ORIGINAL ARTICLE

Early Complications in Patients Undergoing Elective Open Surgery for Infrarenal Aortic Aneurysms

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ABSTRACT

Objective: To assess the type and frequency of early postoperative complications in patients after open surgical infrarenal aneurysms repair and determination of their risk factors.
Study Design: An observational study
Place and Duration of Study: The 4th Military Teaching Hospital in Wroclaw, Poland, from January 2012 to December 2016.
Methodology: Analyses of medical records of 205 patients treated for infrarenal aneurysm with open surgery. Patients with clinical and radiological features of aneurysm rupture were excluded. Complications and early deaths ($\leq$30 days) were recorded.
Results: Men represented 170 (83%) of patients, the average age was 67.9 ±6.68 years. Aneurysm diameter <60 mm occurred in 107 (52.2%) of patients, 60-80 mm in 76 (37.1%), and >80 mm in 22 (10.7%). Aortic prostheses (tube grafts) were implanted in 132 (64.4%) of patients and aorto-bifemoral (bifurcated) grafts in 73 (35.6%). The most common postoperative complications were: reoperation necessity (n=23; 11.2%), respiratory failure (n=21; 10.2%), respiratory tract infection (n=14; 6.8%), circulatory failure (n=14; 6.8%), lower limb ischemia (n=13; 6.3%), kidney failure (n=12; 5.9%), death (n=9; 4.4%), and surgical wound infection (n=9; 4.4%). Statistical analysis indicated intraoperative blood loss, duration of surgery, a larger aneurysm diameter, and diabetes as risk factors for early complications.
Conclusion: Complications were the same as reported from other centres. There is a need to shorten surgery duration and minimise blood loss, as these modifiable factors were the predictors of early complications.

Key Words: Aortic aneurysm, Abdominal surgery, Postoperative complications

INTRODUCTION

Abdominal aortic aneurysm (AAA) is a pathological dilation of the aorta with its diameter 50% greater than normal value (about 3 cm in the most frequent localisation – under the renal arteries) with the loss of parallelism of its walls.[1] The incidence of AAA ranges from 4% to 8%[2,3] and it is more frequent than thoracic aorta aneurysms (TAA).[4] In more than 25% of patients, co-occurrence of aneurysms of both above-mentioned locations is observed, which significantly complicates its management.[4,5] The most important factors for AAA development include advanced age, male gender, positive family history, smoking, presence of other large

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aneurysms or atherosclerosis.[4-7] Genetic predispositions include Ehlers-Danlos [8], Turner and Marfan syndromes. [8,9]

Abdominal aortic aneurysms tend to constantly expand their lumen. The speed of expansion depends on the size – large aneurysms usually develop faster than small ones.[6,7] The strongest risk factor for the rapid increase of an aneurysm diameter is smoking.[1] There are also factors that delay the development of an aneurysm. It was noticed that in patients with diabetes, the progression of the aneurysm enlargement is noticeably smaller, and the same group has a reduced risk of AAA. The reasons for such a relationship remain unknown.[10]

In most cases, AAA does not give any symptoms before rupture.[1] Only some of them may cause abdominal pain radiating to the back or groin.[11] Abdominal palpation may reveal a pulsating mass, but the sensitivity of this examination is low.[1] This leads to a situation, in which many patients with AAA remain undiagnosed.

The conservative treatment of this disease is based on the administration of antihypertensive drugs such as

beta-blockers and ACE inhibitors, which reduces the risk of rupture of the aneurysm.[1] The benefits of using statins have also been demonstrated.[12]

There are two methods of surgical treatment: classic open aneurysm repair (OAR) introduced in the 1950s and endovascular aneurysm repair (EVAR), which has been used since 1990s. There are few publications on this topic in the world literature.

Open surgical repair of AAA is associated with significantly high morbidity and mortality. For infrarenal AAA, 30-days mortality was reported to be 1,5% for elective and 11,1% for symptomatic cases[13]; although in some other reports, it reached 10% after elective repair.[14] The most frequent complications after elective OAR are cardiac and respiratory events along with wound infections, which were described to occur in the perioperative period in 10.2%, 7% and 3.5% of patients after surgery, respectively. [13]

Analysis of risk factors of early complications is the basis for the development of a strategy to effectively reduce the number of complications and increase the survival of patients after repairing surgery of AAA. There are limited data on this topic concerning the Polish population. Moreover, the importance of particular risk factors, like gender or diabetes, remain unclear.[15,16]

The aim of this study was to assess the type and frequency of early postoperative complications occurring in patients after surgical treatment of non-ruptured abdominal aortic aneurysms and to determine their risk factors.

METHODOLOGY

It was an observational study with medical records analyses of 205 patients operated for abdominal aortic aneurysm at the 4th Military Teaching Hospital, Wroclaw, Poland, from January 2012 to December 2016. Patients with clinically and radiologically confirmed features of aneurysm rupture were excluded from the study. Complications and early deaths, defined as those occurring within 30 days of surgery, were recorded.

The data were collected from the digital medical documentation of consecutive patients, who were eligible according to inclusion criteria. Respiratory failure was defined as hypoxemia with or without hypercapnia in an arterial-blood gas test, circulatory failure as symptoms of peripheral hypoperfusion, hypotension (SBP <90 mmHg) or pulmonary edema. Lower limb ischemia was defined as acute or critical ischemia, which required surgical intervention (including amputation). Kidney failure was defined as oliguria or anuria (<0.5 ml/kg/h for 6 h) or serum creatinine increase ($\geq$0.3 mg/dl within 48 h or $\geq$1.5 times within 7 days). Wound infection was defined as clinical signs of local wound inflammation and positive culture from this site. Urinary tract infection was

considered as positive urine bacterial culture and leuko-cytes count. Gastrointestinal bleeding was confirmed in endoscopy. Pulmonary embolism was confirmed with CT pulmonary angiography. Charac-teristics of the group were collected (demographic and clinical data, in particular concomitant diseases before the procedure and course of the surgery) and analysed to determine the risk factors for early complications.

Patients were qualified for elective surgery in accordance with the procedures contained in the current ESC guide-lines for the diagnosis and treatment of the aortic diseases.[11] Indications for the open surgical manage-ment were the aneurysm diameter greater than 55 mm, fast growth dynamics (over 5 mm/6 months), atypical morphology, coexisting aneurysms of the iliac and popliteal artery. The indication for the elective surgery was the aforementioned aneurysm diameter, which is a threshold value for a significant increase of the risk of rupture.[17,18]

The operations were also carried out urgently in the case of symptomatic, unruptured aneurysms. In all patients, the aneurysm was located in the infrarenal aorta.

Exploratory analyses were carried out to determine risk factors for early complications. Complications were initially arranged together as the sum of observed in each patient, without their differentiation. Then, using logistic regression models, analyses of risk factors for the most common complications were performed. The significance level α = 5% was established. During the quantitative analyses, Shapiro-Wilk's W test, Spearman's rank correlation and U Mann-Whitney test were used. The following classification was used to estimate the strength of the R correlation: <0.2 - negligible or very weak correlation; 0.2-0.4 - weak; 0.4-0.7 - moderate; 0.7-0.9 strong; >0.9 - very strong. Changes in the blood parameters before and after the procedure were compared using Student's t-test for dependent groups. The regression model was built using the backward stepwise selection. The analyses were performed with Statistica (StatSoft, 13.0).

RESULTS

Men represented majority of the studied group (n=170; 83%). The average age was 67.9 ±6.68 years. Aneurysms >55 mm were found in 110 (53.6%) of patients. Extremely widened AAA (over 80 mm) occurred in 22 (10.7% of group). Symptomatic course was found in 54 patients (26.3%) and in 5 patients (2.4%), radiological dissection signs were observed.

In 132 (64.4%) of patients, an aortic prostheses (tube grafts) were implanted, the others were provided with aorto-bifemoral (bifurcated) prostheses (n=73; 35.6%).

Hypertension (n=147; 71.7%) and coronary heart disease (n=93; 45.3%) were the most common comorbidities.

Dyslipidemia (n=55; 26.8%), diabetes (n=46; 22.4%), and a history of myocardial infarction (n=39; 19.0%) were reported in patients with similar frequency. Peptic

Table I: Early complications in the open surgery management of non-ruptured AAA (n=205).

Complications	Number of patients	Percentage (%)
Need for reoperation	23	11.22
Respiratory failure	21	10.24
Respiratory tract infection	14	6.83
Circulatory failure	14	6.83
Lower limb ischemia	13	6.34
Kidney failure	12	5.85
Death	9	4.39
Wound infection	9	4.39
Vascular prosthesis obstruction	6	2.93
Urinary tract infection	3	1.46
Gastrointestinal bleeding	3	1.46
Cardiac arrest	3	1.46
Bowels' ischemia	3	1.46
Lower limb amputation	2	0.98
Myocardial infarction	2	0.98
Pulmonary embolism	2	0.98

Table II: Associations between overall number of complications and selected factors.

Total number of complications and:	Correlation coefficient R	p-value
Duration of the surgery	0.18	0.02
Degree of blood loss	0.33	<0.001
Age	-	0.6
Gender	-	0.5
Aneurysm diameter	-	0.2
Comorbidities	-	0.1
Overweight	-	0.9
Nicotinism	-	0.1

Table III: The most frequently observed complications and its established risk factors; OR - odds ratio.

Complications	Predictors
Reoperation necessity	Aneurysm diameter (OR 1.02; p=0.04)
	Blood loss (OR 4.8; p<0.001)
	Surgery duration (OR 2.2; p=0.015)
Respiratory failure	Aneurysm diameter (OR 1.03; p=0.01)
	Blood loss (OR 3.7; p=0.002)
	Surgery duration (OR 2.2; p=0.015)
Circulatory failure	Patient's age (OR 1.1; p=0.035)
	Aneurysm diameter (OR 1.04; p=0.002)
	Blood loss (OR 6.4; p<0.001)
	Surgery duration (OR 2.8; p=0.009)
	Diabetes (OR 2.3; p=0.003)
Lower limb ischaemia	Surgery duration (OR 1.99; p=0.048)
	Blood loss (OR 3.7; p=0.01)
	BMI (OR 2.6; p=0.03)
Kidney failure	Aneurysm diameter (OR 1.03; p=0.02)
	Blood loss (OR 2.8; p=0.046)
	Surgery duration (OR 2.9; p=0.009)
	Diabetes (OR 2.4; p=0.005)
Death	Aneurysm diameter (OR 1.04; p=0.003)
	Surgery duration (OR 2.69; p=0.02)
	Diabetes (OR 2.17; p=0.025)
	Blood loss (OR 2.99; p=0.06)

ulcer (n=21; 10.2%), carotid artery stenosis (n=20; 9.7%), and chronic heart failure (n=19; 9.2%) occurred less frequently. The majority of patients presented a history of smoking (n=144; 70.2%) and BMI >25 in a physical examination (n=130; 63.4%).

Patients required an average transfusion of 2.9 packed red blood cells units (95% CI=2.62-3.19). In 124 (60.5%) of patients, the amount of blood loss during the treatment ranged from 500 ml to 1000 ml. Loss above 1000 ml was observed in 46 (22.4%). The number of patients who lost less than 500 ml of blood was 35 (17.07%). The average duration of the procedure was 1.88 hours (95% CI=1.78-1.99). The average hospitalisation length was about 10 days (95% CI 9.41-11.37).

The most common complication observed up to 30 days after surgery was the need for a reoperation (Table I). Twenty-three patients required reintervention. In 14 of them, it was performed once; in seven cases, there had to be two additional surgeries, and two patients required three re-operations. The reason for performing such a procedure was most often sudden deterioration of the patient's condition, including hypovolemic shock.

At first, the complications were analysed without its differentiation, just as its overall number. The associations are presented in Table II.

Univariate logistic regression was used to determine the predictors for the most frequently observed complications, which were analysed there separately. The results were shown in Table III.

DISCUSSION

Early complications after OAR treatment of unruptured abdominal aortic aneurysms in our study have a similar qualitative and quantitative structure to complications occurring in other centres.[17-23] The percentage of necessary reinterventions observed in our study, at the level of 11.2%, was higher than reported by other authors. It ranged, depending on the study, from 0.6% to 7.1%.[22,23] This difference may result from a greater burden of comorbidities, especially cardiovascular diseases and the qualification of patients with larger diameter aneurysms.[10,21-23] Independent risk factors for re-intervention present in the literature are: age, diameter of the aneurysm, renal failure and ischemic heart disease.[19,23] Predictors, not included in other studies, and increasing the percentage of re-intervention, which were found in our analysis, comprise the amount of blood lost during surgery and the surgery duration.

Respiratory complications occurred as the most frequent. Respiratory failure in a postoperative period was diagnosed in 10.24% of these patients. It is one of the most common, and at the same time, one of the most serious complications, closely related to the invasiveness of surgery.[19,21] Cardiovascular compli-cations, such as

circulatory failure, ischemia of the lower limb or myocardial infarction, are also frequent. Similar complication rate was reported previously by other authors. In the group of patients with nonruptured infrarenal AAA analysed by Law *et al.,* cardiac events occurred in 10.2% and respiratory events in 7% of them within 30 days after repair.[13] Significantly higher rate of pulmonary complications, reaching 42.2% and observed by Dayama *et al.*, may be due to the fact that other localisations of aneurysm were also included in the studied group.[14] There are publications that associate OAR with an increased risk of deterioration of renal function and the development of kidney failure. In the analysed group, 5.85% of patients developed it. This is similar or slightly lower than convergent studies.[19-21]

Perioperative mortality (30 days) presented in other centres did not exceed 4.5%[18], which is similar to the results of our analyses. The low percentage of deaths found after OAR may be associated with the experience of surgeons in our clinic, proper risk assessment, and prudential qualification of patients with an appropriately high chance of survival. Regression analyses showed the effect of the aneurysm diameter, the duration of the procedure, the degree of blood loss, and diabetes on the increased mortality. However, coronary heart disease and renal failure did not occur as risk factors for death, as reported in other papers.[19,23]

Age remains a controversial parameter used to assess the risk of postoperative complications after OAR. Statistical tests carried out showed no significant correlations between age and the total number of complications. However, it was connected with the higher incidence of circulatory failure. Other authors describe a significant relationship between age and the complications incidence, particularly mortality, in the case of both ruptured and unruptured aneurysms.[19,24] Age is an important parameter of the Glasgow aneurysm score. GAS scale is a useful tool for efficient postoperative complications risk stratification.[19] GAS has a high negative predictive value for low-risk patients, as opposed to high-risk ones.[25] For this reason, it should be used to determine the predictive values of the occurrence of early postoperative complications after OAR in patients of the younger age group with a lower burden of comorbidities.[25]

There are several limitations of this study. At first, the data is retrospective, which might impair the precision of study design, its results and established conclusions. Secondly, the numbers of respective complications are relatively low, resulting in a bias while performing multivariate analysis, which would establish the actual associations and risk factors more accurate. That is the reason why only univariate logistic regression was used.

CONCLUSION

Intraoperative blood loss, longer surgery time, and larger diameter of the aneurysm are the risk factors for early complications. Increased body weight also seems to adversely affect the postoperative course. There is a need to shorten the duration of the procedure and minimise blood loss.

ETHICAL APPROVAL:
The study was approved by the Commission of Bioethics at Wroclaw Medical University, Wroclaw, Poland.

PATIENTS' CONSENT:
Written informed consent in Polish was obtained from all patients for the publication of this paper.

CONFLICT OF INTEREST:
Authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
DJ, KM: Helped to draft the manuscript.
WB: Participated in the design of the study.
KB, MM: Participated in the design and coordination of the paper.
PM: Authored the manuscript.
MC: Arranged the manuscript.

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