Smyrna Tıp Dergisi ***Araştırma Makalesi***

The Effect of Surgical and Endovascular Treatment Methods on Mortality in Ruptured Abdominal Aortic Aneurysms
Rüptüre Abdominal Aort Anevrizmalarında Cerrahi ve Endovasküler Tedavi Yöntemlerinin Mortalite Üzerine Etkisi

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Summary
Objective: The present study aims to evaluate the factors affecting mortality in patients with ruptured abdominal aortic aneurysms who were referred from the emergency department and underwent either open surgeries or endovascular procedures.
Material and Method: A total of 34 patients diagnosed with abdominal aortic rupture were included in the study. The patients underwent either open surgery or endovascular procedures between 2009 and 2017. Demographic and perioperative data of the patients were reviewed retrospectively. The study did not include patients with aortic aneurysm diameter less than 55 mm, with a history of previous abdominal aortic surgery, and without rupture detected by computed tomography angiography.
Results: The mean use of total perioperative erythrocyte suspension was 917.64±586.96 mL, the mean time from emergency service to surgery was 526.41±1249.63 minutes, and the mean abdominal aortic diameter was 73.84±21.67 mm. The total number of deaths was 11. The use of perioperative erythrocyte suspension was different between the two groups, which was statistically significant (p:0.001). Demographic data among groups were similar. There was a statistically significant difference between the groups regarding the time from admission to the emergency room to surgery and abdominal aortic diameter (p:0.023 and p:0.045, respectively). The effect of the presence of chronic obstructive pulmonary disease and the choice of treatment method on mortality was statistically significant between the two groups-(p:0.025 and p:0.045, respectively).
Conclusion: Although endovascular methods are advantageous in mortality, open surgery is primarily preferred in ruptured abdominal aortic aneurysms due to anatomical and technical limitations. Developing technology, easier access to stent graft systems, and increased experience in emergency endovascular interventions will provide intervention to ruptured abdominal aortic aneurysms with less mortality.
Key words: Abdominal aortic aneurysm, aortic rupture, endovascular procedures, vascular surgical procedure

Özet
Amaç: Bu çalışmanın amacı, acil servisten danışılan ve abdominal aorta anevrizması rüptürü tanısıyla açık veya endovasküler yöntemlerle opere edilen hastalarda mortalite üzerine etkili faktörleri değerlendirmektir.
Gereç ve Yöntem: Abdominal aorta rüptürü tanısı ile 2009-2017 yılları arasında açık veya endovasküler yöntemlerle opere edilen 34 hasta çalışmaya dahil edilmiştir. Hastaların demografik ve peroperatif verileri retrospektif olarak taranmıştır. Aort anevrizma çapı 55 mm altında olan, bilgisayarlı tomografi anjiografi (CTA) ile rüptür tespit edilmeyen hastalar ile geçirilmiş abdominal aort cerrahisi hikayesi olan hastalar çalışmaya dahil edilmemiştir.
Bulgular: Hastalarda toplam peroperatif eritrosit süspansiyonu kullanım ortalaması 917,64±586,96 mL, acil servisten ameliyata alınana kadar geçen süre ortalaması 526,41±1249,63 dk ve abdominal aort çap ortalaması 73,84±21,67 mm idi. Toplam mortalite 11'di. Operasyon şekline göre peroperatif eritrosit süspansiyonu kullanımı istatistiksel olarak anlamlı farklılık içermekteydi (p:0,001). Gruplar arasında diğer demografik veriler istatistiksel olarak farklılık göstermemekteydi. Hastanın acil servise girişi ile hastanın ameliyata alınışına kadar geçen süre açısından gruplar arasında istatistiksel olarak anlamlı fark mevcuttu (p:0,023). Gruplar arasında abdominal aort çapı istatistiksel olarak anlamlı farklılığa sahipti (p:0,045). Mortalite üzerinde, kronik obstrüktif akciğer hastalığı varlığının ve tedavi yöntemi tercihinin etkisi istatistiksel olarak anlamlı idi (p:0,025 ve p:0,045, sırasıyla).
Sonuç: Mortalite açısından endovasküler yöntemlerin avantajlı olmasına rağmen hala anatomik ve teknik sınırlamalar dolayısı ile açık cerrahi, rüptüre abdominal aorta anevrizmalarında öncelikli tercih olmaktadır.

Gelişen teknoloji, stent greft sistemlerine erişimin kolaylaşması ve acil endovasküler girişimlerdeki tecrübe artışı daha az mortalite ile rüptüre abdominal aorta avrizmalarına müdahale etmeyi sağlayacaktır.
Anahtar kelimeler: Abdominal aort anevrizması, aort rüptürü, endovasküler prosedürler, damar cerrahisi işlemi

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Introduction

Abdominal aortic aneurysm (AAA) can be defined as dilatation of the subdiaphragmatic segment of the aorta that can be seen anywhere in the vessel wall. It is seen in 3-5% of the general population (1). The incidence increases with age, and the risk of annual rupture increases as the diameter increases (2). Regardless of aneurysm diameter, 5-year rupture rates vary between 6-15% in all patients (3). The rupture rate is approximately 9.4%, especially in patients with aneurysms larger than 5.5 cm (4). AAA rupture is the primary cause of death in 1.5% of patients over 55 years of age (5). Although direct radiography, ultrasonography and magnetic resonance imaging are used in the diagnosis, computed tomography (CT) is the gold standard for detecting aneurysms. CT is used to evaluate the general structure of the aorta, the location of the aneurysm, its diameter, and graft attachment sites, especially in patients who are considered for endovascular intervention (6).

Approximately half of the patients diagnosed with an abdominal aortic rupture die before operation or intervention (3). Surgery can always be the choice of treatment for any patient diagnosed with a ruptured abdominal aortic aneurysm (RAAA). However, the mortality rate in emergency surgery is very high (1). For this reason, it is necessary to use new methods, especially in emergency cases. There are limiting factors in endovascular procedures such as contrast agent toxicity, aortic neck requirement for graft seating, allergy, early-stage thrombosis in the graft, and endoleak development (5,6).

The present study aims to evaluate the factors affecting mortality in patients with RAA, which was greater than 5.5 cm in diameter and treated with either open surgeries or endovascular procedures.

Material and Methods

A total of 34 patients who were treated with either open surgeries or endovascular methods between 2009 and 2017 with the diagnosis of abdominal aortic rupture were included in this study. The patients' clinical information, demographic data, and past intervention histories were scanned retrospectively from patient files and electronic media. In addition, whether the patients had chronic diseases such as hypertension, diabetes, chronic obstructive pulmonary disease (COPD), coronary artery disease (CAD), congestive heart failure (CHF), and obesity (body mass index > 30 kg/m^2), their habits such as smoking and clinical findings such as hemoglobin, platelet count, platelet lymphocyte ratio (P/L), neutrophil-lymphocyte ratio (N/L) and aneurysm diameter were recorded.

Patients with an abdominal aortic aneurysm with a diameter of 55 mm and above in the contrast-enhanced thoracoabdominal CT after their admission to the emergency department were included in the study. The study did not include patients with aortic aneurysm diameter less than 55 mm, with a history of previous abdominal aortic surgery, and without rupture detected by computed tomography angiography.

In addition to physical examinations and clinical evaluations, blood tests and CTA were planned for the patients. The type of the operation were decided according to the general conditions of the patients.

All patients were taken to the intensive care unit (ICU) for operation preparation if their general conditions were good after the diagnosis of RAAA. Hemodynamically unstable patients were taken directly to the operating room. Fluid resuscitation was also initiated with a dose of 100 ml/hour. Emergency intervention was planned for the patients endovascular aneurysm repair (EVAR) procedures were done in the angiography unit with the preparations for possible open surgeries in case of unsuccessful procedures. The procedures were performed under local anesthesia, and if necessary, sedation and general anesthesia were used. According to the measurements of the aorta and iliac arteries using CTA, grafts with appropriate sizes were selected. Common femoral arteries were found in all patients bilaterally and turned with tapes after intravenous administration of 100 U/kg heparin.

Systemic heparinization was verified with a target activated coagulation time (ACT) >300 sec. After cannulating the iliac artery and aorta with an extra-hard wire, the proximal graft was positioned 1 cm below the right renal artery. The diameter of the proximal and distal graft landing zones was determined to be 10-30% of normal. With angiographic control, occlusion in the renal arteries, extravasation out of the graft, flow in the distal segment of the graft, and continuity in the rupture were evaluated. Balloon procedure was applied to those areas in patients with proximal and distal leakage. Arteriotomy was closed after the procedure. The skin was closed.

The patients in the surgery group were operated under general anesthesia. Median laparotomy was performed in all patients. The aorta was found, cleaned around, and 100 U/kg heparin was administered intravenously before clamping. Then a cross-clamp was placed, and the aneurysm was cleaned. The proximal graft was sutured from the infrarenal level. Then, an intact iliac artery or femoral artery segment was found, and the distal graft was sutured to this region in accordance with its diameter. Bleeding control was performed. In case of leakage in the distal and proximal of the graft, the bleeding was stopped with additional sutures. Distal flow was evaluated. Then the subcutaneous tissue and skin were closed. Hemodynamic monitoring was performed in all procedures. Central venous catheter and arterial monitoring for continuous blood pressure monitoring were applied because massive transfusion may be required in the patients. After the procedure, all patients were followed up in the intensive care unit on the first postoperative day.

Post-operative Follow-up

In all patients, low molecular weight heparin was administered routinely for 5 days post-operatively. In addition, acetylsalicylic acid (ASA) 100 mg was started. Vitamin K antagonist was initiated in patients with atrial fibrillation. Treatment with dual antiaggregant therapy (clopidogrel 75mg, ASA 100 mg) was continued in patients who were not started on a vitamin K antagonist.

The study's endpoint was the development of complications such as early postoperative wound infection, loss of limb, need for reoperation, and early mortality.

Statistical Analysis

The NCSS (Number Cruncher Statistical System, 2007, Kaysville, Utah, USA) program was used for statistical analysis. Descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum, maximum) were used while evaluating the study data. The Mann-Whitney U test was used to compare two groups of parameters that did not show normal distribution. The Pearson Chi-Square test was used to compare qualitative data. Significance was evaluated at $p<0.001$ and $p<0.05$ levels.

Results

Of the patients, 14.7% (n:5) were female, and 85.3% (n:29) were male, while 79.4% had hypertension, 82.6% had diabetes, 50% had smoking habit, and 23.5% had COPD. The mean age of the patients included in the study was 69.59±10.78 (69.00) years, and the preoperative mean hemoglobin value was calculated as 10.93±2.08 (10.60) g/dL. The mean use of perioperative erythrocyte suspension in patients was 917.64±586.96 (700.00) mL, the mean time from the emergency room to surgery was 526.41±1249.63 (100.00) minutes, and the mean abdominal aortic diameter was 73.84±21.67 (68.50) mm. Early mortality was observed in 11 patients in both groups. While endovascular treatment was applied to 32.4% of the patients, open surgery was performed to 67.6%.

Gender, hypertension, chronic obstructive pulmonary disease, diabetes, coronary artery disease, N/L, P/L, hemoglobin, and C-reactive peptide (CRP) values did not differ statistically between the groups ($p>0.05$). The volume of erythrocyte suspension used during the procedure was lower in the endovascular intervention group compared to the open surgery group. In this respect, there was a statistically significant difference between the two groups (p:0.001). The time between the admission of the patient to the emergency room and the surgery was shorter in the open surgery group, and there was a statistically significant difference between the groups in this regard (p:0.023). There was a statistically significant difference between the groups in terms of abdominal aortic diameter (p:0.045) (Table 1).

When a comparison was made in terms of treatment methods, the mortality rate was found to be statistically significantly lower in

endovascular treatment modality compared to open surgery (p:0.045). Age, presence of coronary artery disease, diabetes, smoking, hypertension, gender, abdominal aortic diameter, time from emergency department to surgery, hemoglobin, P/L, N/L, CRP and erythrocyte use were not found statistically significant on mortality (p>0.05) (Table 2). However, mortality rates were lower in ruptured AAA in females compared to males.

Table 1. *Evaluation of Demographic Characteristics by Operation Type*

		Endovascular (n=11)		**Open Surgery (n=23)**		**p**
Gender	*Female*	1	9,1	4	17,4	***0,523***
	Male	10	90,9	19	82,6	
Hypertension	-	2	18,2	5	21,7	***0,810***
	+	9	81,8	18	78,3	
Chronic Obstructive Pulmonary Disease	-	8	72,7	18	78,3	***0,722***
	+	3	27,3	5	21,7	
Diabetes	-	2	18,2	4	17,4	***0,955***
	+	9	81,8	19	82,6	
Coronary Artery Disease	-	4	36,4	14	60,9	***0,180***
	+	7	63,6	9	39,1	
		Mean±SD (Median)		**Mean±SD (Median)**		
Age (year)		70,36±6,99 (70,00)		69,22±12,32 (69,00)		***[b]0,971***
Hemoglobin (g/dL)		11,65±1,97 (12,10)		10,59±2,08 (10,50)		***[b]0,146***
N/L		8,58±8,67 (4,95)		7,57±9,68 (4,63)		***[b]0,840***
P/L		201,77±206,28 (126,77)		129,98±116,19 (94,85)		***[b]0,217***
Platellet (K/uL)		191,27±47,66 (177,00)		206,29±87,51 (184,00)		***[b]0,883***
CRP (mg/L)		9,29±11,18 (5,06)		4,93±6,24 (2,55)		***[b]0,253***
Erythrocyte Suspension (mL)		436,36±215,74 (400,00)		1147,82±569,58 (1000,00)		***[b]0,001*****
Time to Surgery (minutes)		1318,45±2001,07 (150,00)		147,61±241,95 (60,00)		***[b]0,023****
Abdominal Aortic Aneurysm (mm)		65,00±23,68 (59,00)		78,07±19,79 (78,00)		***[b]0,045****

*[a]Pearson Chi-Square [b]Mann Whitney U Test **p<0,01 *p<0,05*

Discussion

Aortic aneurysm is most common in the abdominal region and is characterized by a pulsatile mass in the abdomen. It is usually silent when there is no rupture (7). However, AAA rupture is associated with a mortality of over 90% (8,9).

In their study including 113 patients, De Rango et al. stated that although the number and mean age of female patients with RAAA who were treated with either open surgery or EVAR were higher than male patients, their mortality rates were lower than males (10). They attribute this situation to the fact that the cases are treated in a single center and that there are different surgeons who determine the procedure to be performed. Similar results were obtained in the present study. However, patients who were operated by the same surgical team were included in this study. The small number of patients was a limiting factor for this study in determining the effect of gender on mortality. Larger randomized studies are needed on this subject.

Considering the meta-analyses conducted in a study that showed the presence of endovascular appropriateness during open surgery in RAAA decreased the mortality in open surgery. It was also stated that endovascular repair caused a decrease in perioperative mortality by approximately 50% compared to open surgery (11). Similarly, in the current study, endovascular treatment in RAAA showed a lower early mortality compared to open surgery.

Table 2. *Evaluation of Demographic Characteristics by Mortality*

		Mortality				
		No (n=23)		**Yes (n=11)**		**P**
Gender	*Female*	4	17,4	1	9,1	***0,523***
	Male	19	82,6	10	90,9	
Smoker	-	12	52,2	5	45,5	***0,714***
	+	11	47,8	6	54,5	
Hypertension	-	4	17,4	3	27,3	***0,505***
	+	19	82,6	8	72,7	
Diabetes	-	5	21,7	1	9,1	***0,365***
	+	18	78,3	10	90,9	
Coronary Artery Disease	-	11	47,8	7	63,6	***0,388***
	+	12	52,2	4	36,4	
Operation Type	*Endovascular*	10	43,5	1	9,1	***[a]0,045****
	Open Surgery	13	56,5	10	90,9	
		Mean±SD (Median)		**Mean±SD (Median)**		
Age (year)		69,26±11,83 (70,00)		70,27±8,68 (68,00)		***[b]0,883***
Hemoglobin (g/dL)		10,91±1,85 (10,60)		10,97±2,59 (10,60)		***[b]0,883***
N/L		7,81±9,25 (4,15)		8,1±9,68 (4,98)		***[b]0,941***
P/L		160,89±156,98 (113,92)		137,14±146,45 (86,00)		***[b]0,320***
Platellet (K/uL)		196,94±73,72 (180,00)		210,82±84,78 (184,00)		***[b]0,797***
CRP (mg/L)		6,62±8,54 (4,80)		5,76±8 (1,80)		***[b]0,645***
Erythrocyte Suspension (mL)		904,34±643,48 (600,00)		945,45±474,05 (800,00)		***[b]0,539***
Time to operation (minutes)		668,8±1492,1 (80,00)		228,6±333,6 (120,00)		***[b]0,685***
Abdominal Aortic Aneurysm (mm)		70,8±22,9 (67,00)		80,2±18,1 (78,00)		***[b]0,217***

[a]Pearson Chi-Square *[b]Mann Whitney U Test*

AAA is thought to be a disease that develops on an inflammatory background (12). In many studies, the diagnostic use of different inflammatory markers in AAA patients was evaluated (13,14). Among these markers, CRP and high sensitivity CRP (hsCRP) stand out as they are easily accessible in clinical use. Wang et al. reported that hsCRP levels were inversely proportional to the diameter of the aneurysm (15). Another clinical study evaluating CRP levels was performed by Woloszko et al. (16). According to the results of this study, no statistically significant relationship was found between AAA growth and CRP. In the current study, CRP values were evaluated, and no statistically significant relationship was found between mean CRP values in terms of operation type and mortality rates. Although this situation includes similar results to the study performed by Woloszko et al., it would be more appropriate to evaluate the results obtained in a separate study with a larger sample, since the relationship between CRP level and aneurysm was not targeted among the primary outcomes of the current study and because of the low number of samples in the study. In addition, in this study by Woloszko et al., age, gender, hypertension, and smoking could not be associated with aneurysm enlargement (16). Contrary to these findings, Aslan et al. reported that concomitant hypertension had a role in increasing the risk of rupture (17). In the same study, it was stated that more aortic aneurysms were detected in smokers and men. In our study, 79.4% of the patients had a diagnosis of hypertension, consistent with the findings of Aslan et al., and the majority of the patients (85.3%) were male (17). However, only 50% of patients were smokers. The incidence of aneurysm increased with age. The mean age of the patients in our study was 69.59 years, which is consistent with the literature (2).

Many parameters were compared in studies conducted regarding operation preference. In the study by Gunes et al., where parameters such as mortality, mean operative time, and perioperative

blood transfusion were evaluated, it was shown that the endovascular method was superior to the open surgical method in AAA (18). From the point of view of emergency intervention, the duration of the operation is important. In the study, the time to surgery was longer in the endovascular group, and there was a statistically significant difference between the two groups in this regard (p:0.023). As stated in the study by İsbir et al., this difference can be due to the necessity of the preparation phase of endovascular treatment and the time it takes to obtain endovascular materials (2). Consistent with the study by Gunes et al. (18), the use of perioperative erythrocyte suspension and mortality rate in the current study were statistically significantly lower in the endovascular intervention group (p:0.001 for mortality; p:0.045 for erythrocyte suspension).

In conclusion, although endovascular interventions were with less blood product use and less mortality in RAAA, open surgery should be kept in mind as an alternative treatment because of long preparation phases of endovascular procedures.

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