Original Research Article

Open repair of abdominal aortic aneurysm in the elderly: Is it worthwhile?

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\textbf{ABSTRACT}

Introduction: Given the steady increase in life expectancy, an analysis of surgical outcomes in the aging population is of significant interest to vascular surgeons. The aim of our study was to assess the outcomes of abdominal aortic aneurysm repair in the elderly aged 75 plus and compare their results with people operated on at a younger age.

Methods: 171 patients who underwent open AAA repair in one centre in 1999–2008 were analyzed. The perioperative and postoperative complications, 30-day mortality, the length of ICU and hospital stay were compared, and the Kruskal–Wallis and the Chi-square tests were used for statistical analysis.

Results: There were no statistically significant differences in gender and patients’ preoperative comorbidities except for ICHS and CHRI which were more frequent in the elderly 75 plus. The frequency of serious perioperative haemodynamic complications and postoperative (cardiac, respiratory, cerebral, bleeding, sepsis, surgical) complications, mortality rate and the length of hospital stay did not significantly differ in the elderly 75 plus. A statistically significant difference was found only in the frequency of postoperative renal damage and the length of ICU stay. The elderly 75 plus without enhanced haemodynamic monitoring had significantly longer ICU stay (5 days vs. 7 days \( p < 0.001 \)) and developed renal damage significantly frequently (\( p = 0.002 \)).

Conclusion: We confirmed acceptable outcomes of patients aged 75 plus who underwent open AAA repair compared with younger population. Elective surgery for AAA can be safely performed in the elderly patients, however, other possibilities of treatment should also be considered.

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1. Introduction

Life expectancy has increased by more than 5 years in the Czech Republic over the last twenty years. Increasing life expectancy leads to more frequent surgery indications in the elderly aged 75 plus (the elderly 75 plus). Improvements in current anaesthesia and surgery enable performing operations with good results on older patients. On the other hand, aortic surgery continues to be associated with severe perioperative trauma. Aortic clamping and declamping cause large haemodynamic changes during the operation and also ischaemic-reperfusion injury. Moreover, the elderly people who undergo vascular operation have more concomitant diseases in their histories and less physiological reserves.

In view of the above-mentioned facts, we must ask whether we can provide open AAA repair safely at an advanced age, whether the risk is acceptable in elderly patients compared with younger population. We tried to answer these questions in our study. The aim of our study was to assess the outcomes of AAA repair in the elderly aged 75 plus and compared their results with people operated on at a younger age.

2. Methods and statistics

171 patients who underwent open repair for asymptomatic abdominal aortic aneurysm in one centre in 1999–2008 were enroled in our study. Among these, 109 (64%) were aged under 75 (mean age 65, range 46–74) and 62 (36%) were 75 plus (mean age 78, range 75–88). No patient with AAA who was indicated for surgical treatment was rejected because of age in 1999–2008.

Data were collected on the patient's age, sex, medical history and risk factors. Patients' demographics and preoperative comorbidities are shown in Table 1.

All operations were performed under general anaesthesia using opioids, benzodiazepines, muscle relaxants and volatile anaesthetics. All 171 patients had standard monitoring of heart rate, invasive arterial pressure, central venous pressure, and urine output. Using perioperative haemodynamic optimization during AAA operation became standard practice in 2003 (pulmonary artery catheter or echo-oesophageal Doppler: OED). All patients received an intravenous bolus of heparin before aortic clamping. No patients required suprarenal clamping.

After AAA operations, the patients were monitored in the Department of Anaesthesia and Intensive care or in the ICU in the Department of Surgery. Opioids were used for pain management postoperatively. Epidural analgesia was not used due to heparin dosing within and after AAA operations.

The frequency of hypertension (BP > 180/95, MAP > 125) and the rate of serious perioperative haemodynamic complications such as acute heart failure, ST changes > 1 mm, new ventricular and supraventricular arrhythmias were noted perioperatively.

Postoperatively, the length of ICU and hospital stay, symptoms and signs of postoperative complications and mortality rate were monitored during all hospital stay. In the case of cardiovascular complications, myocardial infarction (MI), non-stable angina pectoris, acute heart failure, pulmonary embolism and the cardiac rhythm changes (new supraventricular tachycardia, atrial fibrillation, atrial flutter, premature ventricular extrasystoles: frequent > 5/min or multifocal, ventricular tachycardia and fibrillation) were recorded. The non-cardiac complications, which were monitored, included pulmonary (pneumonia, postoperative respiratory failure), renal (urinary output < 0.5 mL kg⁻¹ hr⁻¹ for > 3 h, or increase in baseline creatinine > 50%, or need for RRT) and cerebrovascular complications (TIA, stroke).

### Table 1 - History of diseases in patients' histories and gender.

<table>
<thead>
<tr>
<th></th>
<th>With EHM</th>
<th>Age (years)</th>
<th>Without EHM</th>
<th>p-value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 75 yr</td>
<td>&lt; 75 yr</td>
<td>&lt; 75 yr</td>
<td></td>
</tr>
<tr>
<td>(N=47)</td>
<td>(N=37)</td>
<td>(N=62)</td>
<td>(N=25)</td>
<td></td>
</tr>
<tr>
<td>Heart disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction (MI)</td>
<td>13 27.7</td>
<td>6 16.2</td>
<td>14 22.6</td>
<td>5 20.0</td>
</tr>
<tr>
<td>Angina pectoris (AP) II-III degree</td>
<td>9 19.1</td>
<td>9 24.3</td>
<td>6 9.7</td>
<td>6 24.0</td>
</tr>
<tr>
<td>Chronic congestive heart failure, ejection fraction &lt; 35%</td>
<td>2 4.3</td>
<td>3 8.1</td>
<td>2 3.2</td>
<td>1 4.0</td>
</tr>
<tr>
<td>Arrhythmias (supraventricular, ventricular)</td>
<td>6 12.8</td>
<td>10 27.0</td>
<td>8 12.9</td>
<td>4 16.0</td>
</tr>
<tr>
<td>Serious heart valvular disease</td>
<td>1 2.1</td>
<td>4 10.8</td>
<td>2 3.2</td>
<td>2 8.0</td>
</tr>
<tr>
<td>Ischaemic chronic heart disease (ICHS)</td>
<td>26 55.3</td>
<td>21 56.8</td>
<td>25 40.3</td>
<td>20 80.0</td>
</tr>
<tr>
<td>Summary</td>
<td>28 59.6</td>
<td>28 75.7</td>
<td>32 51.6</td>
<td>22 88.0</td>
</tr>
<tr>
<td><strong>ASA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I–II</td>
<td>15 31.9</td>
<td>9 24.3</td>
<td>22 35.5</td>
<td>2 8.0</td>
</tr>
<tr>
<td>III–IV</td>
<td>32 68.1</td>
<td>28 75.7</td>
<td>40 64.5</td>
<td>23 92.0</td>
</tr>
<tr>
<td><strong>COPD</strong>: Chronic obstructive pulmonary disease—FEV/FVC 0.6–0.45</td>
<td>16 34.0</td>
<td>15 40.5</td>
<td>14 22.6</td>
<td>8 32.0</td>
</tr>
<tr>
<td><strong>CHRI</strong>: Chronic renal insufficiency—creatinine &gt; 110 umol/l</td>
<td>10 21.3</td>
<td>12 32.4</td>
<td>4 6.5</td>
<td>9 36.0</td>
</tr>
<tr>
<td>Male</td>
<td>41 87.2</td>
<td>24 64.9</td>
<td>50 80.6</td>
<td>17 68.0</td>
</tr>
<tr>
<td>Female</td>
<td>6 12.8</td>
<td>13 35.1</td>
<td>12 19.4</td>
<td>8 32.0</td>
</tr>
</tbody>
</table>

<sup>a</sup> Chi square test.
The surgical complications (postoperative graft thrombosis, surgical bleeding requiring transfusion or reoperation, superficial wound infection and deep wound infections with graft infection, perforation of intestine, paraplegia) as well as serious postoperative bleeding with haemorrhagic shock, development of disseminated intravascular coagulopathy (DIC) and sepsis with multi-organ dysfunction (MODS) were monitored too.

2.1. Statistics

For the statistical analysis we were going to compare two groups of patients: the elderly and the younger patients; however, we found that more 75 plus patients were operated on in a later period (after 2003), when enhanced haemodynamic monitoring (EHM) was used. This means that more the elderly 75 plus (57%) had EHM in comparison with younger patients (43%). Knowing that EHM can contribute to better outcomes in patients in vascular surgery we could predict that it might influence the results of the elderly 75 plus in our study. For this reason, we divided the patients according to both their age and whether or not they had EHM.

The groups analyzed were: group 1 (N=47): patients younger than 75 years with EHM; group 2 (N=37): the elderly 75 plus with EHM; group 3 (N=62): patients younger than 75 years without EHM; and group 4 (N=25): the elderly 75 plus without EHM.

Descriptive statistics was calculated for the length of the ICU and hospital stay, namely median, 25th and 75th percentile, minimum and maximum. Categorical parameters were characterized by the number of occurrences and appropriate percentages.

Comparison of hospital and ICU stay was performed by the nonparametric Kruskal-Wallis test. In the case of significant result, multiple comparisons by the mean rank method were used to determine the difference between individual groups. All tests were performed at the significance level $\alpha=0.05$.

The Pearson Chi-square test was used for the comparison of perioperative, and postoperative complications and the 30-day mortality as well as preoperative comorbidities. All the methods, mentioned above, were employed using the statistical software Statistica 8.0. [StatSoft, Inc. (2008). STATISTICA (data analysis software system), version 8.0] and PASW Statistics 18 [PASW Statistics for Windows, Rel. 18.0.1. 2010. Chicago: SPSS Inc.]

3. Results

Four groups of patients did not significantly differ in gender (Table 1). In a comparison of preoperative cardiovascular risk the statistically significant difference was found in the number of the elderly 75 plus who had cardiac diseases in their histories (one or more cardiac diseases in the patient’s history) compared with younger patients (75.7% and 88% vs. 59.6% and 51.6% $p=0.005$). When patients’ individual preoperative comorbidities were compared, there was a statistically significant difference in the frequency of ischaemic chronic cardiac disease: ICHS ($p=0.009$). Other cardiac

<table>
<thead>
<tr>
<th>Table 2 – The frequency of perioperative complications.</th>
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<tbody>
<tr>
<td>With EHM &lt;75 yr (N=47)</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Heart failure</td>
</tr>
<tr>
<td>Hypertension</td>
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<tr>
<td>Arrhythmias</td>
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<tr>
<td>ST changes</td>
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* Chi square test.

<table>
<thead>
<tr>
<th>Table 3 – The frequency of postoperative complications and mortality.</th>
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<tbody>
<tr>
<td>With EHM &lt;75 yr (N=47)</td>
</tr>
<tr>
<td>------------------------</td>
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<tr>
<td>Complicationsb</td>
</tr>
<tr>
<td>Cardiovascular</td>
</tr>
<tr>
<td>Respiratory</td>
</tr>
<tr>
<td>Renal</td>
</tr>
<tr>
<td>Bleeding</td>
</tr>
<tr>
<td>Stroke/TIA</td>
</tr>
<tr>
<td>Surgical</td>
</tr>
<tr>
<td>Others</td>
</tr>
<tr>
<td>Mortality</td>
</tr>
</tbody>
</table>

* Chi square test.

b One patient could have more than 1 complication.
diseases in the patients’ histories were also analyzed, but no statistically significant difference was found in the preoperative frequency of MI, angina pectoris, chronic heart failure, supraventricular and ventricular arrhythmias. When we compared the occurrence of chronic renal insufficiency (CHRI) and chronic bronchopulmonary disease (COPD) in the patients’ histories; there was a statically significant difference in preoperative CHRI and no statistically significant difference in the frequency of preoperative COPD. CHRI was more frequent in the elderly 75 plus (36% vs. 32.4% vs. 21.3% and 6.5% p=0.002) (Table 1).

Perioperative and postoperative complications did not significantly differ in the four groups of patients (Tables 2, 3); a statistically significant difference was found only in the rate of postoperative renal damage (p=0.002). No statistically significant difference was found in the length of hospital stay; only the elderly 75 plus without EHM had a significantly longer ICU stay (5 days vs. 7 days p<0.001) (Figs. 1, 2).

In terms of individual postoperative complications, no statistically significant difference was found in the frequency of cardiac complications (group 1: 12.8%, group 2: 13.5%, group 3: 19.4%, group 4: 36%). Six patients had myocardial infarction; non-stable angina pectoris was postoperatively diagnosed in 3 patients without EHM; all were younger than 75 years. Heart failure appeared in 9 patients; 5 patients were older than 75 years (2 with EHM, 3 without EHM). One patient was treated for pulmonary embolism. The rest of cardiac complications which were noted in the groups of patients were new supraventricular and ventricular arrhythmias.

In the four groups of patients, seven patients developed bronchopneumonia; postoperative respiratory failure was diagnosed in 4 patients: one in each group.

In the case of postoperative renal impairment, the elderly 75 plus without EHM developed renal damage significantly frequently (p=0.002). The rate of renal damage in these patients was almost four times frequent than in the younger group without EHM (46% vs. 12.9%) and nearly three times frequent than in both the younger and the older groups with EHM (17% and 16.2%). Out of 34 patients who had postoperative renal damage three patients required dialysis, two of them being older than 75 years. None of the patients with postoperative acute renal failure had EHM perioperatively.

Cerebrovascular events such as stroke or transient ischaemic attack (TIA) were noted in six patients. TIA appeared in three of them; all patients had perioperative EHM. Three patients developed stroke, two of them ischaemic and one patient haemorhagic stroke; none of them had perioperative EHM.

Sepsis and multi-organ failure (MOF) were noted in six patients; three of them were older than 75 years, and two patients died (76 years old with EHM: bilateral bronchopneumonia with sepsis; 85 years old without EHM: necrosis of intestine with sepsis). Out of three patients younger than 75 years two patients died (71 years old without EHM: bilateral bronchopneumonia with sepsis; 74 years old without EHM: graft thrombosis with multi organ failure).

Serious postoperative bleeding with haemorrhagic shock and later developed disseminated intravascular coagulopathy (DIC) was noticed in two patients younger than 75 years, both of whom died of MOF in the early postoperative period. Postoperative DIC was diagnosed in four patients; two of them were older than 75 years.

Surgical complications were recorded in 12 patients. Five of these patients were older than 75 years; four of them did not have perioperative EHM. Paraplegia was a complication in one patient. One patient suffered from intestinal perforation and necrosis. Deep wound infections and graft infections were not noted in the four groups of patients. Note that all patients were routinely administered prophylactic antibiotics, usually cephalosporin.

In the case of the mortality rate in patients with EHM, there was no death in the group of patients under 75 (0%) and only one death in the older group (2.7%), whereas the mortality rates in patients without EHM were higher (5/62: 8.1%, 3/25: 12%). Among nine patients who died postoperatively, three patients died of cardiac complications (acute MI with cardiac shock) and six died of non-cardiac complications (2 × bilateral bronchopneumonia with sepsis and MOF, 2 × haemorrhagic shock, 1 × perforated ileum with sepsis and MOF, and 1 × graft thrombosis with MOF).
4. Discussion

Given the steady increase in life expectancy, an analysis of surgical outcomes in the aging population is of significant interest to vascular surgeons. The selection of treatment options for vascular patients must be based on an individual approach and assessment of outcomes. The vascular surgery literature amply demonstrates the negative impact of advancing age on mortality in open AAA repair. On the other hand, despite the challenges posed by the limited functional reserve of elderly patients, some centres have documented acceptable, albeit elevated, mortality rates with repair of aneurysm in the elderly [1–5].

In our study we confirmed acceptable outcomes of the elderly 75 plus who underwent open AAA repair compared with younger population. The frequency of perioperative and postoperative (cardiac, respiratory, cerebral, bleeding, sepsis, surgical) complications, mortality and the length of hospital stay did not significantly differ in the elderly 75 plus after open AAA repair. A statistically significant difference was found only in the frequency of postoperative renal damage and the length of ICU stay.

A post hoc analysis of statistically significant differences in the length of ICU stay and the frequency of postoperative renal complications showed a significant difference between the patients younger than 75 years with EHM and the elderly 75 plus without EHM in both the analyzed cases. According to the figures in our study, the median of ICU stay in younger patients with EHM was the same as the median in the elderly 75 plus with EHM (5 days vs. 5 days) but differed significantly from that in the group of the elderly 75 plus without EHM (7 days). Similarly, the frequency of renal impairment in younger patients with EHM was nearly the same as in the elderly 75 plus with EHM (16.2% vs. 17%) but significantly different from the elderly 75 plus without EHM (48%). In view of these results, we must take into consideration that not only age but both age difference and haemodynamic optimization led to a statistically significant difference. It is known that especially elderly and high-risk surgery patients can profit from perioperative haemodynamic optimization. In our study, oesophageal Doppler (OED) has been used for EHM since 2003. It was confirmed in published studies that patients managed with OED required fewer days in an intensive care unit and were medically fit for earlier discharge from hospital. Furthermore, the data suggest that Doppler-guided fluid replacement reduces the risk of postoperative complications [6–15]. Despite this improvement in postoperative morbidity none of the studies was actually prophylactic measure to protect the renal function [17,18]. Renal perfusion may be preserved by pursuing adequate volemia and cardiac output mainstay of the haemodynamic optimization or goal directed therapy [19].

In the Brienza et al. study it was shown that surgical patients receiving perioperative haemodynamic optimization were at a decreased risk of renal impairment [20]. In agreement with these results we found in our study that none of the patients with EHM had acute renal failure (ARF) in contrast to three patients without EHM who were treated with postoperative ARF requiring dialysis.

Knowing that open AAA repair is a preventative operation and even if the outcomes of the elderly can be comparable with the younger population, as was shown in our study, the question is whether it would not be better to let older patients live without any intervention.

As has been published, Jones et al. reported that out of 57 patients who had been turned down for aneurysm repair because of their advanced age more than a third died of aneurysm rupture within 18 months [21]. In another study, Conway et al. followed the course of 106 patients who were denied aneurysm repair because of advanced age or elevated surgical risk [22]. The 3-year survival rate for these patients was only 17%, with 49% of them dying of aneurysm rupture. From the outcomes of these studies it seems that the risk of AAA rupture in elderly patients without intervention is higher than the risk of death after open AAA repair. Mortality among the elderly in our study, when the concept of haemodynamic optimization was used, was only 2.7% compared with the 35% risk of AAA rupture within next 18 months, as was shown in the John et al. study. In view of the fact mentioned above we may say that elderly people should not be denied open AAA repair just because of their advanced age.

Nevertheless, another question is whether endovascular treatment of AAA should not be preferred in older people. In a systematic review of recent evidence for the safety and efficacy of elective endovascular repair (EVAR) in the management of infrarenal AAA [23], the 30-day mortality rate for EVAR was 1.6% in randomized controlled trials, and 2.0% in nonrandomized trials. Technical complications of this procedure were stent migration (4%), graft limb thrombosis (3.9%), endoleak (type I 6.8%, type II 10.3%, type III 4.2%) and artery access injury (4.8%). Technical success (complete AAA exclusion) was in 81.9% of patients at discharge while secondary intervention to treat endoleak or maintain graft patency was required in 16.2% of patients.

The outcomes of EVAR in the elderly were published in the Sicard et al. study. In this study, 38 patients aged 80 plus who underwent conventional open AAA repair were compared with 52 patients who underwent endoluminal graft AAA repair between 1997 and 2000. Operative mortality did not significantly differ between the conventional open repair (5.3%) and endoluminal graft repair (1.9%) groups. Three-year survival was not significantly different between these groups either (83.1% COR vs. 91% ELG repair). But, a significant reduction in postoperative major complications was noted in the endoluminal graft repair group (COR: 14/37%, ELG 6/11.5%, p=0.0043) [24].

In comparison with the results of our study the mortality rate of patients after elective endovascular repair was comparable with the mortality rate in the elderly 75 plus with EHM in our study but when the concept of haemodynamic optimization was not used, the mortality rate was nearly four times higher in our study than in patients after endovascular repair. On the other hand, after open AAA repair we need not
reckon with technical complications such as stent migration, endoleaks and graft thrombosis, for which secondary intervention was provided in 16.2% of patients after EVAR. And, in addition, these 16.2% of the study population had a further surgical or radiological procedure, with its associated cost, morbidity and mortality rates.

In summary of these results it seems that endovascular repair could be a more preferable method for elderly patients due to the significantly lower incidence of postoperative major complications. On the other hand, survival after endovascular repair can be equivalent to conventional therapy and, moreover, EVAR has some limitations. In this case, when EVAR is not an appropriate method, the surgeons should know that open AAA repair in elderly patients can be accomplished without risking of a successive increase in mortality and morbidity.

In conclusion of our study, we may say that open AAA repair in the elderly does not carry a significantly greater risk of surgical mortality and complications compared with younger patients. We did not find a statistically significant increase in perioperative and postoperative morbidity and mortality and in the length of hospital stay in patients aged 75 plus after open AAA repair. A statistically significant difference was found only in the frequency of postoperative renal damage and the length of ICU stay. The results for the elderly 75 plus were comparable with the results for the younger population so that older patients should not be denied open AAA surgery due to their advanced age. Nevertheless, other possibilities of treatment such as endovascular repair should also be considered.

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