Elective surgery of abdominal aortic aneurysms in octogenarians: A systematic review

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Introduction: **Abdominal aortic aneurysm (AAA) is an age-related disease. In an aging population, the prevalence of AAA is likely to increase. Open AAA repair in patients aged >80 years is often not considered because of their advanced age as such or because of comorbidities. In addition, little is known about the natural history in such patients or survival after successful repair. We performed a systematic review of the literature to determine peri-operative and late survival after AAA repair in octogenarians**

Method: **The Medline, Embase, and Cochrane databases were searched to identify all studies reporting on octogenarians undergoing AAA repair published between January 1966 and June 2006. Two independent observers assessed the methodologic quality of the included studies and the data extraction. Outcomes were rates of perioperative mortality, complications, and long-term survival after open or endovascular repair (EVAR). Summary estimates with 95% confidence interval (CI) were calculated using a random effects model.**

Results: **Thirty-nine articles were included. The median aneurysm size was 6.7 cm in the conventional AAA repair group of 1534 patients. The perioperative mortality was 0% to 33%, with a pooled mortality of 7.5% (95% CI, 6.2% to 9.0%). The median 5-year survival rate for this group was 60% (range, 14% to 86%). In the 1045 patients treated with EVAR, the median aneurysm size was 5.9 cm. Their pooled perioperative mortality varied from 0% to 6%, with a pooled mortality of 4.6% (95% CI, 3.4 to 6.0%). We could not derive 5-year survival rates from articles describing endovascular repair of AAA.**

Conclusion: **The mortality rate after open or endovascular AAA repair in carefully selected octogenarians seems acceptable but is higher than the mortality rate in younger patients. Long-term survival rates were acceptable, but small sample size, selection, and publication bias must be taken into account. Finally, selection criteria for successful surgery with low mortality and morbidity rates cannot be derived from the literature. (J Vasc Surg 2008;47:676-81.)**

Abdominal aortic aneurysm (AAA) is an age-related disease. The overall life expectancy of the Western population is increasing, and projections are that more elderly patients will come forward for AAA repair in the future.[1] For example, the octogenarian population in The Netherlands has increased in the past 10 years by more than 10,000 per year. In the United States, there was an annual increase of more than 160,000 octogenarians.[2,3] It is expected that the number of octogenarians will increase in the future.[2]

Elective AAA repair can prevent rupture and death, but the risk of an open operation is considerable. Open repair in patients aged >80 is often not even considered because of comorbidities or their advanced age in itself being an independent risk factor for perioperative death.[4] As age > 80 years was an exclusion criterion for the United Kingdom Small Aneurysm Trial (UKSAT) and Aneurysm Detection and Management (ADAM) trials, robust data on perioperative mortality and possible long-term survival benefit for octogenarians after open repair are lacking. Yet, patients >80 years are treated both with open and endovascular surgery, with seemingly good results as reported in many articles.

We performed a systematic review of the literature to analyze the rates of perioperative mortality, complications, and long-term survival of octogenarians after conventional AAA repair or endovascular aneurysm repair (EVAR).

METHODS

Data sources. Two authors (M.H. and M.J.W.K.) independently performed a search of the Medline (from 1966) and Embase databases (from 1988) and the Cochrane Library through June 2006. Search algorithms combined the medical subject heading (MeSH) terms and key words "aortic aneurysm, abdominal" and "octogenarian" not "ruptured" Combinations of these terms were used depending on the requirements of the database. We also used the Related Articles feature in PubMed. We did not use a language restriction. Reference lists of retrieved articles were used to complete our search. We did not systematically search for unpublished data or abstracts, nor did we contact leading authors in the field to retrieve more articles.

Study selection. Two authors confirmed the eligibility of the identified studies. All studies reporting mortality rates or life expectancy rates, or both, of octogenarians undergoing elective AAA surgery or EVAR were considered for inclusion. We excluded duplicate publications or publications reporting repeatedly on the same study population. Articles on surgery only for ruptured AAA were also excluded. Disagreements were resolved by discussion.

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Competition of interest: none.

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Methodologic quality assessment. The same two observers independently assessed the methodologic quality of the included studies. We examined all articles on the presence of selection bias and information bias and whether correction for confounding variables had been performed. Selection bias and information bias mostly affect the generalizability and reliability of observational studies. We considered selection bias to be present when patients were selected based on absence of severe comorbidities and thus were considered fit for AAA repair. Information bias was defined as completeness of the follow-up of the studied patients. We only considered the follow-up to be complete when this was explicitly mentioned in the text. Differences in case-mix may lead to differences in outcome. We considered whether individual studies had corrected for confounding elements such as sex and comorbidities. Furthermore, we determined whether the studies were based on single or multi-institution data. Discrepancies in methodologic judgement were resolved by discussion. Methodologic quality was not an inclusion or exclusion criterion for our analysis.

Data on author, publication year, number of patients, study design, aneurysm size, and age and sex of the patients, if possible, were extracted from the included studies. We also extracted the rates for mortality, defined as 30-day mortality, and survival. When only in-hospital mortality rates were given and not 30-day mortality, we used the former. We also listed the postoperative complication rates. Data were considered missing if they were not in a table or mentioned explicitly in the text. This systematic review has been performed by the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) guideline, a proposal for reporting and systematically performing a meta-analysis of observational studies in epidemiology.[5]

Analysis. Although we suspected some clinical heterogeneity between studies, if only because of the long time span covered by the included studies, we decided to perform a pooled analysis of perioperative mortality. Data were transformed to a logit-scale after a usual correction of adding 0.5 to cells with a value of 0. The presence of between-study heterogeneity was determined using a standard χ^2 test (denoted as Q in the results) and by calculation of the I^2 value.[6] If no heterogeneity could be detected, data were pooled according to the DerSimonian and Laird random effects model weighted by the inverse of the variance, to calculate a summary risk of perioperative mortality with 95% confidence interval (CI). Separate analyses were performed for open repair and EVAR. Analyses were done using a customized Excel (Microsoft Inc, Redmond, Wash) spreadsheet.

RESULTS

From a total of 1274 studies identified by our search, 50 articles were potentially relevant for our systematic review. One study was excluded because it reported mainly on hospital costs for AAA surgery.[7] Another was excluded because it described the influence of comorbidities in octogenarians and did not describe the mortality or survival rates for this group.[8] Two articles were excluded because they reported only on ruptured cases.[9,10] One was excluded because the authors described three case reports of AAA repair in octogenarians but did not report mortality or survival rates.[11] Five articles were excluded because those did not concern the octogenarian group, but patients aged ≥75 years.[4,12-15] Finally, one article was excluded because the authors included different surgical procedures and did not specify for AAA surgery.[16]

Of the 39 final articles that remained, 34 reported on patients undergoing open AAA repair, seven reported on EVAR, and 2 reported on both open and endovascular repair.[17,18] In the conventional AAA repair group, 1534 patients were evaluated, with a median study size of 30 patients per study (range, 6 to 246 patients). All patients underwent elective open AAA repair between 1975 and 2005. The EVAR group included 1045 patients, with a median study size of 50 patients per study (range, 16 to 697 patients). These patients underwent EVAR between 2001 and 2005.

All articles, except four, were in English: One article each was written in Spanish, German, Italian, and Czech. Twenty studies were performed in the United States, 13 in Europe, 2 in Japan, 1 in Australia, 1 in Chile, 1 in the Czech Republic, and 1 in Canada. Most studies reported perioperative mortality rates and only a few studies reported long-term survival rates. The Table I lists all characteristics of the included studies. We separated the studies according to their intervention technique: elective conventional surgery or endovascular repair of AAA. The methodologic quality of the studies was poor: 87% showed selection bias, 79% showed definite or possible information bias, and only 26% of the studies corrected their results for confounding variables. Almost all studies, except three, were of retrospective design. In the open repair group, six studies were reports of multi-institutions.[19-25] Only one article reporting on EVAR was based on multicentered data.[26]

Table I also lists the rates for mortality rates and survival, including the size of the aneurysm in the treated population. Mortality was defined as 30-day mortality in 25 studies, as in-hospital mortality in 11, and 5 studies described mortality as "perioperative" without specification of the cutoff point. The median aneurysm size was 6.7 cm (range, 5.7 to 8.2 cm) in the conventional repair group. For conventional AAA repair the perioperative mortality rates varied from 0% to 33%. Figure 1 represents the mortality rates in all studies after open AAA surgery. We could not detect heterogeneity for mortality after open repair ($Q = 29.99$, df = 31, $P = .52$, $I^2 = 0$) and used a random effects model to calculate a pooled mortality after open repair of 7.5% (95% CI, 6.1% to 9.0%). Nineteen studies described a median 5-year survival rate of 60% (range, 14% to 86%.) Of the 34 studies that reported on conventional surgery, 15 studies provided data on postoperative morbidity rates (Table I), which were a median 31% (range, 8.6% to 68.6%). Complications described in the articles were ill defined. It was

Table I. Study characteristics, aneurysm size, mortality, survival, and complication rates

Author	*Year*	*N*	*Age, mean y*	*Male (%)*	*A*	*B*	*C*	*AAA size, mean cm*	*Peri-op mortality (%)*[a]	*Post-op complication rate 80+ (%)*	*5-year survival rate (%)*
Open AAA repair											
Baker et al[22]	1975	14	NS	NS	1	1	1	NS	NS	NS	42
O'Donnell et al[32]	1976	63	82	76	1	1	0	8.2	2.0	48	65
Petracek et al[33]	1980	19	83	NS	1	1	0	NS	5.2?	NS	NS
Treiman et al[34]	1982	35	84	69	1	1	0	NS	8.6*	54	14
Edwards et al[35]	1982	16	NS	NS	1	0	0	6-10	12.5*	25	NS
Ammar et al[36]	1983	45	NS	NS	1	1	0	>5	7.8*	NS	NS
Cogbill et al[37]	1986	23	84	NS	1	1	0	4.5-12	4.3	46	54
Harris et al[21]	1987	34	83	65	1	1	0	NS	3.0?	29	NS
Robson et al[38]	1989	14	83	76	1	1	0	NS	0	52	NS
Glock et al[40]	1990	29	83	71	1	1	0	NS	6.9*	NS	65
Pegoraro et al[39]	1990	9	NS	NS	1	1	0	NS	33	NS	28
Dean et al[41]	1993	18	82	78	1	0	0	6.9	5.6*	29	72
Paty et al[42]	1993	77	84	67	1	1	0	6.5	3?	NS	60
Chalmers et al[23]	1993	10	82	71	1	1	0	NS	0	NS	NS
Falk et al[44]	1996	9	83	93	0	1	0	6.9	0*	22	67
O'Hara et al[43]	1995	53	83	78	1	1	1	6.7	3.8	NS	48
Sugawara et al[19]	1996	15	85	73	1	1	0	6.9	0	NS	85.7
Ritter et al[45]	1996	31	NS	NS	1	1	0	NS	3.2	NS	42
Robinson et al[46]	1997	22	84	91	1	1	0	5.7	NS	NS	80
Soisalon et al[49]	1998	12	81	75	1	0	0	NS	8	NS	NS
Ihaya et al[47]	1998	9	84	NS	1	1	0	5.5-10	11?	NS	NS
VanDamme et al[50]	1998	52	82	84	1	1	0	6.5	5.7	NS	47
Wong et al[48]	1998	56	83	70	1	1	0	6.9	10.7?	23	69
Kazmers et al[24]	1998	231	82	NS	1	1	1	NS	8.3*	NS	NS
Dardik et al[25]	1999	246	NS	NS	1	1	1	NS	7.3*	NS	NS
Sicard et al[17]	2001	38	83	71	0	1	1	6.4	5.3	37	83.1†
Mailapur et al[52]	2001	62	83	61	1	1	0	6.7	1.4	NS	83.6
Berry et al[30]	2001	49	NS	80	1	1	1	NS	2*	22.5	NS
Patel et al[18]	2003	30	83	69	1	0	0	6.2	3.3	68.6	NS
Valdes et al[53]	2003	58	NS	76	1	1	0	6.8	5.2	NS	41
Certik et al[54]	2003	13	85	NS	1	2	2	NS	0	NS	NS
Haug et al[20]	2005	105	82	78	0	1	0	6.5	11	8.6-11.4	47
Dainese et al[58]	2005	31	82	84	1	1	1	6.7	3.2	22.6	81‡
Hynes et al[31]	2005	6	83	83	0	1	1	6.8	0	33	83
EVAR											
Sicard et al[17]	2001	52	83	73	0	1	1	5.9	1.9	11.5	90†
Lobato et al[51]	2001	50	82	86	0	1	0	5.2	2	18	NS
Patel et al[18]	2003	16	84	94	1	0	0	5.6	0	25	NS
Brinkman et al[56]	2004	31	83	94	1	1	1	5.9	6	6	68**
Biebl et al[57]	2004	49	84	88	1	1	0	5.7	0	NS	59.8†
Minor et al[55]	2004	150	85	79	1	2	0	6.7	3.3	1.8	73*
Lange et al[26]	2005	697	83	90	1	1	1	6.2	5	NS	64§

A, Selection bias; *B,* information bias; *C,* correction for confounding; *0,* no; *1,* yes; *2,* not clear; *NS,* not stated in the article, *AAA,* abdominal aortic aneurysm; *EVAR,* endovascular aneurysm repair.

[a]Perioperative mortality: 30-days except *in-hospital,

?undefined.

*1.5-year survival rate (%).

**2-year survival rate (%).

†3-year survival rate (%).

‡4-year survival rate (%).

§8-year survival rate (%).

not possible to compare major or minor complications because the definitions of these terms varied between the articles.

For EVAR, the median aneurysm size was 5.9 cm (range, 5.2 to 6.7 cm). The perioperative mortality rates were 0% to 6%. Figure 2 represents the mortality rates in all studies after endovascular repair. Mortality rates after EVAR were not heterogenous ($Q = 3.93$, df = 6, $P = .69$, $I^2 = 0$) resulting in a pooled mortality of 4.6% (95% CI, 3.4 to 6.0%), calculated with a random effects model. Five studies in this group described complication rates, with a median of 11.5% (range, 1.8 to 25%; Table I). The definition of complications also varied in these articles. In the EVAR group, only a few articles provided a long-term survival rate. In addition, follow-up lasted <5 years in all articles, except one[26] (Table I).

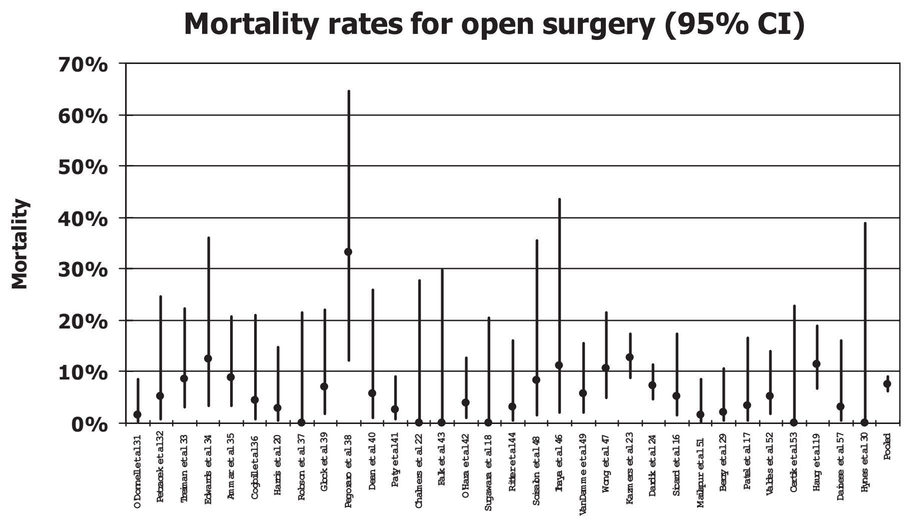

Fig 1. Mortality rates in all studies after open AAA repair.

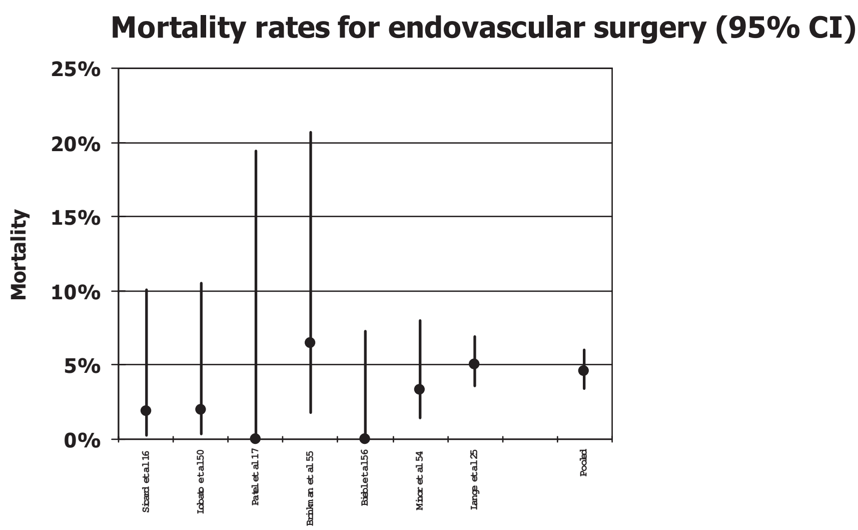

Fig 2. Mortality rates in all studies after endovascular repair.

DISCUSSION

Elective surgical repair of an asymptomatic AAA is a prophylactic operation performed to gain life years at the cost of operative morbidity and mortality. This potential benefit also has to be weighed against the natural course of an AAA.

In the studies identified in our systematic review, perioperative mortality in patients >80 years was higher than generally reported mortality rates, both for open and endovascular surgery, but within acceptable range. We realize that the included studies represent a long period, during which improvements in patient selection and management, such as regional anesthesia and perioperative β-blockade, have probably led to improved patient outcomes. One might question the validity and clinical implications of an analysis that includes older studies. Although clinical heterogeneity is likely when older studies are included, we could not prove statistical heterogeneity and therefore we performed the analysis as such.

The results of our study do not mean that octogenarians can be regarded and treated similarly as their younger counterparts owing to the limited methodologic quality of the included studies. Nearly all studies were small, single center, and retrospective in design, with inevitable selection bias of only patients who were considered fit enough to undergo an operation. Publication bias may have led to selection of studies that presented acceptable results of surgery only. It is certainly a limitation of our review that we did not systematically explore the possibility of publication bias. Another important methodologic limitation is the high rate of information bias in the included studies. This is likely to cause a bias in survival rates because of the possibility of deceased patients that are lost to follow-up. In addition, only a limited number of the included studies reported follow-up data. Finally, small sample size of the included studies brings with it a wide confidence interval of the estimated survival rates, and these were never reported.

Given the limitations summarized, one must make a decision what to do with a patient > 80 years with an AAA. Careful patient selection can result in acceptable mortality rates. Unfortunately, it does not become clear from the included studies how patients were considered to be fit enough to be operated upon with a good risk. One might assume that selection for operation depends on sound judgment regarding cardiovascular and renal comorbidities in relation to operative risk. However, data from the EVAR 1 and 2 trials showed that there was considerable variation among participating centers in deciding whether patients were fit or unfit for open surgery, despite strict selection criteria.[29]

Several models have been evaluated to predict perioperative mortality in AAA surgery. The Glasgow Aneurysm score combines age, history of cardiac and cerebrovascular disease, and renal function in a risk score. Patients with a risk score of ≥77 points belonged to the high-risk group for open surgery.[27] Similar outcomes were reported for patients treated with EVAR.[59] Thus, in patients > 80 years the Glasgow Aneurysm score cannot identify those with a good risk because their age as such defines them as high risk.

Although the mortality rates of open repair and EVAR differ, we must emphasize that this does not imply that EVAR is the better treatment, because we could not find randomized controlled trials that directly compared both modalities in octogenarians. In addition, anaesthetic techniques, postoperative care, and operation techniques have changed over the years and may also account for differences in mortality after open repair between the studies included in our analysis.

The second aspect of decision making, assessment of perioperative morbidity, is even more difficult. We could not find a clear reporting and clear description of severity of complications in the patients undergoing AAA repair. This makes it virtually impossible to weigh this information in the decision to operate. The modified Leiden score has been proposed to adequately predict postoperative morbidity in patients undergoing open AAA repair; however, this score also takes into account the patient's age. In this model, a patient >80 years has as such a high probability of severe postoperative complications and would qualify for an expectant management.[28]

We found only three studies that addressed quality of life after open AAA surgery in people of high age.[31,33,58] In these small studies included a total of 112 patients, and nearly all patients had returned to their homes and resumed daily activities after 6 months. It is clear that more information is needed on this is issue, especially to define the value of modern technologies such as EVAR.

The median 5-year survival rate of octogenarians in this review of 60% seems acceptable. However, this survival percentage is the result of only 19 studies and so possible selection and publication bias must be taken into account. In addition, the question remains whether octogenarians would benefit from AAA surgery at all, because the long-term survival in elderly patients with an AAA has more often been shown to depend on diseases other than the AAA as such.

CONCLUSION

Mortality rates after open or endovascular AAA repair in carefully selected patients seems acceptable, but is higher than mortality in younger patients. However, selection criteria for successful surgery cannot be derived from the literature. The median long-term survival rate of 60% is acceptable but must be interpreted in the light of methodologic limitations. Finally, our study cannot answer the question of whether patients >80 years can eventually benefit from AAA repair in terms of life-years gained.

AUTHOR CONTRIBUTIONS

Conception and design: MK, MH
Analysis and interpretation: MK, MH, AV
Data collection: MH, MK
Writing the article: MH, MK
Critical revision of the article: MK, AV
Final approval of the article: MH, MK, AV
Statistical analysis: MK
Obtained funding: Not applicable
Overall responsibility: MH[59]

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