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Endovascular Repair of Ruptured Aortic Aneurysm: A Single-Center Experience

Aort Anevrizması Rüptürünün Endovasküler Onarımı: Tek Merkez Deneyimi

ORIGINAL ARTICLE
KLİNİK ÇALIŞMA

ABSTRACT

Objective: Aortic rupture is a rare and catastrophic emergency. Prompt diagnosis and treatment are the primary determinants of mortality. During follow-up, the majority of patients who have been effectively treated die from hypovolemic shock and multiorgan failure. This article describes the clinical and procedural details of sixteen patients with ruptured aortic aneurysms treated endovascularly. In addition, it discusses the main factors contributing to the mortality of these patients.

Method: Patients who underwent endovascular treatment for acute aortic rupture at our center from October 2016 to March 2023 were included in this retrospective study.

Results: A total of 16 patients underwent endovascular aneurysm repair (EVAR) or thoracic endovascular aneurysm repair (TEVAR) for acute aortic rupture. The patients' mean age was 73.06 years (range: 52-92), and 15 of them were male. The ruptures occurred in the abdominal aortic aneurysm in ten patients, in thoracic aortic aneurysm in three patients, in the isolated iliac artery aneurysm in two patients, and there was one case of non-aneurysmal aortic rupture. In our series, patients who presented with an impending, self-limited rupture and stable hemodynamic status had good prognostic outcomes. However, eight patients died due to multiorgan failure, hemorrhagic shock, disseminated intravascular coagulopathy, renal failure, or abdominal compartment syndrome. These patients generally had poor admission vital signs and low hemoglobin values. The most critical determinants for the success of the procedure are promptly stopping the bleeding, avoiding general anesthesia, and opting for blood product replacement instead of fluid replacement.

Conclusion: Each patient with ruptured aortic aneurysm should be managed according to the patient's hemodynamics at presentation, the size of the aneurysm, the suitability for percutaneous procedure, logistical factors, and the operator-center's experience.

Keywords: Aortic aneurysm rupture, aortic rupture, endovascular aortic repair

ÖZET

Amaç: Aort rüptürü nadir görülen, katastrofik bir acil durumdur. Mortalitenin birincil belirleyicileri hızlı tanı ve tedavidir. Başarılı bir şekilde tedavi edilen birçok hasta işlem sonrası hipovolemik şok ve çoklu organ yetmezliği nedeniyle kaybedilmektedir. Bu makalede aort rüptürü olan ve endovasküler olarak tedavi edilen on altı hastanın klinik ve prosedür ayrıntıları anlatılacaktır. Ayrıca hastaların mortalitesinin ana belirleyicileri vurgulanmaya çalışılmıştır.

Yöntem: Ekim 2016-Mart 2023 tarihleri arasında merkezimizde akut aort rüptürü nedeniyle endovasküler tedavi uygulanan hastalar retrospektif olarak çalışmaya dahil edildi.

Bulgular: Akut aort rüptürü için toplam 16 hastaya endovasküler anevrizma onarımı (EVAR) veya torasik endovasküler anevrizma onarımı (TEVAR) uygulandı. Hastaların yaş ortalaması 73.06 (52-92) yıl olup, 15 hasta erkekti. 10 hastada abdominal aort anevrizması rüptürü, 3 hastada torasik aort anevrizması rüptürü, 2 hastada izole iliak arter anevrizması rüptürü ve 1 hastada anevrizmal olmayan aort rüptürü saptandı. Bizim serimizde kendi kendini sınırlayan, hemodinamik durumu stabil olan hastaların prognozu oldukça iyiydi. Ancak sekiz hastamız multiorgan yetmezliği, hemorajik şok, dissemine intravasküler koagülopati, böbrek yetmezliği veya abdominal kompartman sendromu nedeniyle kaybedildi. Bu hastalar genellikle kötü başvuru hayati belirtileri ve hemoglobin değerlerine sahipti. İşlemin başarısı icin en önemli faktörler kanamayı bir an önce durdurmak, genel anesteziden kaçınmak ve sıvı replasmanı yerine kan ürünü replasmanı yapmaktı.

Sonuç: Her hasta başvuru anındaki hemodinamiğine, anevrizma boyutuna ve EVAR'a veya prosedürün cerrahi uygunluğuna, lojistik faktörlere ve operatör merkezin deneyimine göre yönetilmelidir.

Anahtar Kelimeler: Aortik anevrizma rüptürü, aortik rüptür, endovasküler aortik tamir

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Aortic rupture is an uncommon, catastrophic emergency with a nearly 100% fatality rate when left untreated, and a 30-day mortality rate of up to 70% observed in some studies.[1,2] Prompt diagnosis and treatment are the primary determinants of mortality. Recent advancements in the field of endovascular medicine have improved the prognoses for these patients. However, many patients who are successfully treated with endovascular aortic grafts or surgical methods still die due to bleeding problems, hypovolemic shock, multiorgan failure, and disseminated intravascular coagulopathy during the follow-up period.[2] Achieving optimal outcomes depends on the coordinated efforts of a multidisciplinary team, providing critical care, medical and interventional management, and rapid resuscitation of patients with aortic rupture.[2]

Most aortic ruptures develop based on pre-existing aneurysms. Ruptures not associated with aneurysms are very rare and are primarily caused by blunt aortic injury resulting from rapid deceleration, penetrating trauma, and, infrequently, infectious diseases. Aortic aneurysms are usually asymptomatic unless complications arise, and they are often diagnosed through nonspecific symptoms and screening programs. Aortic rupture, the primary and most frequent complication of aortic aneurysms, is thought to cause 150,000–200,000 fatalities annually worldwide.[3] Estimating the incidence of aortic aneurysm rupture is difficult due to occurrence of out-of-hospital arrests. It is estimated that 4% to 5% of sudden death cases are secondary to aortic aneurysm rupture.[4] The overall incidence of ruptured abdominal aortic aneurysm in patients with an aortic aneurysm diameter > 5.5 cm is 5.3% per year.[5]

Recent studies and registries have reported a significant decrease in the number of cases of aortic aneurysm rupture presenting to hospitals, as well as improvements in in-hospital mortality rates.[6,7] These results can be attributed to an increase in prophylactic elective repairs of aortic aneurysms, the introduction of endovascular aneurysm repair (EVAR), a rise in the number of centers performing emergency EVAR, and the growing experience of these centers.[6,7] Despite these advancements, mortality rates can be as high as 50% in high-experience centers due to bleeding problems, hypovolemic shock, multiorgan failure, and disseminated intravascular coagulopathy during the follow-up period.[2] In this article, we described the clinical, laboratory, computed tomography images, and procedural details of 15 patients with aortic aneurysm rupture and one patient with non-aneurysmal aortic rupture, all of whom were treated endovascularly. In addition, we discussed the main factors contributing to the mortality of these patients.

Materials and Methods

This study was designed as a retrospective registry study. We included patients who underwent endovascular treatment for acute aortic rupture at our center between October 2016 and March 2023 and whose data were accessible. All patients underwent a joint evaluation by the cardiovascular surgery and cardiology departments. Patients deemed unsuitable for endovascular repair and better suited for surgical treatment were operated on and subsequently excluded from this analysis. Only three patients were treated with open surgery. Open surgery was performed on one very young patient (42 years old), while the others underwent the procedure due to suprarenal abdominal aortic aneurysms. The same team, comprising two cardiologists and one cardiovascular surgeon, performed all endovascular aortic procedures. Patients whose data were inaccessible were excluded, and no additional exclusion criteria were established. The Gülhane Training and Research Hospital Ethics Committee approved the study (Approval Number: 2023-89, Date: 14.03.2023).

ABBREVIATIONS

AAA	Abdominal aortic aneurysm
EVAR	Endovascular aneurysm repair
POSSUM	Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity
TEVAR	Thoracic endovascular aneurysm repair

Results

Between October 2016 and March 2023, we examined a total of 137 patients with aortic aneurysms at our center. Of these, 16 patients underwent EVAR or thoracic endovascular aneurysm repair (TEVAR) for acute aortic rupture. The mean age of the patients with acute aortic rupture was 73.06 years, ranging from 52 to 92 years, and 15 of these patients were male. Table 1 provides details on patients' risk factors, admission symptoms, hemoglobin values upon hospital admission, lowest hemoglobin values, and blood product replacement details.

Abdominal aortic aneurysm rupture was diagnosed in ten patients, thoracic aortic aneurysm rupture in three patients, isolated iliac artery aneurysm rupture in two patient, and non-aneurysmal aortic rupture in one patient. In seven cases, the procedure had to be performed under general anesthesia due to poor hemodynamic status. The Chimney technique was used for left subclavian artery preservation in only one patient, but it resulted in a Type 1 endoleak. Two patients had a history of EVAR: one of them was admitted due to an aneurysm sac rupture caused by a Type 1a endoleak, and the other was admitted due to a Type 3 endoleak caused by the separation of modular components. Type 1a endoleak was successfully treated with an aortic cuff, and Type 3 endoleak was addressed using bilateral iliac extensions. In another patient, the aneurysm sac encompassed the renal and mesenteric arteries, necessitating the occlusion of these arteries with a graft implantation. This was followed by renal and mesenteric artery graft interposition through open surgery. However, this patient succumbed to postoperative multiorgan failure. In all other cases, the procedures were successfully concluded without any incidents of endoleak and hemorrhage. Nonetheless, eight (50%) of our patients died due to complications such as multiorgan failure, hemorrhagic shock, disseminated intravascular coagulopathy, renal failure, or abdominal compartment syndrome. These patients generally presented with poor admission vital signs and low hemoglobin values. Computed tomography evaluations and procedural features of the patients are summarized in Table 2.

Figures 1 and 2 provide computed tomography angiography and procedural images from one of our cases.

Table 1. Basal Demographic and Laboratory Examination Details

	Age	Gender	Comorbidities	Hospital Admission Complaints and Findings	Hospital Admission Hemoglobin Value	Lowest Hemoglobin Value	Blood Product Replacements
Patient 1	63-year-old	Male	HT, DM, smoker	Confusion, back pain, hypotension arrest	12.1 g/dL	6.0 g/dL	4 units of erythrocyte suspension 3 units of fresh frozen plasma
Patient 2	86-year-old	Male	HT, ex-smoker	Confusion, abdominal and lower back pain	13.6 g/dL	6.4 g/dL	4 units of erythrocyte suspension 2 units of fresh frozen plasma
Patient 3	69-year-old	Male	HT, CAD, ex-smoker	Abdominal pain	14.4 g/dL	12.8 g/dL	---
Patient 4	81-year-old	Male	HT, DM, stroke, ex-smoker	Confusion, abdominal pain, hypotension, bradycardia, arrest	11.8 g/dL	7.3 g/dL	4 units of erythrocyte suspension 2 units of fresh frozen plasma 1 unit of platelet apheresis
Patient 5	81-year-old	Male	CAD, ex-smoker	Back pain	12.5 g/dL	10.2 g/dL	---
Patient 6	75-year-old	Male	HT, CAD	Back pain	10.2 g/dL	7.6 g/dL	4 units of erythrocyte suspension
Patient 7	78-year-old	Male	HT, Alzheimer's	Abdominal pain	14.8 g/dL	13.7 g/dL	---
Patient 8	52-year-old	Male	HT, smoker	Abdominal pain	13.1 g/dL	8.1 g/dL	4 units of erythrocyte suspension 2 units of fresh frozen plasma
Patient 9	64-year-old	Male	Smoker	Confusion, abdominal pain, hypotension arrest	10.2 g/dL	5 g/dL	4 units of erythrocyte suspension
Patient 10	73-year-old	Male	---	Confusion, abdominal pain, hypotension	15.1 g/dL	4.7 g/dL	4 units of erythrocyte suspension 2 units of fresh frozen plasma
Patient 11	68-year-old	Female	HT, DM, RA	Back pain, hemoptysis	10.3 g/dL	8.2 g/dL	2 units of erythrocyte suspension
Patient 12	71-year-old	Male	HT, CAD	Abdominal pain	15.0 g/dL	13.1 g/dL	---
Patient 13	92-year-old	Male	CAD	Dyspnea, back pain, unilateral massive pleural effusion	14.0 g/dL	8.0 g/dL	4 units of erythrocyte suspension 2 units of fresh frozen plasma
Patient 14	66-year-old	Male	HT	Abdominal pain	13.5 g/dL	8.9 g/dL	4 units of erythrocyte suspension 2 units of fresh frozen plasma 1 unit of platelet suspension
Patient 15	75-year-old	Male	HT, history of EVAR	Abdominal pain	12.6 g/dL	7.4 g/dL	4 units of erythrocyte suspension
Patient 16	75-year-old	Male	HT, CKD, history of EVAR	Syncope, confusion, abdominal pain, hypotension	7.7 g/dL	7.2 g/dL	3 units of erythrocyte suspension 2 units of fresh frozen plasma

CAD, coronary artery disease; CKD, chronic kidney disease; DM, diabetes mellitus; EVAR, endovascular aneurysm repair; HT, hypertension; RA, rheumatoid arthritis.

Table 2. Computed Tomographic Angiography and Procedural Details

	CT Angiography	Indication	Location	Anesthesia	Arterial Approach Location	Graft Type and Size	Procedural Result	Intensive Care Unit Result
Patient 1	67x58.5 mm abdominal aortic aneurysm	Rupture	Infra-renal abdominal aortic aneurysm	General Anesthesia	Right femoral (main delivery system), left brachial	Uni-iliac graft and fem-fem bypass (Medtronic-Endurant)	Successful	Ex
Patient 2	90x90 mm abdominal aortic aneurysm	Rupture	Infra-renal abdominal aortic aneurysm	General Anesthesia	Right femoral (main delivery system), left femoral	Bi-iliac graft (Medtronic-Endurant)	Successful	Ex
Patient 3	43x60 mm abdominal aortic aneurysm	Impending rupture	Infra-renal abdominal aortic aneurysm	Sedation	Right femoral (main delivery system), left femoral	Bi-iliac graft (Medtronic-Endurant)	Successful	Discharged
Patient 4	58x63 mm right iliac aneurysm	Rupture	Iliac aneurysm	General Anesthesia	Right femoral (main delivery system)	Iliac graft covered stent (Fluency)	Successful	Ex
Patient 5	43x60 mm thoracic aortic aneurysm	Rupture	Thoracic aortic aneurysm	Sedation	Right femoral (main delivery system)	Thoracic aortic graft (Medtronic-Valiant)	Successful	Discharged
Patient 6	Non-aneurysmal abdominal aortic rupture	Psoas abscess associated abdominal aortic rupture	Infra-renal abdominal aorta	Sedation	Right femoral (main delivery system), left femoral	Tubular aortic graft (28x28 mm Medtronic-Endurant)	Successful	Discharged
Patient 7	46x70 mm abdominal aortic aneurysm	Impending rupture	Infra-renal abdominal aorta	Sedation	Right femoral (main delivery system), left femoral	Bi-iliac graft (Medtronic-Endurant)	Successful	Discharged
Patient 8	107x109 mm abdominal aortic aneurysm	Rupture	Infra-renal abdominal aorta	General Anesthesia	Right femoral (main delivery system), left femoral	Bi-iliac graft (Medtronic-Endurant)	Successful	Discharged
Patient 9	89x110 mm abdominal aortic aneurysm	Rupture	Infra-renal abdominal aorta	General Anesthesia	Right femoral (main delivery system), left femoral	Bi-iliac graft (Medtronic-Endurant)	Successful	Ex
Patient 10	81x85 mm abdominal aortic aneurysm	Rupture	Infra-renal abdominal aorta	General Anesthesia	Right femoral (main delivery system), left femoral and left carotid	Bi-iliac graft (Medtronic-Endurant)	Successful	Ex
Patient 11	62x98 mm thoracic aortic aneurysm	Rupture	Thoracic aortic aneurysm	Sedation	Right femoral (main delivery system), left femoral	Thoracic aortic graft (Medtronic-Valiant)	Successful	Discharged
Patient 12		Impending rupture	Infra-renal abdominal aorta	Sedation	Right femoral (main delivery system), left femoral	Bi-iliac graft (Medtronic-Endurant)	Successful	Discharged
Patient 13	66x69 mm thoracic aortic aneurysm	Rupture	Thoracic aortic aneurysm	Sedation	Right femoral (main delivery system), left femoral, left brachial	Thoracic aortic graft (2), Chimney technique for preserving the left subclavian artery. (Medtronic-Valiant)	Type 1 endoleak	Discharged
Patient 14	91x82 mm abdominal aortic aneurysm	Impending rupture	Infra-renal abdominal aorta	General Anesthesia	Right femoral (main delivery system), left femoral, left brachial	Bi-iliac graft (Medtronic-Endurant), Superior mesenteric artery and renal artery graft interposition	Successful	Ex
Patient 15	140x126 mm abdominal aortic aneurysm	EVAR Type 1a endoleak and Type 3 endoleak due to separation of modular components. Rupture	Infra-renal abdominal aorta	Sedation	Right femoral, left femoral, left brachial	Proximal aortic cuff, bilateral iliac limb extension for separation of modular components. (Medtronic-Endurant)	Successful	Ex
Patient 16	57x81 mm rupture left iliac aneurysm, 75x72 mm right non-ruptured iliac aneurysm	Rupture	Bilateral iliac aneurysm	Sedation	Bilateral femoral arteries (iliac extension)	Bilateral iliac limb extension (Medtronic-Endurant)	Successful	Ex

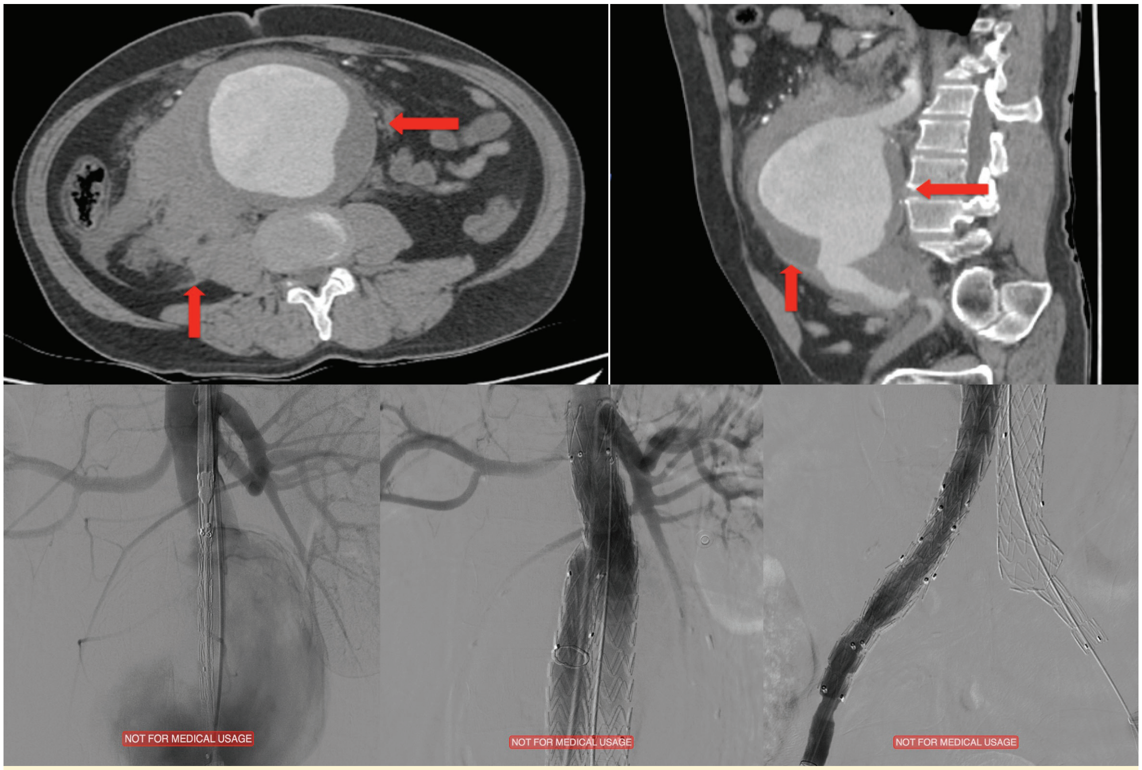

Figure 1. Massive abdominal aortic aneurysm rupture and its successful treatment using endovascular aortic graft implantation.

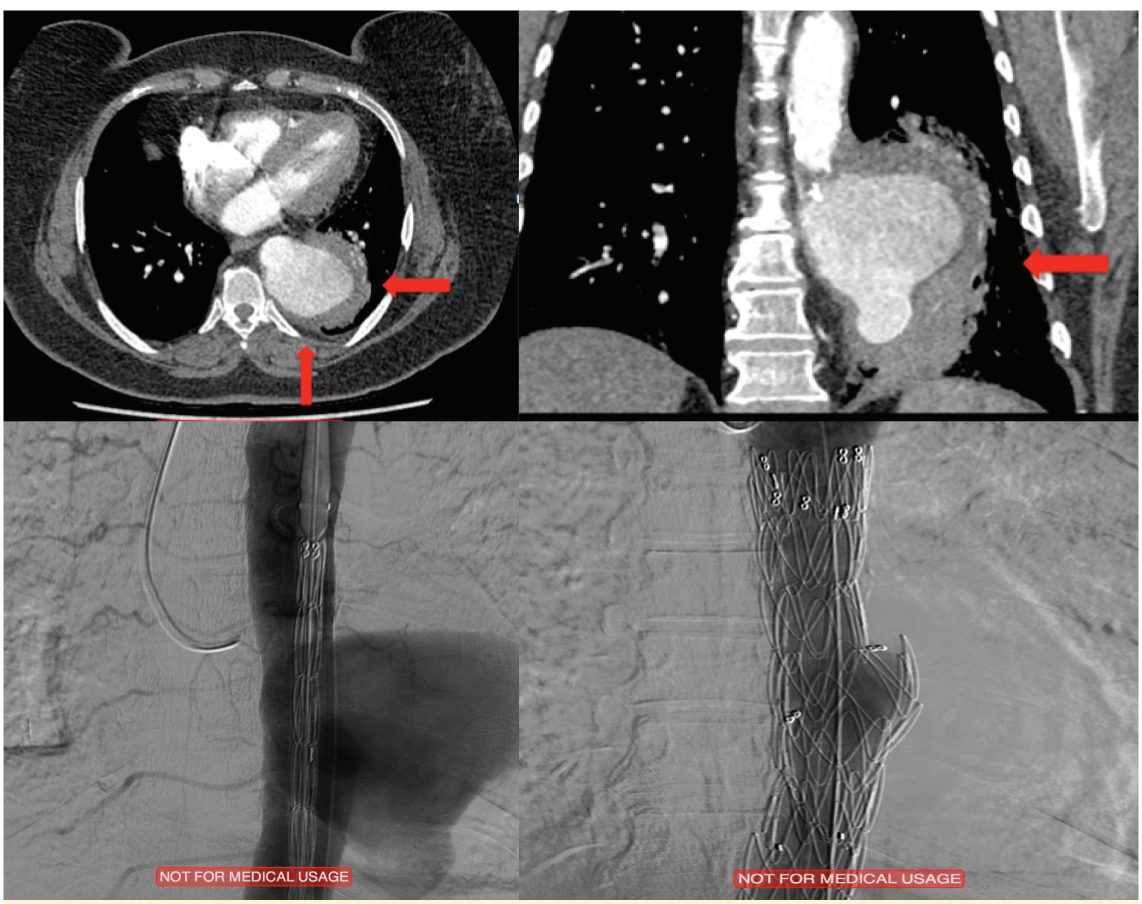

Figure 2. Computed tomography images of a thoracic aortic aneurysm rupture.

Discussion

The rupture of an aortic aneurysm is a rare emergency, characterized by a high mortality rate. Determining exact frequency and mortality rates is challenging, as most patients die before reaching the hospital. This study reports on the factors influencing the clinical, demographic, laboratory, and survival aspects of 16 aortic rupture cases treated at our center.

Aortic aneurysm rupture is a complex biological process influenced by biochemical, cellular, proteolytic variables, and biomechanical considerations. Proteolytic activity of matrix metalloproteinases has been linked to the weakening and rupture of the aneurysm wall. The diameter of an aneurysm is the most common factor predisposing it to growth and rupture, while the growth rate of an aneurysm also predicts the risk of rupture.[8] The risk of rupture is influenced by factors such as wall stress, aneurysm shape and geometry, intraluminal thrombus, wall thickness, calcification, and metabolic activity.[4,9]

Over the last 30-40 years, there have been significant changes in public health, ranging from reduced smoking rates to improved air quality, as well as more aggressive strategies for cardiovascular risk reduction.[9] These improvements in public health initiatives are anticipated to influence the rate of aortic aneurysm rupture.[10] Cardiovascular risk reduction strategies, such as smoking cessation, blood pressure control, statin treatment, and screening approaches, have significantly improved the prognosis of aortic aneurysms.[9] Furthermore, the increasing prevalence of elective aortic aneurysm repairs, the introduction of endovascular techniques, and the growth in the number of centers performing these procedures have contributed to a decrease in aortic aneurysm mortality.[7] Consequently, despite the decrease in hospital mortality rates for aortic aneurysm rupture, more than 50% of patients die before reaching the hospital. Even when patients who do reach the hospital receive appropriate treatment, 30-50% of them die. Laine et al.[11] reported that the overall 30-day mortality rate was 72.1% for all patients with ruptured aneurysms, 39.7% for those who arrived at the hospital alive, and 32.8% for those who underwent surgery for ruptured abdominal aortic aneurysms between 2003 and 2013 in Helsinki. In addition, estimating population-based mortality for ruptured abdominal aortic aneurysm (AAA) is challenging because many individuals die outside of the hospital and without a diagnosed AAA. Many of these individuals have other comorbidities, and the real cause of death is frequently unknown due to lower autopsy rates in many countries.

Numerous studies and risk scores have been developed to predict the mortality of patients admitted to the hospital with a diagnosis of aortic rupture. Some of these include the Hardman Index, Glasgow Aneurysm Score, Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity (POSSUM), and the Vancouver Scoring System. However, there is no evidence that any scoring system has complete or consistent validity.[12] Additionally, there is no variable or combination of variables that can reliably and consistently predict the outcome based on the available data.[12] These risk scoring systems often include variables such as the patients' admission hemoglobin value, systolic blood pressure, consciousness status, serum creatinine values, age, and comorbid diseases.[12]

Despite all these trials, we have learned from our cases that one of the most important factors in determining patient prognosis is prompt surgery or an EVAR procedure. Recent studies have shown no significant difference between surgery and EVAR in terms of 30-day mortality and severe complications.[13] However, reports indicate that EVAR may yield better results in hemodynamically unstable patients.[14] According to the most recent meta-analysis, in-hospital mortality was 30% for patients treated with EVAR and 42% for those treated with surgery.[15] Although early-period EVAR results are better, EVAR-specific complications and endoleaks are frequently seen in patients during follow-up. In our patient series, we observed two patients with Type 1 and Type 3 endoleak-related ruptures. Consequently, many reports in the literature discuss the risk of rupture after EVAR.[16,17] Therefore, open surgery should be considered for every patient whose aneurysm neck is unsuitable for EVAR, especially younger patients.[2]

Also, it is crucial to avoid general anesthesia in patients with aortic rupture who are experiencing a severe drop in hemoglobin levels, bordering on hypovolemic shock. If possible, performing the procedure under local anesthesia and sedation is recommended. Local anesthesia has been associated with decreased operative time, estimated blood loss, intraoperative blood transfusions, intraoperative crystalloid administration, intensive care unit length of stay, and postoperative pulmonary complications.[18] General anesthesia has been shown to negatively affect thermoregulation, inflammatory state, and hemodynamic autoregulation, among other processes.[18] Furthermore, due to all these effects, general anesthesia has been reported to increase mortality in patients with ruptured aortic aneurysms compared to local anesthesia.[18,19] In our series, the procedure was performed under general anesthesia for five patients who ultimately died. Although we successfully completed the procedures, the patients succumbed to multiorgan failure and other complications in the early postoperative period. The most important lesson we learned from our case series of 16 patients was to avoid general anesthesia in these patients.

Another critical determinant of mortality and morbidity is blood product replacement. There is substantial evidence that excessive fluid replacement, known as the normotensive resuscitation strategy, can exacerbate bleeding and be harmful to patients with hemodynamic compromise.[20] Avoiding excessive volume replacement, providing bleeding control, and maintaining controlled hypotension may reduce massive bleeding and contribute to thrombus formation. Preferably, blood products such as erythrocyte suspension, fresh frozen plasma, and thrombocyte suspension should be used for fluid replacement. It has been reported that the strategy of deliberately lowering blood pressure with pharmacological agents, enough to keep the patient conscious (systolic blood pressure between 70-90 mmHg), which is defined as "hypotensive hemostasis" in normotensive patients, may also be beneficial.[21]

The most time-consuming and crucial step in the EVAR procedure is wiring the opposite iliac artery from the contralateral femoral artery access, complicated further by the presence of a large aneurysm sac. Therefore, brachial or radial sheaths should be routinely placed during the initial step of the procedure while the patients' hemodynamics are stable. Additionally, opting for a bi-iliac graft prolongs the duration of the procedure. In such cases, an aorto-uni-iliac graft can be considered on a case-by-case basis, depending on the patient, and surgery can be performed on the opposite iliac artery once the patient's hemodynamics have stabilized. Another time-saving and life-saving procedure is halting aortic blood flow with an aortic occlusion balloon.[22] Studies have reported that one-third of ruptured aortic aneurysm cases present with hemodynamically unstable conditions, making it imperative to plan for immediate bleeding control.

Another critical consideration in cases of rupture is determining the appropriate extent to which the graft stent should be oversized. Given that these patients often present with hypotension, their aortic diameters may be underestimated. Therefore, it is recommended to oversize the stents by around 30% to avoid a possible Type 1 endoleak in the future.[22]

An important factor determining mortality and morbidity in cases of aortic rupture is the complications encountered in the post-op period, as well as their treatments. It is imperative to be aware of the complications specific to these patients, in addition to contrast-induced nephropathy and infection, which are particularly common. Disseminated intravascular coagulopathy is a significant issue in patients who have received extensive blood product replacement. Another critical complication that should not be overlooked is abdominal compartment syndrome, seen in 7% of abdominal aortic rupture cases.[23]

Limitations

The most significant limitation of our article is the extremely limited number of patients and the fact that it is based on a single-center experience. However, the literature contains minimal data on patients with aortic rupture, which is generally based on retrospective registry studies. Another major limitation is that making inferences from a small patients sample would not be appropriate. Nevertheless, at this point, we have avoided erroneous interpretations by bolstering our experience with knowledge from the literature.

Conclusion

In our series, the outcome for patients who presented with an impending, self-limited rupture and stable hemodynamics was quite good. However, most patients with impaired consciousness and low hemoglobin values at admission died within the first 24 hours after the procedure, even if it was successfully completed. As we have outlined above, the most critical aspects for the success of the procedure in this patient group are stopping the bleeding as quickly as possible, avoiding general anesthesia, and opting for blood product replacement rather than fluid replacement. Each patient should be managed based on their hemodynamics at presentation, aneurysm size, the suitability of EVAR or surgery for the procedure, the extent of bleeding and whether it is self-limiting, logistical factors, and the experience of the operator and center.

Ethics Committee Approval: The Gülhane Training and Research Hospital Ethics Committee approved the study (Approval Number: 2023-89, Date: 14.03.2023).

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