Open abdominal aortic aneurysm repair in octogenarians before and after the adoption of endovascular grafting procedures

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Objective: **This study evaluated (1) elective open abdominal aortic aneurysm repair (OAR) in patients aged ≥80 years before and after stent graft devices for endovascular aneurysm repair (EVAR) became commercially available and (2) the effect on perioperative (30-day) outcome of the anatomic constraints that led to EVAR being excluded for many of them.**

Methods: **A review was conducted on the records of 111 patients aged ≥80 years who underwent elective OAR during a 14-year period at the University of Padua School of Medicine. Patients were separated into two groups: group 1 (n = 65) had OAR before and group 2 (n = 46) after an EVAR program was adopted at the medical school in mid-2000. Perioperative death and morbidity, location of proximal aortic clamp, management of the left renal vein, associated iliac aneurysmal or occlusive diseases, the type of surgical reconstruction, operating time, and lengths of stay in the intensive care unit and the hospital were recorded. All the data were compared between the two groups.**

Results: **Retroperitoneal approach, suprarenal clamping, left renal vein division, and longer operating room time were statistically more common in group 2 (36.9% vs 12.3%, $P = .002$; 15.2% vs 3.1%, $P = .032$; 23.9% vs 7.7%, $P = .026$; and 117 ± 8 min vs 95 ±7 min, $P < .001$, respectively). Although group 2 had significantly more iliac aneurysms (52.1% vs 32.3%; $P = .036$), the number of bifurcated reconstructions was comparable. The overall perioperative mortality rate was 1.8% (2 of 111), and the figures for groups 1 and 2 were comparable (3.1% vs 0%; $P = .510$). No deaths were cardiac related. Group 2 had a significantly higher incidence of kidney failure (8.7% vs 0%; $P = .027$). Kaplan-Meier analysis showed an overall 3-, 5-, and 10-year survival rate of 80.6%, 67.2%, and 59.4%, respectively, with a 3- and 5-year survival rate comparable between groups 1 and 2 (77.8% and 66.7% vs 87.8% and 45.8%, respectively; log-rank test, $P = .921$).**

Conclusions: **Octogenarians can tolerate OAR with acceptable rates of perioperative mortality and morbidity. Although the complexity of OAR has increased significantly in the era of EVAR, the perioperative outcome has not changed.**
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Abdominal aortic aneurysm (AAA) is an age-related disease accounting for 1% to 2% of all deaths.[1] Longevity has increased in the last century, and survival >80 years is now common in all industrialized countries.[2] As a greater proportion of the population lives longer, it is realistic to expect more elderly people to be considered for AAA repair. Although morbidity and mortality rates after AAA repair have continued to drop significantly during the last decades,[3-5] octogenarians are generally approached with reserve when it comes to the surgical management of AAA because the medical comorbidities so often accompanying older age (rather than age in itself) are commonly considered significant risk factors for major surgery.[6]

In the current era of endovascular alternatives to the treatment of aneurysmal disease, debate is evolving about whether high-risk patients with an AAA, such as elderly patients, are best treated with an open (OAR) or an endovascular AAA repair (EVAR), although it is commonly assumed that the less-invasive nature of EVAR makes it particularly suited to patients at high risk of faring poorly with OAR.[7]

EVAR is not currently applicable to all patients, however, for a variety of anatomic reasons, including inadequate size of the AAA neck (absent, too short, too large, or flared) or excessive angulation that precludes satisfactory proximal fixation, or owing to the associated presence of iliac aneurysmal (uncertain distal fixation and risk for pelvic ischemia) or iliac occlusive diseases (difficult vascular access), or both.[8-10] These constraints may mean that many patients cannot be considered for EVAR and have to be recommended for OAR, thus influencing patient selection and modifying the technical management of OAR, that is, the more anatomically favorable AAA is repaired by EVAR and the more complex AAA is left to OAR.

This study evaluated the perioperative (30-day) and long-term outcomes of patients aged ≥80 years who underwent OAR at University of Padua School of Medicine before and after stent graft devices for EVAR become commercially available and analyzed whether the anatomic conditions that ruled out EVAR could affect the perioperative outcome.

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METHODS

Patients. Since 1992, pertinent clinical data for all consecutive patients undergoing elective OAR of infrarenal and juxtarenal AAA at our institution have been prospectively entered into a computer-based vascular registry. By definition, an AAA is considered juxtarenal if it does not involve the renal arteries but extends proximally up to their origin, leaving no space for infrarenal aortic clamping and requiring either suprarenal or supravisceral cross-clamping for proximal control; in pararenal AAAs, one or both renal arteries are involved in the AAA, making their reimplantation necessary.[11]

The database was queried to identify patients aged ≥80 years who underwent OAR during the study period (1992-2005), and particularly before (group 1) and after (group 2) an EVAR program began at the University of Padua School of Medicine in mid-2000. Patients with a ruptured AAA or who needed an emergency operation, patients with suprarenal or pararenal AAA, and those who required late conversions secondary to the EVAR failure were excluded from the analysis. The study was undertaken in compliance with the local ethical committee standards.

During the study period, many octogenarians with an infrarenal AAA >5.5 cm maximum diameter on ultrasound scan at the time of their first examination, referred to our institution specifically for an opinion concerning the surgical repair of their AAA, were turned down for surgery by an experienced vascular surgeon on clinical grounds alone. Patients with impaired mental faculties, malignancies with a poor life expectancy, or severe cardiovascular or respiratory function impairments were considered too ill for surgery and discouraged from OAR or, in the second half of the study period, offered an EVAR procedure. In dubious cases, patients were admitted to the hospital for cardiac and respiratory assessment, and a consultant vascular anesthetist reviewed their cases. All patients were informed about the pros and cons of OAR by the same vascular surgeon, and some patients considered the risk of the surgical procedure unacceptable and refused OAR.

Demographic variables, preoperative risk factors and comorbidities, the American Society of Anesthesiology (ASA) classification, and perioperative outcomes of the study patients were obtained from the database and supplemented from the hospital's computer-based medical record system and chart review.

Between August 2000 and December 2005, 13 octogenarians with AAAs were treated with EVAR. Demographic and risk factors data were collected on these patients and compared with the data for the OAR population in group 2.

Risk factors. To define the cardiac risk, cardiovascular history was carefully assessed, and resting electrocardiogram (ECG) and transthoracic Doppler echocardiograms were obtained in all cases. Cardiac disease included a history of myocardial infarction (MI), a positive exercise test result, chest pain due to ischemia, atrial fibrillation, coronary artery angioplasty/stenting or bypass grafting (CABG), surgery for valve disease or signs of ischemia on ECG, and nitrate therapy.

All patients with a history suggestive of coronary artery disease (CAD) or with abnormalities revealed by the ECG were examined before OAR by a consultant from the cardiology division, whose assessment sometimes prompted noninvasive testing of left ventricular function or coronary perfusion using dipyridamole-thallium scan or dobutamine stress echocardiography. Patients with positive noninvasive test results generally underwent cardiac catheterization to determine any presence and severity of CAD or valvular heart disease. According to the results of this evaluation, patients with CAD that could be revascularized were generally treated with coronary artery angioplasty/stenting or CABG before OAR. Patients who had previously undergone CABG were examined as described when they were clinically symptomatic or when the CABG had been performed >2 years before OAR.

The medical therapy for patients not requiring revascularization or with CAD that could not be revascularized was optimized before OAR. Dobutamine stress echocardiography revealed abnormalities in 29 patients (26.1%), and they were evaluated with coronary angiography before OAR. Significant CAD was diagnosed in 11 (9.9%), who underwent either CABG (n = 7) or coronary angioplasty (n = 4) at median of 5 months before OAR. Three other patients were diagnosed with severe valvular disease, and they underwent valvular replacement.

Pulmonary disease was defined as a history of chronic restrictive or obstructive disease based on pulmonary function tests, pulmonary embolism, or prior lobectomy or pneumonectomy. Chronic kidney disease (CKD) was defined as a serum creatinine level >1.5 mg/dL in either conservative or dialysis treatment.

Data collection. Two surgeons collected data from the surgical reports, paying attention to the location of the proximal aortic clamp, the need to divide the left renal vein (LRV) close to the vena cava, the concomitant presence of aneurysmal or occlusive disease, and the type of reconstruction. To assess any problem situations in the surgical procedure due to particular anatomic or technical features capable of affecting the perioperative outcome, these technical data were analyzed for the two periods. The AAA proximal neck features (length <15 mm; diameter >29 mm; angulation >60°) and other reasons why EVAR had been ruled out for most of the octogenarians who then underwent OAR were also recorded.

Arteriography and computed tomography (CT) or magnetic resonance imaging (MRI) scans were obtained in most patients early in the study period, whereas CT or MRI scans alone were used in the latter part of the study.

Surgical procedure. All OARs were performed under general anesthesia by the same surgeon, and an epidural catheter was used for postoperative pain management in most patients. Repair was usually through a transabdominal approach, although a left retroperitoneal access was used in many patients. All patients received a radial artery catheter and were intravenously administered heparin (5000 U) before aortic cross-clamping; heparinization was never reversed with protamine sulphate on removal of the clamp. Patients who required suprarenal clamping were administered furosemide and mannitol before aortic clamping. Selective renal perfusion was not used. A cell saver was used routinely. Operating room time, intensive care unit stay, and hospital length of stay were also recorded.

Study end point. The primary end point was perioperative death and major complications. Cardiac complications were classified by the consultant cardiologist and included (1) MI with a diagnosis based on creatinine kinase-MB levels and ECG findings, (2) pulmonary edema confirmed by chest radiography, (3) documented ventricular fibrillation or primary cardiac arrest, and (4) new complete heart failure requiring a pacemaker. A postoperative ECG was routinely obtained in all patients with a history of CAD, congestive heart failure (CHF), or arrhythmia (rhythm other than sinus). Cardiac isoenzymes were obtained in all patients who had new findings at postoperative ECG.

Pulmonary adverse events were defined as respiratory failure requiring intubation for >2 days or reintubation, noncardiogenic pulmonary edema, lobar pneumonia confirmed by chest radiography and requiring antibiotic therapy, and pulmonary embolism documented by autopsy, angiography, or a high-probability ventilation-perfusion scan. An acute renal dysfunction was defined as an increase in serum creatinine level of >2.0 mg/dL in conservative treatment. Additional outcomes included overall complications, 6-month mortality, and 10-year cumulative survival.

Our practice is to see patients with uncomplicated conditions at 6 months, 1 year, and then every 3 to 5 years with a CT scan of the descending thoracic aorta and the visceral aortic segment to rule out any new proximal aneurysms. Complete follow-up information was collected by review of the outpatient records and a telephone canvass of patients, their surviving family members, or their referring physicians.

Statistical analysis. The Student *t* test was used for continuous data and the χ^2 analysis or Fisher exact test (two tailed), as appropriate, for categoric data. Kaplan-Meier life-table analysis was used to estimate survival rates, and curves were compared with the log-rank test. Significance was inferred at $P < .05$. Cox proportional hazards multivariate analysis was used to determine which factors with statistical or marginal significance at univariate analysis could influence the perioperative and postoperative outcome.

RESULTS

During the study period, 11 octogenarians (9 before and 2 after adopting the EVAR procedure) were turned down for surgery, and eight (all in group 1) refused OAR. Elective OAR was performed in 111 patients aged ≥80 years, and 46 (41.4%) were in group 2. The preoperative demographic data, risk factors, and some anatomic and operative features of the two groups are shown in Tables I and II. The differences between the two groups in terms of their demographic and risk factor data were not statistically significant. The mean age was 84.1 ± 2.3 years in group 1 (range, 80 to 91 years) and 83.7 ± 2.8 years (range, 81 to 90 years) in group 2. The size of the AAA (transverse diameter) was statistically larger in group 1 (7.2 ± 1.5 cm vs 6.7 ± 0.4 cm, $P = .020$). A retroperitoneal approach, suprarenal cross-clamping, and LRV division were statistically more frequent in group 2 (36.9% vs 12.3%, $P = .002$; 15.2% vs 3.1%; $P = .032$, and 23.9% vs 7.7%; $P = .026$, respectively).

Table I. Demographics and risk factors of patients undergoing open abdominal aortic aneurysm repair

	All patients (N = 111)		
*Characteristics**	*Group 1*[†]	*Group 2*[†]	*P*
Total	65 (58.6)	46 (41.4)	
Age, y	84.09 ± 2.3	83.7 ± 2.8	.388
Male	46 (70.1)	33 (71.7)	.912
AAA size, cm	7.2 ± 1.5	6.7 ± 0.4	.020[‡]
Risk factors			
Smoking	50 (76.9)	29 (63.0)	.112
Diabetes	24 (36.9)	11 (23.9)	.146
Hyperlipidemia	14 (21.5)	9 (19.5)	.801
Hypertension	37 (56.9)	22 (47.8)	.344
Cardiac disease	29 (44.6)	18 (39.1)	.565
CKD	11 (16.9)	8 (17.4)	.949
Pulmonary disease	25 (38.5)	18 (39.1)	.943
Concomitant	28 (43.1)	20 (43.4)	.966
PAD			
CVD	19 (29.2)	14 (30.4)	.891
ASA score ≥3	24 (35.3)	12 (28.2)	.230

AAA, Abdominal aortic aneurysm; *CKD,* chronic kidney disease; *PAD,* peripheral arterial disease; *CVD*, cerebrovascular disease; *ASA*, American Society of Anesthesiologists.
*Continuous data are presented as mean ± SD; categoric data as number (%).
[†]Group 1 patients underwent open aneurysm repair before an endovascular aneurysm repair program was established; group 2 had repair after the program was established.
[‡]Statistically significant.

Although the incidence of occlusive arterial disease did not change during the two periods, group 2 had a significantly higher rate of associated iliac aneurysms (52.1% vs 32.3%; $P = .036$). The number of aortoaortic (tube graft), and aortofemoral or aortoiliac reconstructions was comparable for the two groups. The operating time was significantly longer in group 2 (117 ± 8 min vs 95 ± 7 min, $P < .001$), but both groups had comparable the lengths of stay in the intensive care unit and the hospital. The reasons why group 2 patients were unfit for EVAR are summarized in Table III.

During the second half of the study period, 13 octogenarians were treated with EVAR in addition to the 46 who had OAR, representing 22% of all AAAs treated. These patients were a mean 1 year older than group 2 patients and had a significantly higher incidence of diabetes mellitus (61.5% vs 23.9%, $P = .018$). The incidence of CKD and pulmonary disease was lower in the EVAR group and higher for concomitant PAD and ASA score ≥3, but the differences did not reach statistical significance. The two

Table II. Technical details and anatomic or operative features of patients undergoing open abdominal aortic aneurysm repair

	All patients (N = 111)		
*Technical/operative details**	*Group 1*[†]	*Group 2*[†]	*P*
Total	65 (58.6)	46 (41.4)	
Transperitoneal approach	57 (87.7)	29 (63.1)	.002
Retroperitoneal approach	8 (12.3)	17 (36.9)	
Infrarenal clamp	63 (96.9)	39 (84.8)	.032
Suprarenal clamp	2 (3.1)	7 (15.2)	
LRV division	5 (7.7)	11 (23.9)	.026
Iliac aneurysm	21 (32.3)	24 (52.1)	.036
Iliac occlusive disease	11 (16.9)	10 (21.7)	.523
AF reconstruction	8 (12.3)	7 (15.2)	.659
AI reconstruction	21 (32.3)	15 (26.7)	.973
AA reconstruction	36 (55.3)	24 (52.1)	.738
EBL, mean mL	1863	2169	.079
Operating time, min	95 ± 7	117 ± 8	<.001
Length of stay, d			
ICU	2.8 ± 2	3.5 ± 3	.143
Hospital	7.5 ± 5	8.1 ± 6	.567

AAA, abdominal aortic aneurysm; *LRV,* left renal vein; *AF,* aortofemoral; *AI,* aortoiliac; *AA,* aortoaortic; *EBL,* estimated blood loss; *ICU,* intensive care unit.

*Continuous data are presented as mean ± SD; categoric data as number (%).

[†]Group 1 patients underwent open aneurysm repair before an endovascular aneurysm repair program was established; group 2 had repair after the program was established.

Table III. Reasons for exclusion from endovascular aneurysm repair

Criteria	*No. (%)*
AAA neck anatomy	24 (52.2)
Absence of a neck	4
Short neck*	12
Large-diameter neck[†]	5
Angled neck (>60°)	3
Iliac aneurysm	9 (19.6)
Iliac occlusive disease	6 (13.0)
Patient preference	5 (10.9)
Surgeon preference	2 (4.3)

AAA, Abdominal aortic aneurysm.

*Mean, 6 mm (range, 5-9 mm).

[†]Mean, 33 mm (range, 31-38 mm).

groups had comparable rates of hyperlipidemia, hypertension, cardiac disease, and cerebrovascular disease.

Perioperative mortality and morbidity. No operative deaths occurred in groups 1 and 2. Two perioperative deaths (1.8 %) occurred in group 1 (3.1% vs 0%; $P = .510$): one patient died of multisystemic organ failure and the other of pulmonary insufficiency secondary to an overwhelming pneumonia (Table IV). The overall and major morbidity rates were 26.1% and 5.4%, respectively. Details of major and minor 30-day morbidities are listed in Table IV. Although groups 1 and 2 had comparable overall major morbidity (3.1% vs 8.7%, $P = .230$), the incidence of kidney failure was significantly higher in group 2 (8.7% vs 0%, $P = .027$). Minor morbidity was similar (group 1, 20% vs group 2, 21.7%; $P = .824$).

Long-term results. No deaths occurred at 6 months in this series. There were 33 late deaths (30.2%) in the series as a whole. The main causes were cardiac in 15 patients (45.4%), consisting of 9 with MI, 5 with CHF, and 1 arrhythmia; cancer in 6 (18.2%); pulmonary in 3 (9.1%) and renal in 1, due to a worsening renal insufficiency (3%). Miscellaneous events were responsible for seven other deaths (21.2%), and the cause of death was unavailable for one patient (3%). Three patients in group 1 were lost during a median follow-up of 27 months.

Kaplan-Meier analysis showed survival rates of 80.6% at 3 years, 67.2% at 5 years, and 59.4% at 10 years for the whole series (Fig 1), with a comparable 3- and 5-year survival rate of 77.8% and 66.7% for group 1 vs 87.8% and 45.8% for group 2 (log-rank test, $P = .921$; Fig 2). At univariate analysis, only cardiac disease resulted a predictor for late death, but this factor revealed no significant influence at multivariate analysis (Table V).

Late graft complications. Apart from the two patients who died perioperatively and the three lost to follow-up, 106 patients were eligible for the assessment of late complications after aortic replacement grafts. We identified only two late graft complications (1.9%), including one graft limb occlusion in a patient with an aortobifemoral graft and one distal aortic pseudoaneurysm in a patient with a tube graft insertion.

DISCUSSION

The AAA geriatric population is clearly a clinical challenge. Until a decade ago, no therapeutic alternative to OAR was available for patients with AAA, and given results of AAA natural history studies, watchful waiting would seem an appropriate clinical recommendation for those with the most extreme medical comorbidities, old age being just one of the many potential risk factors. This explains why 11 octogenarians with infrarenal AAA were turned down for surgery during the study period and eight refused OAR after a careful evaluation of the surgical risks.

Given its less-invasive nature, EVAR has expanded the indications for repair, offering a relatively better chance for those at higher risk for OAR of effectively excluding their AAA and preventing rupture with a considerably lower physiologic stress. In recent years, many patients aged ≥80 years with AAA have specifically or exclusively requested EVAR, having learned about this "less-invasive" treatment from the media or their personal physician; however, EVAR can only be performed in patients with a specific aortic anatomy. The decision whether or when to perform OAR in octogenarians denied EVAR because of their aortic anatomy ultimately lies with the patient after a thorough discussion with the vascular surgeon of the risks of surgery weighed against the risks of conservative management.

The main outcome of this study is a 1.8% overall perioperative mortality rate, with a comparable mortality rate between patients in groups 1 and 2 (3.1% vs 0%), a

Table IV. Perioperative morbidity and mortality

30-day outcome	*Group 1, No. (%)**	*Group 2, No. (%)**	*Total, No. (%)*	*P*
Total	65 (58.6)	46 (41.4)		
Death	2 (3.1)	0	2 (1.8)	.510
Major morbidity	2 (3.1)	4 (8.7)	6 (5.4)	.230
Myocardial infarction	0	0	0	
Renal failure	0	4 (8.7)	4	.027
Pneumonia	2 (3.1)	0	2	.510
Other (minor) morbidity	13 (20.0)	10 (21.7)	23 (20.7)	.824
Iliac vein injury	0	2 (4.3)	2	.170
Ureteral injury	0	1 (2.2)	1	.414
Arrhythmia	4 (6.1)	1 (2.2)	5	.401
Protracted ileus	3 (4.6)	2 (4.3)	5	1
Inguinal lymph leak	5 (7.7)	3 (6.5)	8	1
Peripheral emboli	1 (1.5)	1 (2.2)	2	1

*Group 1 patients underwent open aneurysm repair before an endovascular aneurysm repair program was established; group 2 had repair after the program was established

figure that correlates well with the 3.2% mean mortality rate reported by Rutherford and Krupski[12] in a survey of 30 peer-reviewed reports from 1990 to 2002 on OAR performed in elderly and younger patients at centers of excellence with sizeable series (n = 9291).

Although many authors reported a perioperative mortality rate of >7% for octogenarians after OAR,[13-16] we found that such patients can tolerate OAR with acceptable perioperative death rate, confirming the results obtained in many early reports,[7,17-25] which in some series even approached the results achieved in younger cohorts (Table VI). In addition, the nil 6-month mortality rate was reassuring, meaning that the relative safety of surgery was not limited to the first 30 days. Although the aim of our study was not to compare OAR with EVAR, it may worth adding that the perioperative mortality rate was comparable with or better than that reported in recently published large series concerning octogenarians treated with EVAR[26,27]; this is particularly noteworthy considering that the perioperative mortality rate was 0% in group 2, among which were patients whose aortic anatomy precluded EVAR.

Although CAD is reported as the first cause of perioperative death in older patients undergoing OAR,[6] and patients with documented CAD at the time of OAR are predicted to have shorter survival,[28,29] the only two deaths in our series were not cardiac-related, and there were no major cardiac complications. Like other authors,[13,23] we also believe that optimizing preoperative cardiac status contributes substantially to the safety of elective OAR in elderly patients. That is why we adopted an aggressive screening protocol to ensure an appropriate medical therapy (statins or β-blockers) or surgical treatment (coronary artery angioplasty/stenting or CABG) before OAR, which reduced the cardiac-related perioperative mortality and

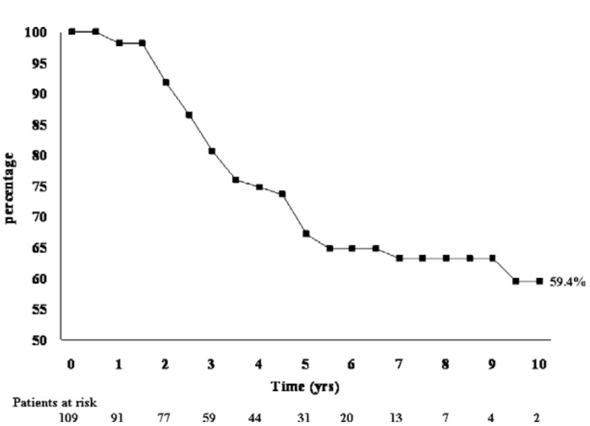

Fig 1. Kaplan-Meier curve shows long-term survival of all the patients. The percentage on the right represents the rate of survival at 10 years. The standard error is <10% at each time point in the curve (range, 0% to 9.2%). Raw numbers of the patients at risk analyzed at each time point are provided below the figure.

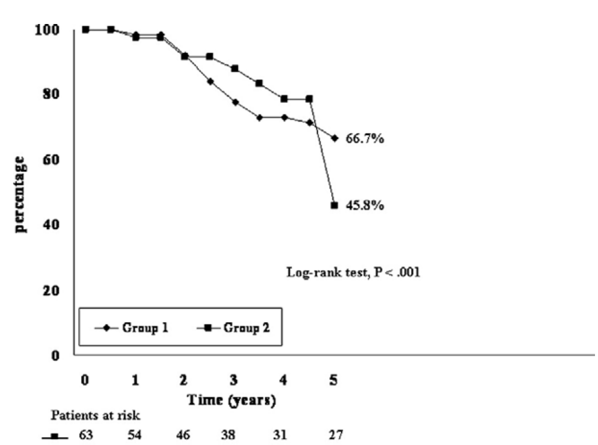

Fig 2. Kaplan-Meier curves show long-term survival of patients in groups 1 *(diamonds)* and 2 *(squares)*. The percentages on the right represent 5-year survival rates. The standard error is <10% at each time point in the group 1 curve (range, 0% to 5.8%). The standard error is less than 10% until the 4-year point in the group 2 curve (range, 0% to 8.8%) and 19.5% at the 5-year point. Raw numbers of the patients at risk analyzed at each time point are provided below the figure.

Table V. Univariate analysis of preoperative variables on long-term survival

Variable	*P*
Male gender	.753
Smoking	.290
Diabetes	.246
Hyperlipidemia	.526
Hypertension	.151
Cardiac disease	.045
Chronic kidney disease	.384
Pulmonary disease	.159
Concomitant PAD	.348
Cerebrovascular disease	.647
ASA score ≥3	.751
Transperitoneal approach	.831
Retroperitoneal approach	
Infrarenal clamp	.835
Suprarenal clamp	
Left renal vein division	.277
Iliac aneurysm	.773
Iliac occlusive disease	.295
Aortofemoral reconstruction	.882
Aortoiliac reconstruction	.790
Aortoaortic reconstruction	.628

PAD, peripheral arterial disease; *ASA,* American Society of Anesthesiologists.

Table VI. Data on perioperative mortality rate from studies of octogenarians undergoing elective open abdominal aortic aneurysm repair

First author	*Year*	*Patients*	*30-day death (%)*
Harris[17]	1986	34	2.9
Robson[18]	1989	14	0
Glock[19]	1990	29	6.9
Paty[20]	1993	77	2.6
Dean[21]	1993	18	5.6
O'Hara[13]	1995	94	9.6
Van Damme[22]	1998	52	5.7
Kazmers[14]	1998	206	8.3
Dardik[15]	1999	246	7.3
Sicard[7]	2001	38	5.3
Haug[16]	2005	105	10.5
Dainese[23]	2006	31	3.1
Costin[24]	2006	606	3.0
Manis[25]	2006	78	1.3
Present series	2007	111	1.8

morbidity in the cohort with CAD in about 10% of the patients.

Our survival rates at 3, 5, and 10 years are significantly better than those reported in many early institution-based series[13,16,22] in which the 5-year survival rate was always <50%. This probably reflects both the relatively good general health of most of our patients (>65% of them had an ASA score <3) and the careful preoperative cardiac management of such patients, focusing on CAD. Although almost half of the late deaths were cardiac-related, our findings are remarkably similar to those reported in patients with perioperative diagnosis of CAD who had coronary revascularization before OAR. O'Hara et al[13] reported a 5-year survival rate of 80% in 27 octogenarians who underwent prior myocardial revascularization vs 38% for the 70 others who did not. More recently, Dainese et al[23] recorded a 4-year survival rate of 81% in a series of 31 octogenarians who underwent OAR, and 6.5% of them underwent myocardial revascularization before OAR.

Although the perioperative mortality and overall complication rates were comparable between the two groups in our study, managing the OAR after adopting EVAR proved technically challenging. More than half of the group 2 patients were rejected for EVAR owing to unsuitable anatomy of the AAA neck, and this meant a different management of the proximal aortic control, with significantly more suprarenal cross-clamping and LRV division in group 2 (five and three times more often, respectively) and a significantly longer operating time.

Suprarenal cross-clamping reportedly coincides with a higher perioperative rate of mortality and morbidity because it involves more complex surgical maneuvers, wider dissections, and the temporary exclusion of the kidney from blood flow,[30] whereas LRV division has been identified as an independent predictor of postoperative kidney failure.[31,32] These maneuvers probably accounted for the significantly higher incidence of transient kidney failure in group 2 (overcome during the hospital stay, with no long-term dysfunctions or need for dialysis) that is consistent with the transient renal insufficiency found by Breckwoldt et al[30] in a study comparing infrarenal with suprarenal cross-clamping during OAR and that confirms the deterioration in renal function seen by other authors after LRV division.[31,32]

Likewise, an unfavorable aortic neck anatomy requiring pararenal exposure and suprarenal clamping accounted for the statistically more frequent reliance on a retroperitoneal approach in group 2. A similar figure was reported in a landmark retrospective study by the Montefiore Medical Center group[33] focusing on the role of OAR in the endovascular era and showing that the retroperitoneal approach may be particularly useful to facilitate OAR in difficult circumstances, enabling it to be performed with acceptable mortality and morbidity rates.

Managing iliac aneurysms associated with infrarenal AAA is likely to entail more complex reconstructions and longer operating times, more intraoperative blood loss, and the likelihood of neighboring venous and ureteral injury, resulting in a higher rate of aortofemoral or aortoiliac reconstructions. Iliac aneurysmal disease was statistically more frequent in group 2, involving more than half the patients, but although the minor perioperative morbidity rate was higher in group 2, the difference was not statistically significant. In addition, although the number of bifurcated reconstructions was higher in group 2, the difference was likewise not statistically significant. A possible explanation for this finding lies in that most of the patients unfit for EVAR because of an unsuitable neck anatomy may have had more tube graft reconstructions that balanced the patients with aneurysmal iliac disease who would have needed bifurcated reconstructions.

Our findings should be interpreted in the light of the study's limitations. First, although the data were collected prospectively, the analysis is retrospective in nature.

Second, the study was conducted on a selected group of relatively healthy patients with an active life and a longer perceived life expectancy than the average for octogenarians. They are not representative of the octogenarian population with AAA as a whole because they reflect a preselection made by the physicians referring patients at our institution, who probably chose patients with a longer life expectancy, preferring medical management for patients with multiple comorbidities and a worse general health.

Third, all OARs were performed electively by the same surgeon. This may help to explain the low mortality and morbidity rates, which cannot be influenced by having excluding EVAR patients from the group 2 data because they do not seem to be at higher risk than the group 2 patients, and why our results cannot be extrapolated to the population in general.

The aim of the study, however, was to provide information on the outcome of OAR in octogenarians. With the ageing of our population and the rising numbers of elderly people unfit for EVAR, the relevance of such information can be expected to increase.

CONCLUSION

This study has shown that octogenarians may tolerate OAR with acceptable perioperative mortality and morbidity rates that could serve as a standard against which to compare any alternative therapy and to bear in mind when advocating nonoperative management or expanding the indication for EVAR. Many octogenarians who are denied EVAR because of their aortic anatomy still carry a relatively low risk for OAR and can undergo this type of repair with excellent results.

AUTHOR CONTRIBUTIONS

Conception and design: EB, GDG, BM
Analysis and interpretation: EB, BM
Data collection: AB, AP, MG
Writing the article: GDG, BM
Critical revision of the article: EB, GDG
Final approval of the article: EB, GDG, AB, AP, MG, BM
Statistical analysis: AB
Obtained funding: Not applicable
Overall responsibility: EB, BM

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