Original Article

Is Prompt Surgical Treatment of an Abdominal Aortic Aneurysm Justified for Someone in Their Eighties?

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Objectives: The aim of this study is to review the early and long-term results and quality of life after abdominal aortic aneurysm (AAA) surgery in octogenarians to justify our prompt surgical intervention.

Patients and Methods: We reviewed the consecutive 444 patients who underwent graft replacement of AAA in our center from October 1997 to September 2002. The median age of the patients was 72.3. An elective operation was carried out in 401 cases (90.3%) and an emergency operation in 43 cases (9.7%). We evaluated the early and long-term results of AAA surgical treatment, including the quality of life after hospital discharge.

Results: There were 12 hospital deaths (2.7%) in the early outcomes, 11 of which (25.6%) were during emergency operations, and only one patient (0.2%) died among the elective cases ($p < .0001$). In the early results, the emergency operation ($p = 0.0001$) was the only risk factor in the early deaths investigated by the multivariate logistic regression; patients aged 80 years and over did not constitute a risk factor. There were 36 late deaths, but none related to AAA surgical treatment. The strongest predictors for late mortality included patients aged 80 years and over ($p = 0.027$), male gender ($p = 0.048$), chronic renal failure with preoperative serum creatinine level equal to or greater than 1.5 mg/dl ($p = 0.043$), a history of atherosclerotic obliterans ($p = 0.009$), and an emergency operation ($p < .001$) investigated by the Cox hazard multivariate logistic regression. Among the survivors, 86.1% of the patients aged 80 years and over were able to maintain their previous lifestyles with the independent activities of everyday life.

Conclusions: AAA surgical treatment in octogenarians had comparable results with younger patients, in either elective or emergency settings. The extension of indications for AAA elective surgery in octogenarians might lead to a lower rate of emergency settings and subsequently to better early and late surgical outcomes. (Ann Thorac Cardiovasc Surg 2009; 15: 23–30)

Key words: abdominal aortic aneurysm, octogenarian, surgical treatment

Introduction

Surgical indication for abdominal aortic aneurysm (AAA) in elderly patients depends on the risk of the operation compared with the risk of rupture of the unoperated aneurysm in the natural course of events. However, the surgical risk tends to rise with age because of the increase in the prevalence of various diseases associated with declines in the homeostatic reserve. Our principle is not to deny AAA surgical

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Received January 29, 2008; accepted for publication February 12, 2008

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treatment even in patients aged 80 years and over if the surgical risk would not exceed the risk of rupture, and if the surgery would not impair the quality of life. The aim of this study is to review early and long-term results, including the quality of life after AAA surgical treatment in octogenarians, to justify our prompt surgical intervention.

Patients and Methods

We reviewed the consecutive 444 patients who underwent graft replacement of AAAs in our center during a 5-year period, from October 1997 to September 2002. All patients had infrarenal AAAs and underwent in-situ graft replacements of the aneurysm. Patients having suprarenal AAAs, redo cases, and patients undergoing concomitant coronary artery bypass grafting were excluded from this study. The patients' profiles are shown in Table 1. This study includes all 444 cases. Male patients comprised 83.3% of the cases, and the male-to-female ratio was 4:1. An elective operation was carried out in 401 cases (90.3%), and an emergency operation in 43 (9.7%). In the emergency settings, there were 30 cases of a ruptured AAA and 13 of an impending ruptured AAA. The median age of patients was 72.3, ranging from 49 to 89. Octogenarian patients numbered 69 (15.5%), and 375 of all the patients (84.5%) were less than 80 years old. The ratio of emergency operations was significantly higher ($p = 0.003$) in the octogenarians (20.3%; 14/69), but only 7.7% (29/375) in patients younger than 80. Two cases, aged 85 and 87, had a previous history of stent graft implantation for the AAA. They had undergone surgical treatment 2 years after the stent grafting. One patient underwent an elective operation for the severe coagulopathy resulting from a type I endoleak of the previous stent, and the other underwent an emergency operation for AAA rupture. The maximum diameter of the aneurysm was 54.9 ± 10.3 (35–110) mm. The past history is also shown in Table 1. Ischemic heart disease was detected in 182 cases (41.0%), 68 of which had undergone percutaneous coronary intervention, and 45 had a previous history of coronary artery bypass grafting. Thirty patients were suffering from chronic renal failure, and 8 had been maintained with hemodialysis. We evaluated the early and long-term results of AAA surgical treatment. Surgical treatment was indicated for aneurysms larger than 45 mm, even for smaller ones with expansion rates exceeding 10 mm per year, and for all cases of ruptured or impending rupture of the aneurysm. The emergency settings included ruptured and impending ruptured AAAs. An impending AAA rupture was defined as a nonruptured, large symptomatic AAA that had undergone graft replacement within 24 hours after the diagnosis.

Table 1. Patients' profiles

	Number of patients	%
Total	444	
Male gender	370	83.3
Age	72.3 ± 7.6 (49–89) years	
Maximum diameter	54.9 ± 10.3 (35–110) mm	
Elective	401	90.3
Emergency: rupture	30	6.8
Emergency: impending rupture	13	2.9
Hypertension	351	79.1
Hyperlipidemia	243	54.7
Diabetes mellitus	55	12.4
Cerebrovascular disease	50	11.3
Ischemic heart disease	182	41.0
COPD	36	8.1
Chronic renal failure (Cr ≥ 1.5 mg/dl)	30	6.8
maintained by HD	8	1.8
TAA/TAAA	27	6.1
Aortic dissection	29	6.5
Atherosclerotic obliterans	27	6.1

COPD, chronic obstructive pulmonary disease; Cr, creatinine; HD, hemodialysis; TAA/TAAA, thoracic and/or thoracoabdominal aortic aneurysm.

Our strategy involves performing dipyridamole myocardial scintigraphy for preoperative evaluation of coronary artery disease in all cases in elective settings. This is followed by coronary angiography only for patients having positive findings of myocardial ischemia detected by the scintigram, and having past histories of coronary artery disease or of surgical or catheter intervention. In a case of significant coronary artery stenoses, a catheter intervention or coronary artery bypass grafting was performed before AAA surgery. Coronary artery bypass grafting was carried out simultaneously with graft replacement of the AAA for patients having a large AAA (greater than 70 mm) and/or severe coronary artery disease. These patients having concomitant surgery were excluded from this study.

Clinical data collection, definition, and follow-up

The data were collected from the medical records. The preoperative complications and past histories were defined as the following criteria: (1) ischemic heart disease included myocardial infarction with a history of enzymatic elevation and echocardiographic signs of necrosis and angina pectoris diagnosed by coronary angiography and scintigraphy; (2) chronic obstructive pulmonary disease with less than 70% of forced expiratory volume in one second; (3) chronic renal failure with serum creatinine (Cr) level equal to or more than 1.5 mg/dl; (4) thoracic and/or thoracoabdominal aortic aneurysm (TAA/TAAA); unoperated aneurysm over 40 mm in diameter; (5) past history of aortic dissection; (6) atherosclerotic obliterans for patients having intermittent claudication with significant arterial stenosis. Mortality in the early results included hospital deaths from all causes. The surviving patients were followed up in our outpatient clinic or other local clinic after hospital discharge. The most recent information was obtained by mailing and calling the patients or their families. For looking at the long-term outcome, we mailed a questionnaire to all patients who had survived the operation and returned home. Recent information about patients whose addresses were uncertain was obtained from their most recent clinical records. We asked the patients or their families about the clinical histories and daily activities after discharge and, if the patient had died, the cause of death and time. The end point of the late outcome was defined as death from any cause.

Statistical analysis

The results were expressed as mean ± standard deviation. A statistical analysis comparing the two groups was performed with an unpaired two-tailed Student's *t*-test for the means or χ^2 test for categorical variables, for which the relative risk with 95% confidence interval was calculated. The two-sided p values were calculated with Pearson's χ^2 test or, if expected frequencies fell below 5, with Fisher's χ^2 test. The actual survival curve was obtained by the Kaplan-Meier life table method, and statistical analysis was calculated with the log-rank test. The Cox hazard analysis model was used to evaluate the independent risk factors of the early and late results. Stepwise logistic regression was used to select the independent variables that could predict stronger factors for the early and late outcomes and included all the univariate variables with a p value less than or equal to 0.2. Independent variables were expressed as an odds ratio (OR), and the related p value was also reported. Significant factors from the univariate analysis were then entered into the multivariate analysis. In the Cox hazard model, the independent variables were expressed as an odds ratio, and the related p value and 95% confidence interval (95% CI) were also reported. The p values less than or equal to 0.05 were considered a statistically significant difference.

Table 2. Early outcome

Hospital death	12/444	2.7%
Elective	1/401	0.2%
Rupture	10/30	33.3%
Impending rupture	1/13	7.7%
Major complication	52/444	11.7%
Blood transfusion	246/444	55.4%
Operation time	266.5 ± 91.7 mins	
Hospital stay (survivors only)	20.5 ± 14.0 days	

Results

Early outcome

There were 12 hospital deaths (2.7%) in the early results (Table 2). Among the elective cases, only one patient died (0.2%). This patient had previously undergone bifurcated stent implantation because at 85 years of age he was considered to be a very high-risk patient for surgery. Elective graft replacement was required because of severe coagulopathy resulting from a type I endoleak at the proximal portion of the previous stent, but he expired from multiple organ failure. Among 30 cases of ruptured aneurysm, 10 patients died (33.3%) during their hospital stay. The causes of death were bowel necrosis in 4 patients and renal failure in 2. The other 4 patients, who had suffered from cardiac arrest before the operation and emergency laparotomy under cardiopulmonary resuscitation, died because of multiple organ failure, though the graft replacement had been successful. The remaining patient had died of impending aneurysm rupture, pan peritonitis from the previously inserted peritoneal dialysis catheter. Major complications occurred in 52 patients (11.7%) (Table 3). The incidence of fatal complications after the surgical treatment—heart failure, respiratory insufficiency requiring a tracheotomy, acute renal failure requiring hemodialysis, and bowel necrosis—was significantly higher in the emergency cases (p <.0001, respectively). Bowel necrosis was observed in 4 patients with ruptured AAAs, and a laparotomy was carried out in the 4. They all died, though a colectomy had been successfully performed on 2. Colon resection could not be carried out for the

Table 3. Complications

	Elective (n = 401)	Emergent (n = 43)	P value
Cardiac	4 (1.0%)	6 (14.0%)	<.0001
Respiratory	6 (1.5%)	8 (18.6%)	<.0001
Acute renal failure	4 (1.0%)	10 (23.3%)	<.0001
Ileus	7 (1.7%)	1 (2.3%)	0.7858
Gastrointestinal bleeding	3 (0.7%)	1 (2.3%)	0.2982
Bowel necrosis	0	4 (9.3%)	<.0001
Distal emboli	12 (3.0%)	1 (2.3%)	0.8053
Postoperative bleeding	4 (1.0%)	1 (2.3%)	0.4328
Graft infection	1 (0.2%)	0	0.7430

Table 4. Univariate and multivariate analysis related early death

	Univariate p value	Multivariate OR (95% CI)	Multivariate p value
Male gender	0.4725		
Aged over 80	0.0030	3.314 (0.924–11.891)	0.0660
Emergency operation	<.0001	68.553 (8.042–584.364)	0.0001
Hypertension	0.6880		
Hyperlipidemia	0.5690		
Diabetes mellitus	0.7601		
Ischemic heart disease	0.7596		
Old cerebral infarction	0.7275		
COPD	0.6820		
Chronic renal failure	0.6936		
TAA/TAAA	0.8280		
Aortic dissection	0.7470		
Atherosclerotic obliterans	0.4380		

COPD, chronic obstructive pulmonary disease; TAA/TAAA, thoracic and/or thoracoabdominal aortic aneurysm; OR, odds ratio; 95% CI, 95% confidence interval.

other 2 patients because necrosis had spread throughout most of the colon and the small intestine.

In the early results, only the emergency operation (p = 0.0001; OR = 68.553; 95% CI, 8.042–584.364) was the risk factor for an early death by multivariate logistic regression (Table 4). In the previous clinical history, patients aged 80 years and over at the time of the operation and gender did not correlate with the early outcomes.

Table 5. Causes of late death

	Number	%
Total late deaths	36	
Malignant tumor	14	38.9
Thoracic and/or thoracoabdominal aortic aneurysm	5	13.9
Ischemic heart disease	5	13.9
Respiratory failure	4	11.1
Gastrointestinal bleeding	3	8.3
Brain hemorrhage	2	5.6
Cerebral infarction	2	5.6
Renal failure	1	2.8

Long-term outcomes

A long-term follow-up was carried out for the 432 patients (97.3%) who survived and were discharged from the hospital. Recent clinical data were obtained by phone or from a questionnaire mailed to 335 patients (77.5%) or their families. The other cases were checked out through their most recent clinical records. Follow-up periods were 33.8 ± 24.8 months. There were 36 late deaths (Table 5), 14 of which (38.9%) were attributed to malignant tumors, 5 (13.9%) to rupture of the TAA/TAAA, and an unnamed number of hospital deaths after surgical treatment for the TAA/TAAA. The other causes of late death were ischemic heart disease in 5 patients, respiratory failure in 4, gastrointestinal bleeding in 3, cerebrovascular event in 4, and renal failure in

Table 6. Univariate and multivariate analyses related late death

	Univariate p value	Multivariate OR (95% CI)	Multivariate p value
Aged 80 years and over	<.001	2.091 (1.088–4.017)	0.027
Male gender	0.059	7.414 (1.017–54.050)	0.048
Hypertension	0.926		
Hyperlipidemia	0.143	0.917 (0.487–1.726)	0.788
Diabetes mellitus	0.440		
Old cerebral infarction	0.764		
Ischemic heart disease	0.842		
COPD	0.086	2.002 (0.821–4.881)	0.127
Chronic renal failure (Cr ≥ 1.5 mg/dl)	0.131	2.359 (1.026–5.425)	0.043
TAA/TAAA	0.341		
Aortic dissection	0.913		
Atherosclerotic obliterans	0.036	3.279 (1.350–7.964)	0.009
Emergency operation	<.001	5.663 (2.711–11.833)	<.001

COPD, chronic obstructive pulmonary disease; Cr, creatinine; TAA/TAAA, thoracic and/or thoracoabdominal aortic aneurysm; OR, odds ratio; 95% CI, 95% confidence interval.

1. The late complications correlated with the previous surgical treatments of AAA in 14 patients. Eleven patients experienced mechanical ileus, 2 underwent additional surgical treatment for the aneurysm of common iliac arteries after straight grafting of the AAA, and 1 had undergone surgical intervention for the pseudoaneurysm at the previous anastomotic site. All 3 patients survived after the second operation.

The strongest predictors of late mortality included patients aged 80 years and over (p = 0.027; OR = 2.091; 95% CI, 1.088–4.017), male gender (p = 0.048; OR = 7.414; 95% CI, 1.017–54.050), chronic renal failure with serum creatinine (Cr) level equal to or greater than 1.5 mg/dl (p = 0.043; OR = 2.359; 95% CI, 1.026–5.425), history of atherosclerotic obliterans (p = 0.009; OR = 3.279; 95% CI, 1.350–7.964), and emergency operation (p <.001; OR = 5.663; 95% CI, 2.711–11.833) by the Cox hazard multivariate logistic regression (Table 6).

The quality of life was assessed by asking the patients or their families. Among the survivors, 86.1% of patients aged 80 and over and 91.6% of patients less than 80 were able to maintain their previous lifestyles with independent activities in everyday life. The median age of the octogenarians upon investigation was 84.5 years, ranging from 83 to 92. More than 80% of the octogenarians had returned to their preoperative environment and lifestyle, though some patients were transferred to extended care or nursing facilities after surgical treatment.

The Kaplan-Meier life table analysis demonstrates the long-term survival curve. The late results were significantly worse in the emergency operation group, as well as in the early results (Fig. 1). By comparing the late survival after the elective operation between the octogenarians and patients less than 80 years old, we found no significant difference in the 3-year survival rate (Fig. 2). The 1- and 3-year rates were 97.6% and 90.9% in the octogenarians and 97.8% and 92.9% in patients less than 80 years old.

Discussion

Life expectancy has recently become longer, and the ratio of elderly patients subjected to AAA surgical treatment has increased. The surgical indication for AAA in elderly patients depends on the relative risk of the operation compared with the risk of rupture of the unoperated aneurysm in the natural course. However, the surgical risk tends to rise with age because of increases in the prevalence of various diseases associated with declines in the homeostatic reserve.[1,2] Our principle is not to deny surgical treatment of AAA even in patients aged 80 and over if the surgical risk would not exceed the risk of rupture, and if the surgery would not impair the quality of life. We reviewed the early and late outcomes of AAA surgical treatment to evaluate the early and long-term results to justify our prompt surgical intervention even for elderly patients.

The early results of the elective surgical treatment for AAA had been well established because of the development of high-quality artificial graft and postoperative management. The surgical outcome of the emergency operation, however, is not satisfactory. The early mor-

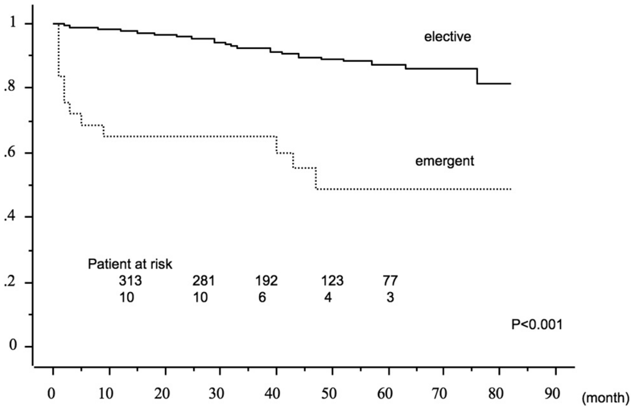

Fig. 1. Kaplan-Meier analysis of late survival compared with elective and emergency cases.

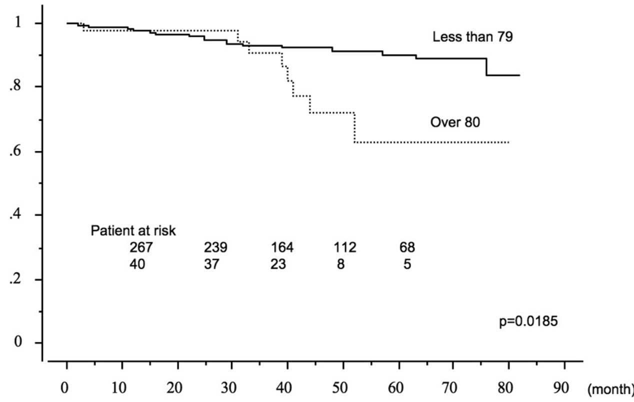

Fig. 2. Kaplan-Meier analysis of late survival among elective operations compared with octogenarians and patients less than 80 years old.

tality reported after the surgical treatment for non-ruptured AAA, including impending rupture, was 0 to 8.0%, and for the emergency operation for the ruptured AAA it was 34 to 68%.[3–15] These reports did not include patients who suffered from cardiac arrest after the aneurysm's rupture and died before reaching the hospital; however, the actual mortality rate for ruptured AAA would be even higher than that of previous reports.

In our study, the early mortality rate was extremely low and showed satisfactory surgical outcomes in comparison with previous reports.[3–15] In the early results, the mortality rates for elective and emergency operations were 0.2% and 25.6%, respectively. The predictive risk factor for early mortality was only the emergency settings. The previous clinical history, patients aged 80 years and over at the time of operation, and gender did not correlate with the early outcome.

The incidence of postoperative fatal complications after an emergency operation was higher than after an elective operation.[1–3,16–19] The higher rate of fatal complications, such as bowel necrosis or renal failure, especially with rupture cases, led to the unsatisfactory surgical outcome if the graft replacement itself had undergone completely. In our study, heart failure, respiratory insufficiency required a tracheotomy, acute renal failure required hemodialysis, and bowel necrosis was significantly higher in the emergency cases ($p < .0001$, respectively) than in the elective cases.

The ratio of the emergency operation in our study was significantly higher in the octogenarians than in younger patients (20.3% versus 7.7%; $p = 0.003$). The higher incidence of emergency operations among the elderly patients may be attributed to the reluctance of primary care physicians to refer elder patients for surgery. The mean age of the patients was slightly higher ($p = 0.0046$) in the emergency cases (74.4 ± 9.0 years old) compared with that of the elective cases (72.0 ± 7.3 years old). In 50% (7/14) of the octogenarians who had undergone emergency operations, surgical treatment had been denied at referral because of patient refusal, unacceptable operative risk, or poor general condition judged by the local clinicians. Surgical treatment was finally indicated for those patients in the emergency settings because of rupture or large symptomatic aneurysm.

The elderly patients were considered a high risk for surgery, not only because of their poor general condition, but also because of the potentially high risk of postoperative complications. In the elective operations, there were no fatal complications except for one patient that died after the operation as a result of multiple organ failure following serious reoperative coagulopathy. We sometimes experience difficulties during the postoperative management of elderly patients. However, there were no fatal complications in the elective cases, and there was no significant difference ($p = 0.4278$) in the hospital stay after elective surgical treatment between the octogenarians (21.4 ± 12.6 days) and the younger patients (19.8 ± 13.5 days).

The previous report showed that bowel necrosis and renal failure after surgical treatment had strongly correlated with the worse early surgical outcomes.[6,7,16–18] The reported bowel necrosis after AAA surgical treatment was from 3.1 to 18.9% in ruptured AAAs, and 0 to 0.6% in nonruptured AAAs.[16–21] The reported mortality rate for cases with bowel necrosis was 42 to 78%, remarkably higher than for those without bowel infarction. The incidence and mortality rate of our study, which was complicated by the bowel necrosis, was significantly high, as in previous reports. Four patients (9.3%) experienced bowel necrosis after the emergency operation, and all of them died, though no cases of necrosis were found among the elective operations ($p < .0001$). Two patients died after the second laparotomy as a result of serious and extensive necrosis of the bowel and small intestines impeding colectomy, and the other 2 died despite early diagnosis and treatment with colectomy. The prevention of bowel ischemia is important to achieve a better surgical outcome, since the infarction of the colon or small intestine leads to higher mortality.

Acute renal failure requiring temporary hemodialysis was observed in 14 patients, 4 in the elective patients and 10 in the emergency patients. The 4 patients of elective cases could finally be weaned from hemodialysis, and they survived after the operation. Acute renal failure occurred in the 10 patients having emergency operations. Only 3 survived this complication despite early and aggressive dialytic therapy.

In the late surgical outcome, no late deaths related directly to AAA surgical treatment. Malignant tumor was the most frequent cause of death in these cases as it also is reported to be in general statistical data in Japan. Heart failure after myocardial infarction and respiratory insufficiency were the next frequent causes of late death. Five patients died in the late period because of TAA/TAAAs. In 6.1% (n = 27), the size of either nontreated aneurysm was more than 30 mm at the initial AAA surgical treatment, and 5 patients died in the late period as a result of ruptured TAA/TAAA or of fatal complications after an elective graft replacement for either aneurysm. By Cox hazard multivariate regression, neither the history of nontreated TAA/TAAAs nor of aortic dissection was the predictive factor for late mortality. Careful observation and adequate treatment are important for better long-term survival, including surgical or nonsurgical treatment, because of generalized atherosclerosis, of which AAA is the one manifestation.

The predictive risk factor for early mortality was only the emergency operation. The strongest predictors for late mortality included an age of 80 years and over, male gender, chronic renal failure with serum Cr level equal to or exceeding 1.5 mg/dl, a history of atherosclerotic obliterans, and emergency operation resulting from the Cox hazard multivariate analysis. Surgical treatment is therefore recommended in elective settings for octogenarians and also for younger patients, and close follow-up is necessary for patients having a high risk of late mortality.

The surgical treatment for AAA, even in elderly patients, did not exceed the risk of rupture and did not impair the quality of life. By the Kaplan-Meier life table analysis, the 5-year survival rate after the elective surgical treatment was 62.9% in the octogenarians and 90.4% in patients less than 80 years old. This rate is considered to be an excellent late outcome of surgical treatment for octogenarians, compared with the 5-year survival rate of Japan's general population aged 80, which was 50%.[5,12] In this study, patients aged 80 years and over who had survived had kept their previous lifestyles with independent activities of everyday life. The 3-year survival rate was similar in the octogenarians and younger patients (90.9% and 92.9%, respectively), and 86.1% of octogenarians who survived had returned to their preoperative environments and lifestyles, except for those who were transferred to nursing or extended care facilities.

Conclusions

The surgical treatment for AAA in octogenarians had comparable results with the younger patients in either the elective or emergency settings. We believe that the optimal method to reduce the high mortality rate of emergency AAA operations is to repair AAA in the elective setting with early diagnosis. The extension of indications for AAA elective surgery in octogenarians might lead to a lower rate of emergency settings and subsequently to better early and late surgical results.

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