Elective endovascular and open repair of abdominal aortic aneurysms in octogenarians

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Objectives: **Endovascular aortic aneurysm repair (EVAR) is an increasingly popular treatment option for patients with abdominal aortic aneurysms (AAA), although open repair is considered the standard by virtue of its durability. Octogenarians, as a subgroup, may stand to benefit the most by EVAR. The purpose of this study is to review operative results and durability of open AAA repair and EVAR in octogenarians.**

Methods: **From May 1996 to August 2006, 150 patients aged ≥80 years underwent elective repair of their infrarenal AAA. Eighty-one underwent EVAR and 69 had open repair. Demographic data, aneurysm specifics, comorbidities, operative morbidity and mortality, intensive care unit and hospital length of stay, and late outcomes were analyzed.**

Results: **In the EVAR group, 27 of 81 (33%) patients died during a mean follow-up of 25 months. In the open repair group, 34 of 69 (49%) patients died during a mean follow-up of 43 months. The median survival time for EVAR was 350 weeks (range, 145-404 weeks) compared with 317 weeks (range, 233-342 weeks) for the open repair group. A Kaplan-Meier log-rank analysis showed no difference in early or long-term survival between EVAR and open repair (*P* = .13). EVAR was associated with decreased blood loss, decreased length of intensive care unit and hospital stays, and a greater number of patients discharged to home.**

Conclusions: **EVAR and open repair are comparable in safety and efficacy in octogenarians. Operative repair outcomes remain acceptable. Mid- and long-term survival are similar, indicating no survival advantage of one procedure compared with the other. (J Vasc Surg 2008;47:924-7.)**

Perhaps the most remarkable paradigm shift in the care of patients with vascular disease has been the development and rapid acceptance of endovascular repair of abdominal aortic aneurysms (AAA). Endovascular aneurysm repair (EVAR) enjoys the benefits of less blood loss, shorter hospital stay, and fewer discharges to an intermediate care facility.[1-3] In higher-risk patients, however, it is associated with a 2% per year aneurysm-associated death rate when averaged over 4 years.[4] Open aneurysm repair is recognized as a more durable procedure requiring less intense follow-up and fewer postprocedural interventions. Meanwhile, our population is aging, with a growing percentage of individuals living into their 80s and beyond, which raises the questions of whether age by itself is a risk factor for adverse outcomes during repair of AAAs and whether EVAR is the preferred technique.

Several studies have shown that age increases the perioperative mortality rate in both open aneurysm repair and EVAR.[1,5-9] A definitive comparison of open aneurysm repair with EVAR in octogenarians is lacking, with only two reports to date with a limited numbers of patients.[10,11] Furthermore, available data on follow-up of AAA repair in octogenarians are limited, with the longest being 36 months.[1,6,10,12-14] Reports indicate that there is a decrease in operative morbidity with EVAR; however, overall mortality rates are similar to open repair.[10,11] Physicians intuitively favor EVAR vs open repair in octogenarians, believing that older patients face a higher likelihood of procedure-related death with conventional open repair.

At our center, both open repair and EVAR have been performed since 1996. A recent report from our center comparing open aneurysm repair with EVAR showed no survival benefit for EVAR in any age group.[1] The purpose of this analysis is to specifically investigate AAA repair in octogenarians and to determine whether age alone is a risk factor for procedure-related and long-term death in AAA patients.

METHODS

Between June 1996 and August 2006, 777 patients underwent elective repair of an infrarenal AAA, 150 of whom were aged ≥80 years and are the focus of this analysis. Data were prospectively entered into a vascular registry and retrospectively analyzed. The operating room database and surgeon case lists were also used to corroborate data. Patient-related and AAA-related information were recorded from these databases in addition to lab records, operative notes, physician notes, and radiology records. The study was approved by our Institutional Review Board. Patients with ruptured aneurysms and aneurysms involving the renal arteries were excluded from this analysis.

The type of repair was decided by the vascular surgeon, patient preference, and aneurysm anatomy. Devices used for the EVAR group included 4 Vanguard (Boston Scientific, Natick, Mass), 1 Lifepath (Edwards, Irvine, Calif), 8 Zenith (Cook, Bloomington, Ind), 56 Talent and AneuRx

From the Jobst Vascular Center.

Competition of interest: none.

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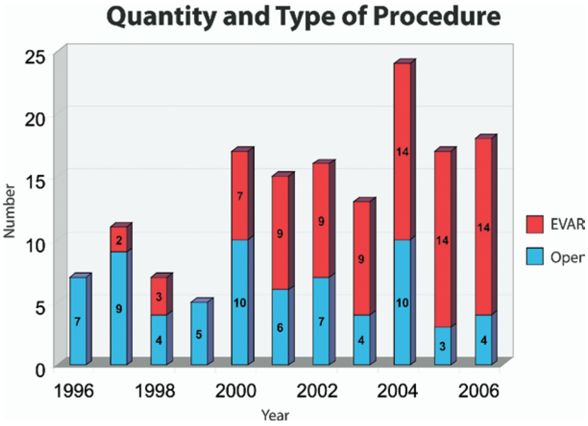

Fig 1. Graphic representation of quantity and type (EVAR, *red bars*; open, *blue bars*) of abdominal aortic aneurysm repair by year. *EVAR*, Endovascular aneurysm repair.

(Medtronic, Santa Rosa, Calif), 1 AnCure (Guidant, Indianapolis, Ind), 2 PowerLink (Endologix Inc, Irvine, Calif), and 9 Excluder (W. L. Gore & Associates, Flagstaff, Ariz).

Computed tomography (CT) scans and arteriography were obtained in nearly every case of EVAR early in the experience and evolved to CT scans alone as the sole imaging method during the latter part of the study. CT scans were the predominant imaging method for patients having open repair.

Main outcome measures were operative death (defined as death <30 days of the procedure or during the same hospitalization, whichever was longer), blood loss, length of hospital stay, discharge to home, and long-term mortality.

The EVAR group was monitored with physical examination, serial CT scans, and plain abdominal radiographs at 1, 6, 12, 18, and 24 months, and yearly thereafter. Patients in the open repair group were monitored at 1, 6, and 12 months with physical examination and yearly thereafter. Postoperative imaging was not routinely performed in patients having open repair. Follow-up data were retrieved from the hospital database, the inpatient and outpatient data systems, and the United States Social Security Registry.

RESULTS

Eighty-one octogenarian patients underwent EVAR and 69 had open repair. The quantity and type of repair with respect to time are illustrated in Fig 1. During the first 6 years, 59% of open repair compared with 26% of EVAR cases were performed, whereas only 41% of open repair and 74% of EVAR cases were performed during the last 5 years of the study. There were 57 men (70.4%) in the EVAR group and 48 (69.6%) in the open group. Comorbidities were equally distributed between the two groups (Table I) with the exception of chronic obstructive pulmonary disease (COPD), which was significantly more prevalent in the open group (37.7% vs 14.8%, $P = .0013$).

Mean follow-up was 25 months (range, 1-80 months) for EVAR and 43 months (range, 1-121 months) for open repair.

Table I. Patient comorbidities

Variable	*EVAR (n = 81)*	*Open (n = 69)*	P
Males, No. (%)	57 (70.4)	48 (69.6)	.9
Age, mean ± SD y	83.7 ± 3.2	83.2 ± 2.8	.4
Family history, No. (%)	3 (3.7)	3 (4.3)	.8
Past smoker, No. (%)	42 (51.9)	38 (55)	.7
Current smoker, No. (%)	8 (11.6)	10 (12.3)	.9
COPD, No. (%)	12 (14.8)	26 (37.7)	.0013
Hypertension, No. (%)	56 (69.1)	51 (73.9)	.5
CAD, No. (%)	42 (51.9)	32 (46.4)	.5
CHF, No. (%)	9 (11.1)	11 (15.9)	0.4

CAD, Coronary artery disease; *CHF*, congestive heart failure; *COPD*, chronic obstructive pulmonary disease; *EVAR*, endovascular aneurysm repair.

Table II. Patient results

Variable	*EVAR (N = 81)*	*Open (N = 69)*	P
Aneurysm size, median cm	5.8	6.2	.04
Blood loss, median mL	325	2800	<.0001
Length of stay, median d	3.0	9.0	<.0001
Discharge to home, No. (%)	69 (86)	40 (58)	<.0001
Operative mortality, No. (%)	4 (5)	6 (8.5)	NS
1-year mortality, No. (%)	10 (12)	12 (17)	NS
3-year mortality, No. (%)	15 (18)	13 (19)	NS
5-year mortality, No. (%)	12 (15)	19 (28)	NS
Survival time, median wks	350 (145-404)	317 (233-342)	NS

EVAR, Endovascular aneurysm repair.

Average age was not different between groups (EVAR, 83.7 ± 3.2; open, 83.2 ± 2.8). Aneurysm size (EVAR, 5.8 ± 1.0 cm; open, 6.2 ± 1.3 cm), blood loss (EVAR, 325 ± 498 mL; open, 2800 ± 1812 mL), and length of hospital stay (EVAR, 3.0 ± 3.2 days; open, 9.0 days ± 7.6 days) were all significantly less in EVAR patients (Table II). Patients having EVAR were discharged to home more frequently than those in the open group (EVAR, 86%; open, 58%; $P < .001$).

Operative mortality was similar in the EVAR and open groups. Mortality rates at 1, 3, and 5 years were similar in the two groups. The EVAR and open patients had similar median survival times of 350 weeks (range, 145-404 weeks) and 317 weeks (range, 233-342 weeks), respectively (Table II). In those patients who died during follow-up, the average time to death was 111 weeks in EVAR vs 155 weeks in open repair ($P = .19$). A life-table analysis showed no difference in operative or long-term survival between EVAR and open repair ($P = .56$; Fig 2). Included in Fig 2 are the survival data for an age- and sex-matched control of

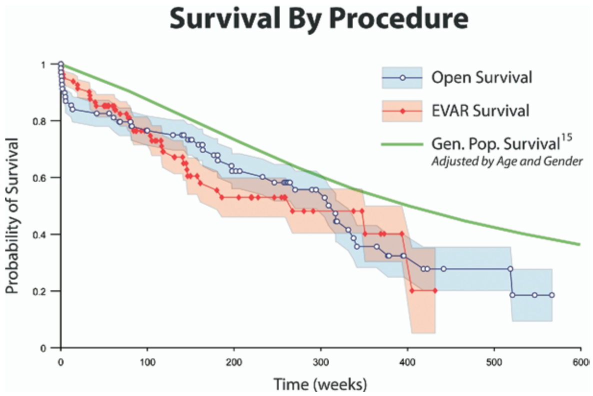

Fig 2. Survival analysis by procedure (open, *circles*; EVAR, *diamonds*) contrasted with survival in general population *(green line)* adjusted by age and sex.

the general population derived from the National Vital Statistics Reports.[15] No known long-term aneurysm-related deaths occurred in the open group, and only one, resulting from delayed ruptured AAA, occurred in the EVAR group. Of interest is a separation of mid-term survival (150 weeks) that favors open repair.

The EVAR group required 13 (17%) secondary interventions. Two type I endoleaks were repaired with proximal aortic cuff placements, a third was repaired with coil embolization, and a fourth with iliac stent placement. Three type II endoleaks were repaired with either coil embolization or thrombin injection, and a fourth was repaired with a direct sac puncture and thrombin injection. A patient with a type IV endoleak died of nonaneurysm-related causes before he could be treated. One proximal migration was treated with aortic cuff placement. Two limb thromboses were repaired with thromboembolectomies, and one groin lymphocele was treated with débridement and closure.

DISCUSSION

Our initial review of perioperative and long-term survival of patients undergoing elective repair of their infrarenal AAA failed to show any difference between open repair and EVAR.[1] Overall, however, age at treatment was a risk factor for operative death. Because the mean age of our patients is increasing, and because an increasing number of our patients will be >80 years, we investigated whether this higher-risk group might be better treated with EVAR. Our analysis of 150 octogenarians failed to show any survival advantage to EVAR compared with open repair, either operatively or long term.

Most published reports on octogenarians analyze EVAR or open repair alone rather than comparing these procedures with each other. In a single institutional analysis, Brinkman et al[12] monitored 31 EVAR patients for a mean of <1 year and showed a 6% perioperative mortality rate and 3% aneurysm-related mortality. Biebl et al[13] provided another single institutional report comparing 49 octogenarians with 133 patients aged <80 years receiving EVAR. The estimated risk of death in octogenarians was 1.8 times that of their younger counterparts ($P = .131$).

A series of 150 octogenarians undergoing EVAR and monitored for a mean of 16.9 months was reported by Minor et al.[14] They demonstrated an operative mortality of 3.3% and long-term mortality of 26.7%. No late deaths were aneurysm-related. The European Collaborators on Stent/Graft Techniques for Aortic Aneurysm Repair (EUROSTAR)[6] analyzed their results in octogenarians undergoing EVAR. Comparisons were made between 697 octogenarians and 4198 of their younger counterparts. Operative mortality was 5% in the octogenarians and 2% in patients aged <80 years. Aneurysm-related mortality was 7% in octogenarians vs 3% in non-octogenarians ($P < .0001$). Our operative mortality in EVAR of 5% for octogenarians and 2.4% for patients aged 70 to 79 matches that of the EUROSTAR study, as does the aneurysm-related mortality in EVAR.

No randomized data have compared open vs EVAR in octogenarians. Only two reports retrospectively compare these two groups of patients. Sicard et al[10] evaluated 38 open and 52 EVAR patients monitored for a mean of 25.2 months and 16.6 months, respectively. Overall, mortality was 5% for open repair and 2% for EVAR ($P =$ NS). Jordan et al[11] addressed "high-risk" patients having aneurysm repair, and age ≥80 was considered high risk. Of those patients aged ≥80 years, 15 had open repair and 33 had EVAR. Age alone did not surface as a risk for operative death. Of interest was that were no differences in complication rates between open and EVAR patients.

More of our patients had open repair early in our series, and most patients had EVAR during the last 5 years. EVAR is our preferred recommendation for octogenarians requiring AAA repair owing to the perceived reduction in morbidity and anticipated reduced mortality. Within the octogenarian group, some patients are considered higher risk than others and EVAR would be preferred. Often, however, these patients had unacceptable anatomy for EVAR. Carpenter et al[16] showed that only 49% of patients considered to be high surgical risk were acceptable candidates for EVAR, whereas 80% of low-surgical-risk patients were candidates for EVAR ($P < .001$). Chronic obstructive pulmonary disease is a particularly worrisome risk factor and was more frequently present in our open repair patients ($P = .0013$). Respiratory failure was responsible for 40% of our operative deaths.

Dainese et al[17] reported an operative mortality of 3% in 30 octogenarians undergoing open AAA repair, with a remarkable 81% surviving to 48 months and 46% surviving to 96 months postprocedurally. All patients underwent a full preoperative evaluation that included dobutamine stress echocardiography. Their outcomes may be the result of selecting a particularly healthy group of patients, chance observations due to a small sample size, or a combination of both.

To our knowledge, our data set is the largest to compare operative and long-term mortality rates between open aneurysm repair and EVAR in octogenarians. A comparison of these data with all patients treated show that age is an independent risk factor for death ($P < .001$). Although the type of AAA repair had an influence on length of hospital stay and blood loss, there was no difference in operative or long-term mortality.

Limitations of this study include its retrospective design and that much of the long-term mortality data were extracted from the national database, which does not provide cause of death. Although our comparative data set is larger than most others, it still may not be robust enough to detect true differences between open repair and EVAR in octogenarians. This will likely be remedied in the future as our population grows and additional patients are added to the database.

CONCLUSION

Our data showed no differences in operative and long-term survival between open aneurysm repair and EVAR in octogenarians. Although age itself is an independent risk factor for death after AAA repair, age is not a factor that would favor EVAR compared with open repair. Therefore, age in general and age ≥80 specifically should not be a consideration in the type of treatment offered to patients with AAA. We confirm that patients aged ≥80 years have an acceptable but a higher mortality risk in both open repair and EVAR.

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AUTHOR CONTRIBUTIONS

Conception and design: DP, SC, AC
Analysis and interpretation: DP, SC, AC
Data collection: DP, SC, JP, DW
Writing the article: DP, SC, AC
Critical revision of the article: DP, AC
Final approval of the article: DP, AC, JP
Statistical analysis: FL
Obtained funding: AC
Overall responsibility: AC

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