risk factor.

Table II - Angiographic classification of coronary heart disease in patients undergoing cine coronary angiography

Result of catheterization	Number of patients (n = 73)*	%
Normal	20	27.4
1-vessel disease	16	22.0
2-vessel disease	21	28.8
3-vessel disease	16	22.0

* The result of 2 patients was not available.

for comparison between 2 means, the chi-square test or Fisher exact test for comparison between 2 proportions, and the Kaplan-Meyer survival curve for obtaining the estimate of the probability of survival. The significance value of P=0.05 was adopted.

Results

Postoperative complications occurred in 48 (37%) patients, 11 (8.5%) being cardiac and 37 (28.5%) being noncardiac (tab. III). One (0.77%) patient had nonfatal acute myocardial infarction on the tenth postoperative day, after hospital discharge. The most frequent cardiac complication was acute atrial fibrillation, which occurred in 7 (5.4%) patients, followed by cardiac decompensation, which occurred in 3 (2.3%). Having a previous history of myocardial revascularization and heart failure showed a significant correlation with cardiac complications (P=0.013 and < 0.001, respectively). The major noncardiac complication was pulmonary, which was the most frequent complication among all patients (14 patients, 37.8%).

Four (3.1%) patients died within a 30-day period, and the major cause of death was mesenteric ischemia, which occurred in 3 patients. In 2 patients, the diagnosis was established on surgical reexploration. The third patient died due to septic shock attributed to mesenteric ischemia. The fourth patient had severe chronic obstructive pulmonary disease and died due to pneumonia. No death was due to a cardiac cause (tab. IV).

The variables that significantly correlated with early morbidity and mortality were as follows: clinical predictors (P=0.016), patients with a minor clinical predictor had fewer complications; mean age of 70.5 years, with a standard deviation of 6.7 (P=0.0002); heart failure (P=0.048); and chronic renal failure (P=0.024).

Late mortality was 10.2% (9 patients): 5 patients died due to neoplasia and 4 due to acute myocardial infarction. The research team lost contact with 8 patients. Survival in the first year was 95% (86 patients); in the third year, 87% (48 patients); and, by the end of 6 years, 76% (8 patients) (tab. V and fig. 1).

None of the variables analyzed showed a significant association with late mortality (tab. IV).

Discussion

Our most striking finding is the fact that nonfatal acute myocardial infarction occurred in less than 1% of our sample, and no patient died due to acute myocardial infarction, although the association between coronary heart disease and abdominal aortic aneurysm occurred in 31.5% of the patients. The association between those 2 diseases is very well known and is one of the major concerns about patients who need to undergo surgical repair of an abdominal aortic aneurysm[4,11-14]. The prevalence of that association is sometimes greater than that found in our case series. In a case series of 234 patients with abdominal aortic aneurysms, Hertzer et al[15] reported that only 18% of the patients did not have coronary heart disease.

Although none of our patients died due to acute myocardial infarction, the latter is frequently reported as the major cause of death in the surgical repair of abdominal aortic aneurysm[4,8,11,15-21].

Table III - Postoperative complications in 48 patients

Complication	Number of patients	%
Cardiovascular	11	8.5
Acute atrial fibrillation	7	5.4
Heart failure	3	2.3
Nonfatal AMI*	1	0.8
Noncardiovascular	37	28.5
Pulmonary	14	37.8
Others	11	29.7
Pulmonary + others	4	10.8
Pulmonary + renal + others	3	8.1
Renal	2	5.4
Renal + others	1	2.7
Renal + digestive + others	1	2.7
Cerebral	1	2.7
Total	48	37

* Acute myocardial infarction; others: suture dehiscence, infection of the operative wound, bleeding, anemia, distal microembolism, iliac artery embolism, partial intestinal occlusion, mesenteric ischemia, deep venous thrombosis in the lower limb, epididymitis, low platelet count, hepatitis.

Table IV - Six-year survival of patients (Kaplan-Meyer)

Time (years)	Estimated chance of survival	Number of patients undergoing follow-up
0	1.00	122
1	0.95	86
3	0.87	48
5	0.80	22
6	0.76	8

Table V – Causes of early (in-hospital) and late death

	Cause	N	%
In-hospital death		4	
	Bronchopneumonia	1	25
	Septic shock	1	25
	Mesenteric ischemia	2	50
Late death		12	
	Colon CA	2	16.7
	Gastric CA	1	8.3
	Prostate CA	2	16.7
	Hemorrhagic shock	1	8.3
	Acute myocardial infarction	4	33.3
	Sudden death	1	8.3
	Cranial trauma	1	8.3

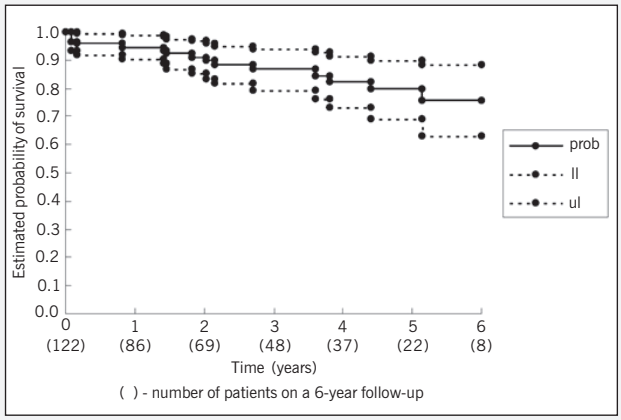

Fig. 1 - Survival curve of patients undergoing abdominal aortic aneurysm surgical repair with a 95% confidence interval. prob - probability; ll - lower limit, ul - upper limit.

In the case series by Herzter et al[8], acute myocardial infarction accounted for 40% of the deaths in the immediate postoperative period of abdominal aortic aneurysm surgical repair, and those deaths were more frequent in patients with clinical evidence of coronary heart disease.

It is worth emphasizing that in our case series, the number of preoperative cardiac interventions was elevated (12.3%), particularly because at the beginning of the study all patients underwent cine coronary angiography. That number is equivalent to that in the case series of Komori et al[6], in which 11.94% of the patients had previously undergone cardiac surgery. Previous coronary revascularization reduces the risk of postoperative cardiac complications, according to Foster et al[22], who reported a reduction from 6% to 2.2% in the occurrence of postoperative acute myocardial infarction, for patients treated with medications or undergoing coronary surgical procedures, respectively. However, it should be considered that, if patients undergo previous myocardial revascularization, the mortality of the procedure should be added to that of the abdominal aortic aneurysm surgical repair.

The acute myocardial infarction rate of our case series should not be explained only because of the initial practice of having patients undergo cardiac catheterization and eventual surgical coronary repair, because this only happened in the initial phase of the study. Considering that all patients who were taking acetylsalicylic acid underwent surgical repair of an abdominal aortic aneurysm without its suspension, one may think that that practice may have contributed to the result. It is worth noting that acetylsalicylic acid never caused significant intraoperative bleeding. Occasional greater loses have always been attributed to a technical problem. Other authors have also agreed that medicamentous suspension is not required, because no evidence exists that its maintenance increases the incidence of intraoperative bleeding[23].

The complication rate in our case series was 37%, and the noncardiac complications accounted for 28.5%, a similar rate as that reported by other authors[24].

Of the cardiac complications, acute atrial fibrillation was the most frequent (5.4%). Maybe due to the small number of patients with that complication, its causing factors could not be determined. In the study by Perzanowski et al[25], age (73 ± 10 years), systemic arterial hypertension, diabetes, chronic obstructive pulmonary disease, and preoperative infarction were predictors of acute atrial fibrillation.

In regard to the noncardiac complications occurring in 28.5% of the patients, the pulmonary ones were the most significant in number, accounting for 37.8% of the complications. They are usually one of the major factors of morbidity. AbuRahma et al[5] reported 29% of respiratory complications in a case series of 332 patients operated on due to abdominal aortic aneurysm. Komori et al[6] reported a lower rate of 14.5%, but they emphasized that those complications significantly influenced the overall complication rate. Other authors reported that pulmonary infection is the most common cause of morbidity in patients undergoing surgical repair for abdominal aortic aneurysms and that one third of them have chronic obstructive pulmonary disease as a risk factor for mortality[3,12].

Seven (18.9%) patients in this case series developed renal complications, isolated or associated with other types of complications. However, they were not severe enough to require hemodialysis. In the study by Komori et al[6], renal complications accounted for 1.2%, and, by using multivariate analysis, they reported that previous renal failure is a significant risk factor for those patients. Similarly, Norwood et al[26] reported that patients with severe renal failure, some in the final stage, had high postoperative morbidity and mortality. Their 5-year survival was 43.5%, while that of patients without renal failure was 78.1%. Those authors even question the validity of surgical indication in such cases. In our case series, although no patient had significant preoperative renal failure, the latter significantly correlated with early morbidity and mortality. In the study by Sugawara et al[27], which included patients with creatinine serum levels ≥ 1.5 mg/dL, a greater rate of postoperative complications before surgery has been valued as a risk predictor, and it was included as a moderate clinical risk predictor (creatinine ≥ 2 mg/dL) in the preoperative assessment of the ACC/AHA[28].

Heart failure has also correlated with morbidity and mortality, corroborating the findings of the meta-analysis published by Steyerberg et al[29].

Although age has been considered a minor clinical predictor by the ACC/AHA classification[28], in our study it correlated in a statistically significant way with early morbidity and mortality, in accordance with other studies[12,30-32].

Late survival in this series was 95%, 87%, 80%, and 76% in the first, third, fifth, and sixth years after the surgical procedure, respectively.

Although we found no risk predictor in the long run, maybe because of the low number of deaths, Komori et al [6] reported that the late postoperative survival rates in individuals aged 75 years were 73.3%, 50.6%, and 22.3% in the third, fifth, and tenth postoperative years. For patients aged less than 75 years, those rates were 86.5%, 72.1%, and 58.3%, respectively. Advanced age in association with vascular disease may be considered an independent predictor of cardiac events.

The most prevalent risk factors were arterial hypertension (63.8%), followed by dyslipidemia (54.3%) and smoking (53.8%). Hypertension and smoking are usually considered significant risk factors[6,8,11-13], and dyslipidemia is more rarely correlated with abdominal aortic aneurysm[4,5,8].

In the long run, neoplasia and acute myocardial infarction were the major causes of death, which has also been reported by Komori et al[6] in the Japanese population, stressing the development of malignancy in that population during long-term follow-up.

The fact that, since 1997, we have adopted a less invasive preoperative evaluation, and, therefore, performed fewer preoperative cardiac interventions, has not apparently interfered with the patients' evolution in the postoperative period of vascular surgery, which may be observed in the low incidence of cardiac events in our sample.

The early mortality of 3.1% in our case series may be compared with that in large case series, except that it did not relate to the degree of coronary heart disease, as frequently observed[33-36].

In conclusion, although it has been considered a high-risk surgery mainly performed in elderly patients, who have several comorbidities, obstructive coronary heart disease being the most common, abdominal aortic aneurysm surgical repair may be performed with a low mortality rate and result in a good outcome.

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