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Comparison of Endovascular Aneurysm Repair with Open Repair in Patients with Abdominal Aortic Aneurysm in Our Own Material in Years 2002–2011

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Abstract

Background. Endovascular abdominal aortic aneurysm repair has become an alternative to open surgical repair of abdominal aortic aneurysm since the early 1990s. The conventional method remains the gold standard in the treatment of Abdominal Aortic Aneurysm (AAA); however, a large percentage of patients do not qualify for this treatment due to the high risk of perioperational death and complications.
Objectives. The objective of this work was to compare AAA surgeries performed by both classical and endovascular methods in years 2002–2011.
Material and Methods. Medical documentation of elective AAA patients undergoing surgical treatment was retrospectively analyzed on the basis of archive- and computer database data. The analysis included the patients' demographics, internal disease burden, as well as causes of deaths and complications within 30 days after the procedure and 1 year follow-up.
Results. Thirty-day and 1-year mortality rates in patients treated in the elective setting were 1.5% and 8.7% for endovascular method and 4.0% and 15.7% for the open method. The comparison of mortality rates in 115 high-risk patients undergoing elective OR treatment with 275 high-risk treatment patients undergoing EVAR surgery (7.8% vs. 1.5%, 8.7% vs. 15.7%, $p < .01$) showed that the endovascular method significantly reduced the mortality in the latter group.
Conclusions. Endovascular treatment is an attractive option in AAA; especially in heavily burdened patients, because it definitely reduces mortality. EVAR was found to be advantageous over OR in case of high-risk patients (**Adv Clin Exp Med 2015, 24, 3, 475–479**).

Key words: abdominal aortic aneurysm, endovascular aneurysm repair, open repair.

The number of diagnosed abdominal aortic aneurysm (AAA) has been increasing recently, especially in the group of elderly and internal burdened patients. According to the literature data, such diagnosis is made in about 1.3% of men aged 45–54 and in up to 12.5% of men above the age of 75. In women the incidence of AAA in the same age groups is about 0 to 5% respectively [1–4]. Many of patients, who are qualified for surgery treatment, have a lot of comorbidities.

Aneurysm repair can be accomplished using open surgical techniques or endovascular techniques. In the past endovascular repair (EVAR) was introduced for patients of poor health status, considered unfit for open surgery (OR) [5]. Since the advancement of stent graft the indications for EVAR expanded. Nowadays, EVAR is the approved method of treatment AAA. As the technology developed, EVAR has been used increasingly in patients judged fit for OR [6]. New endovascular

techniques allow us to overcome difficult anatomy. A new generation of stent-grafts can be used in the treatment of patients who have highly angulated aorta or those with short aneurysm neck [7].

The aim of this work was to compare AAA surgeries performed by both open and endovascular methods in years 2002–2011.

Material and Methods

Medical documentation of elective AAA patients undergoing surgical treatment in years 2002––2011 was retrospectively analyzed on the basis of archive- and computer database data. Elective repairs were performed by the open or the endovascular method. Subjects to repair were AAAs exceeding 5.0 cm or AAAs with the size of > 4 cm, growing at the rate of more than 0.5 cm per 6 months. The analysis included the patients' demographics, internal disease burden, as well as causes of deaths and complications within 30 days and 1 year after the procedure. Anatomical criteria for endovascular treatment included the proximal aneurysm neck length of ≥ 15 mm and diameter of ≤ 30 mm, as well as angulation between the longitudinal axis of the proximal neck and the longitudinal axis of the aneurysm of ≤ 60 degrees. The diameter and the status of iliac arteries were also taken into consideration. All patients managed at our site by the endovascular method belonged to the high-risk surgical group. Patients were qualified as high risk if they met at least one of the following criteria: age ≥ 80 years; pulmonary dysfunction with forced expiratory volume in 1 s (FEV1) < 1 L; vital capacity < 50% of the predicted value based on the patient's age; PaO_2 < 70 mm Hg, PCO_2 > 45 mm Hg and home oxygen therapy; ejection fraction < 40% of the predicted value; New York Heart Classification (NYHA) class 3 or 4 dyspnoea and symptomatic heart failure; renal failure corresponding to serum creatinine ≥ 2 mg/dL; and a history of stroke. Disease burden, main death causes and early and late complications were also compared between EVAR (endovascular abdominal aortic aneurysm repair) and OR (open surgery repair) groups. Statistical analysis was performed using STATISTICA 7.0 and Microsoft* Office Excel software. Chi-square test incorporating Yates' correction for continuity was used. P values of < .05 were considered statistically significant.

Results

From 2002 through 2011, 275 patients underwent elective EVAR, 743 OR of non-ruptured AAA. Elective endovascular AAA repairs lasted from 60 min to 255 min, with the average duration of 132 min, while the classic repair lasted from 90 min to 345 min, with the average duration of 151 min. Table 1 reports the baseline characteristics for all patients undergoing AAA repair. Compared to patients undergoing elective open repair, the group of patients undergoing elective endovascular treatment was characterized by a decidedly higher ratio of patients with significant comorbidities. Cardiac, pulmonary, renal and CNS diseases, as well as diabetes, were more common in the EVAR group. No differences were observed between EVAR and OR groups regarding the incidence of hypertension (Table 2). One hundred fifteen patients in the open surgery group met the high-risk criteria. Thirty--day mortality rates in patients treated in the elective setting were 1.5% (4 out of 275 patients) for endovascular method and 4.0% (30 out of 743 patients) for the open method. There were 9 deaths (7.8%) in the group of 115 patients meeting the high-risk criteria and managed by elective open repair (Table 5). In our study cohort, no differences were observed in death causes in EVAR and OR groups. Four deaths in EVAR group were the results of: circulatory failure and/or myocardial infarction (3 patients) and acute renal failure (1 patient). Most common causes of death within 30 days after the procedure in the OR group were circulatory failure with or without myocardial infarction (15 patients), pulmonary embolism and stroke (4 and 3 patients, respectively). Deaths occurring > 30 days after procedures for treated patients for EVAR vs. OR were 8.7% vs. 15.7% (Table 5).

Table 1. Baseline characteristics for 1018 patients undergoing surgical treatment for abdominal aortic aneurysm during study period

Characteristics	EVAR (275)	OR (743)	p
Demographic factors			
Age, mean	74 ± 6	69 ± 6.7	
Age > 60, % (no.)			
Male sex, % (no.) Risk factors, % (no.)	88 (242)	88 (655)	
Cardiac disease	72 (199)	64 (476)	0.01696
Pulmonary disease	43 (117)	26 (193)	0.0000
Renal failure	18 (49)	8 (37)	0.00001
Cerebrovascular disease	17 (48)	10 (74)	
Diabetes	17 (48)	5 (37)	0.00157
Hypertension	73 (202)	69 (521)	
Smoking	55 (141)	46 (341)	

Table 2. Risk factors for 390 high-risk patients undergoing surgical treatment for abdominal aortic aneurysm during study period

	EVAR (275)	OR (high-risk patients) (115)	p
Risk factors, % (no.)			
Cardiac disease	72 (199)	83 (95)	0.0441
Pulmonary disease	43 (117)	34 (39)	0.0007
Renal failure	18 (49)	18 (21)	ns.
Cerebrovascular disease	17 (48)	15 (17)	ns.
Diabetes	17 (48)	11 (13)	ns.
Hypertension	73 (202)	93 (107)	0.0000
Smoking	55 (141)	74 (85)	0.0001

Table 3. 30-day complications

	EVAR (275)	OR (high-risk patients) (115)	p
30-day complications, % (no.)			
Bleeding	1.1 (3)	5.2 (6)	0.0219
Bowel ischemia	0 (0)	2.6 (3)	ns.
Wound infection	2.9 (8)	4.3 (5)	ns.
Sepsis	0 (0)	2.6 (3)	0.0252
Cardiac	3.6 (10)	3.5 (4)	ns.
Pulmonary	2.5 (7)	2.6 (3)	ns.
Renal	3.5 (10)	3.5 (4)	ns.
Multiple organ failure	0 (0)	1.7 (2)	0.0252

Comparing a patient's 30-day complications treated with open and endovascular method relevant were sepsis, multiorgan failure and bleeding (Table 3). We have not observed internal bleeding after implantation of self-expanding prostheses, bleeding was experienced as early complication by 30 patients (4.0%) ($p < .05$) in the elective open repair group. Bleeding was experienced as an early complication by 6 patients meeting high risk criteria (5%) in the open group and by 9 patients (1%) in the EVAR group ($p < 0.05$, $p = 0.0219$). We also observed no multiorgan failure in patients treated by EVAR and 2 cases of this complications (3%) in high-risk patients treated by OR ($p < .05$, $p = 0.0252$). On the other hand, more cases of circulatory failure with or without myocardial infarction were observed within 30 days after the procedure in the

Table 4. 1-year complications

	EVAR (275)	OR (high-risk patients) (115)	p
1-year complications, % (no.)			
Bleeding	0 (0)	0.9 (1)	ns.
Bowel ischemia	0.4 (1)	1.7 (2)	ns.
Wound infection	0 (0)	0 (0)	ns.
Sepsis	0 (0)	2.6 (3)	0.0252
Cardiac	0.72 (2)	4.3 (5)	0.03
Pulmonary	0.72 (2)	3.4 (4)	ns.
Renal	1.1 (3)	4.3 (5)	ns.
Multiple organ failure	0 (0)	1.7 (2)	ns.

Table 5. Mortality

	EVAR (275)	OR (115)	p
30-day mortality, % (no.)	1.5 (4)	7.8 (9)	0.003
Deaths occurring > 30 days	8.7 (24)	15.7 (18)	0.003

EVAR group compared to OR group. The most common procedure-related complications in the EVAR group were endoleaks suffered by 23 patients. Prosthesis dislocation occurred in 5 patients, while the inability to deploy the device was encountered in 3 patients. Mean follow-up was 12 months. When comparing a patient's 1-year complications treated with open and endovascular method, sepsis and cardiac complications were relevant (Table 4). We have not observed sepsis in patients treated by EVAR, but there were 3 cases (2.6%) in OR group ($p = 0.0252$). There were 2 patients (0.7%) with circulatory insufficiency in EVAR group and 5 patients (4.3%) in OR group ($p = 0.03$).

Discussion

The segment of abdominal aorta located below the origin of renal arteries is the most common site of aneurysm formation. Classic surgery remains the gold standard of abdominal aortic management in both elective and emergency settings. In addition, endovascular management of aneurysms is increasingly popular. Endovascular method is a very good alternative to the classic method in cases of elderly and heavily burdened patients

at high risk of aneurysm rupture. AAAs are 4 to 5 times more common in men than in women [4]. Ultrasound screening for AAA leads to a significant increase in the number of elective procedures and prevents aneurysm rupture in over 50% of cases [8]. Despite the increasing availability of imaging examinations, no screening examinations are performed in AAA risk patients in Poland.

In the case of elective AAA repairs, the endovascular technique is particularly recommended in high risk patients [9, 10]. Tara et al. reported that endovascular treatment of multiburdened patients led to acceptable results [11]. In our group of 743 patients treated by OR, our high-risk criteria were met by 115 patients. We considered these patients ineligible for endovascular procedure due to unfavorable anatomical conditions. There were 9 deaths in this patient group. There were also 21 deaths among the remaining 628 patients treated by the conventional method (7.8% vs. 3.3%, $p > .05$). Similar results were obtained by other authors as well [12, 13]. There were no statistically significant differences in mortality rates between the high- and low-risk patients treated by the open repair method. However, taking into consideration the percentage of deaths in both groups of patients, the classic method is associated with a high mortality rate in patients with internal comorbidity burden. The comparison of mortality rates in 115 high-risk patients undergoing elective OR treatment with 275 high risk treatment patients undergoing EVAR surgery (7.8% vs. 1.5%), $p < .01$) showed that the endovascular method significantly reduced the mortality in the latter group. Similar results were presented by other authors [12, 14]. In their group of ASA IV patients, Zanetti et al. have observed 8% perioperative mortality following EVAR treatment in high-risk patients, compared to 3% in ASA < IV patients [15]. In their group of 92 high-risk patients with AAAs managed by the endovascular method, Jean-Baptiste et al. observed perioperative mortality of 4.3% [9]. Stainmetz et al. divided their patients into 3 groups: high-risk patients treated by EVAR or OR and low-risk patients treated by OR. In contract to our results, the authors found no statistically significant difference in perioperative mortality rates in individual groups. 5.4% of patients in the high-risk EVAR group died within the first 30 days, compared to 3.7% of patients in the high-risk OR group [16]. Our patients were qualified for endovascular treatment only if they met the anatomical criteria. We did not stretch the adopted criteria in order to avoid complications associated with the endovascular procedure [17]. There were 4 deaths (1.5%) in the group of patients undergoing elective EVAR treatment and 30 deaths (4.0%) in the group of patients undergoing classic surgery. Sayers et al. and Chew et al. reported similar mortality rates following elective classic AAA management [18, 19]. A significant part of systemic complications following aortic reconstructions due to aneurysms stems from cardiac diseases [12]. We observed a statistically larger number of cases of post-procedural circulatory inefficiency, including the myocardial infarction setting in the EVAR group compared to the OR group, namely 10 patients (4%) vs. 15 patients (2%). Therefore, there is a need for detailed examinations in patients, especially those with cardiological burden, before they may be qualified for elective EVAR treatment. The remaining early complications, observed both in the EVAR group and in the OR group did not differ in their incidence rates. We observed a total of 229 early complications in the OR group. There is a group of complications that are specific to the endovascular method only, such as endoleaks, prosthesis dislocation or failure to deploy the device. These complications accounted for 31 of the total of 80 complications in our EVAR group. The most common complication in our EVAR patients were type I and II endoleaks. Endoleaks were also the most common complications observed by Franks et al. in their 12-year analysis of patients treated for their AAAs by the endovascular method [20]. In our study material, systemic complications such as circulatory, respiratory, or renal failure were also observed in the EVAR group. Systemic complications after elective EVAR treatment are most commonly associated with cardiac and pulmonary dysfunction or renal failure. Similar perioperative complications were presented by Alric et al [21].

Our 1-year follow-up confirms that EVAR gives benefits for high-risk patient. We observed more complications in OR group. More interesting is that circulatory insufficiency occurred often in OR group, not in EVAR, differently than in 30-days complications. Biancari et al. has also reported better long-term survival in EVAR group (3-year survival EVAR vs. OR, 90% vs. 75%) [22]. However, the late outcomes are not so obvious. The Society for Vascular Surgery found that OR had lower 1-year mortality (EVAR vs. OR, 15.9% vs. 8.5%) [23].

The search for novel methods of abdominal aortic aneurysm management to reduce mortality and complication rates should be continued. Endovascular treatment is an attractive option in AAA; especially in heavily burdened patients, because it definitely reduces serious post-operative complications and mortality. However, it is associated with numerous restrictions, such as anatomical conditions. The classic open repair method maintains its prominent position in elective and emergency treatment of abdominal aortic aneurysms. EVAR was found to be advantageous over OR in case of high-risk patients.

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