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RESEARCH ARTICLE

Early Period Results for Endovascular Stent Grafting in Abdominal Aortic Aneurysms: A Single-Center Experience

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Abstract

Introduction: In the management of abdominal aortic aneurysm (AAA), endovascular aneurysm repair (EVAR) presents as a superior alternative to conventional surgery, especially for elderly patients with elevated surgical risks and accompanying comorbidities. This study aimed to examine the early outcomes of AAA patients who underwent EVAR. **Methods:** A total of 33 patients diagnosed with AAA who underwent EVAR were evaluated retrospectively. In every patient, the indication for the EVAR procedure was an abdominal aorta diameter exceeding 5.5 cm or over 5 cm when accompanied by additional comorbid factors. During the 1-year follow-up period for the patients, data on early-phase outcomes, lengths of stays in ICU and the hospital, and post-procedure complications were collected. **Results:** In 5 of the patients who underwent EVAR, both iliac artery aneurysm and AAA were present, while in 28, only AAA existed. The median length of ICU stay was 13 hr, and the median length of hospital stay was 3 days. In 12% of the patients, Type I-III endoleak was detected. In the follow-ups examinations, two patients without detected endoleaks manifested lower extremity ischemia or rupture. The total complication rate was 21.2%. There were no mortality cases during the early follow-up period. **Conclusion:** EVAR, in older patients with coexisting comorbidities, offers advantages in diminishing durations in intensive care and hospital stays, potentially boosting early survival outcomes. However, the results from our single-center study indicated that a substantial fraction of patients are susceptible to complications during the early postoperative period.

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Introduction

Abdominal aortic aneurysm (AAA) is a pathologic condition characterized by an enlargement of the abdominal aorta measuring 3.0 cm or greater, which can lead to the aorta's potential rupture.[1] The majority of AAAs are asymptomatic, frequently detected incidentally during imaging procedures for other indications, and pose a significant risk of mortality.[2] The etiology of AAA is multifactorial, with male gender, tobacco usage, age exceeding 65, and coexisting conditions such as hypertension, coronary artery disease, and peripheral vascular diseases being significant contributors.[3]

In young patients with a life expectancy exceeding 15 years, devoid of additional risk factors, without anatomical constraints like horseshoe kidney or abdominal stoma, and without any comorbidities, open surgery is advised for aneurysm repair.[4] In the early 1990s, endovascular aneurysm repair (EVAR) emerged as a fusion of vascular surgery and interventional radiology, serving as a complement to open surgery. Its aim was to address a higher-risk patient group. Due to its minimally invasive nature and success in the early period, it has become a strong alternative to open surgery.[5]

EVAR is associated with situations such as the risk of permanent rupture, the risk of re-intervention, and the need for continuous surveillance.[6,7] In addition to these, the data on early, mid-term, and long-term outcomes of EVAR are still not comprehensive enough. This study aimed to examine the early outcomes of AAA patients who underwent EVAR.

Material and Methods

This retrospective study included patients diagnosed with AAA who underwent EVAR in Izzet Baysal Training and Research Hospital Cardiovascular Surgery Clinic between January 2016 and July 2019. The study initiated with the approval of the Bolu Abant Izzet Baysal University Clinical Resarches Ethics Committee (Date: 18.09.2023, Decision No: EA-1568) and was carried out in accordance with relevant ethical guidelines and the Declaration of Helsinki (revised in 2013, Brazil). The need for informed consent was waived by the local ethics committee due to the retrospective design.

A total of 33 patients diagnosed with AAA who underwent EVAR were evaluated retrospectively. The diagnoses of the patients and the graft sizes were determined based on the results of the 64-slice computed tomography angiography. In every patient, the indication for the EVAR procedure was an abdominal aorta diameter exceeding 5.5 cm or over 5 cm when accompanied by additional comorbid factors. All procedures were performed in the interventional angiography laboratory (GE Innova 2100). An operating room had been kept available during each procedure to address any unforeseen need for emergency surgical intervention. After anesthesia was administered, a bilateral femoral artery dissection had been conducted, preparing both main femoral arteries. After administering anesthesia, a bilateral femoral artery dissection was performed, preparing both main femoral arteries. An arteriotomy was then performed, and through the transfemoral approach, a suitable endovascular graft was inserted. Every patient was treated using the Endurant (Medtronic, Minneapolis, MN, USA) EVAR graft. After the procedure, a control angiography was performed to confirm the graft was open and the aneurysm was fully sealed (Figure 1). The arteriotomy in the femoral artery was closed, and patients were monitored in intensive care unit (ICU) for one day following the procedure.

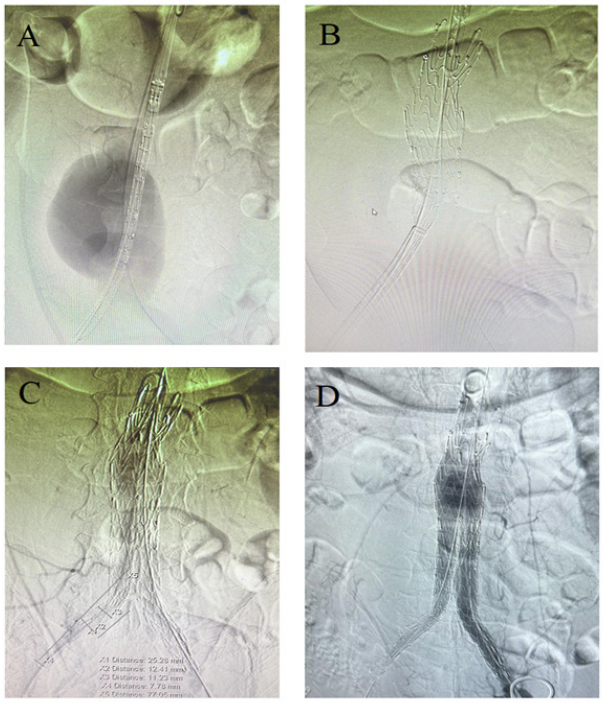

Figure 1. Imaging results of a patient's abdominal aortic aneurysm: (A) Filling of the aneurysm sac before the graft is opened during the EVAR procedure, (B) The main body of the EVAR graft placed at the infrarenal level, (C) Placement of the contralateral limb of the graft, and (D) The final configuration with the entire graft in place.

During the early hospitalization period of patients, renal functions and lower extremity arterial circulation were monitored. Post-discharge, patients were evaluated using abdominal CT or ultrasonography at the end of the first, 6th, and 12th months. In the control medical evaluations, the migration of the stent, the presence of endoleaks, and the stent's positional integrity were assessed.

The hospital's electronic information system and patient files were used to gather demographic and clinical data. During the 1-year follow-up period for the patients, data on early-phase outcomes, lengths of stays in ICU and the hospital, and post-procedure complications were collected.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows 20.0 (IBM Corp., Armonk, NY, USA). Based on the results of the Kolmogorov-Smirnov test, normally distributed numerical data were presented as mean ± standard deviation and non-normally distributed variables were presented as median values (25th-75th quartiles; IQR). Categorical variables were expressed as numbers and percentages.

Results

In 5 of the patients who underwent EVAR, both iliac artery aneurysm and AAA were present, while in 28, only AAA existed. Three patients underwent the procedure on an emergency due to an aneurysm rupture, while 30 patients had it done under elective conditions. All patients treated in emergency situations received aorto-uniiliac stent grafts. Table 1 presents the pre-procedural characteristics and accompanying diagnoses. The demographic and clinical findings of the patients are presented in Table 1. The preoperative and postoperative levels of creatinine, blood urea nitrogen, and estimated glomerular filtration rate for the patients are shown in Table 2. No patients were detected with contrast-induced nephropathy or kidney damage.

The mean operation time was 2.5 (IQR: 2.0 – 3.5) hours and the mean fluoroscopy time was 40 (IQR: 24 – 65 minutes) minutes. The median length of ICU stay was 13 (IQR: 7-19) hr, and the median length of hospital stay was 3 (IQR: 1-7) days. During the follow-up period, complications were detected in seven patients (21.2%). One patient with a Type I endoleak underwent balloon dilation. In two patients with a Type II endoleak, the leak resolved without intervention. In one patient, a Type III endoleak developed due to stent migration, and an additional iliac artery stent graft was placed inside the existing stent (Table 3). In every patient with an endoleak, the proximal neck diameter and the aneurysm diameter exceeded the mean values, registering at >29 mm and >66 mm respectively. In one patient, despite the absence of an endoleak during follow-up examinations, lower extremity ischemia developed due to an occlusion in the graft leg. Consequently, a cross-femoral bypass was performed for this patient. In one patient without endoleak during the follow-up examinations, a rupture developed at the end of the one-year follow-up, and a femorofemoral crossover bypass was performed during the aorto-uni-iliac graft procedure for this patient. In one diabetic patient, healing problems in the femoral incision line were observed due to delayed scar tissue formation. There were no mortality cases during the early follow-up period (Table 3).

Table 1. Demographic and clinical findings in patients with abdominal aortic aneurysm.

Variables	All population n = 33
Demographic findings	
Gender, n (%)	
Male	28 (84.8)
Female	5 (15.2)
Age, years	72.4 ± 10.3
Smoking, n (%)	18 (54.5)
Comorbidities, n (%)	
Hypertension	30 (90.9)
Coronary artery disease	24 (72.7)
Diabetes mellitus	11 (33.3)
Peripheral artery disease	10 (30.3)
Chronic obstructive pulmonary disease	6 (18.2)
Chronic kidney disease	4 (12.1)
Symptomatic, n (%)	3 (9.1)
Morphological features	
Aneurysm diameter, mm	65.5 ± 12.4
Aneurysm length, mm	95.6 ± 20.8
Proximal neck length, mm	26.2 ± 5.1
Proximal neck diameter, mm	28.9 ± 4.5

Values are shown as mean±SD or median (IQR) or number (%).

Table 2. Postoperative findings in patients with abdominal aortic aneurysm.

Variables	All population n = 33
Endoleak, n (%)	
Type I	1 (3.0)
Type II	2 (6.1)
Type III	1 (3.0)
Peripheral vascular ischemia, n (%)	1 (3.0)
Stent migration, n (%)	1 (3.0)
Rupture, n (%)	1 (3.0)
Requirement for secondary intervention, n (%)	4 (12.1)
Occlusion in the graft leg, n (%)	1 (3.0)
Healing problem in femoral incision, n (%)	1 (3.0)
Length of ICU stay, hours	13 (7-19)
Length of hospital stay, days	3 (1-7)
Mortality, n (%)	-

Values are shown as mean±SD or median (IQR) or number (%). Abbreviations: ICU, intensive care unit

Table 3. Postoperative findings in patients with abdominal aortic aneurysm.

Variables	All population n = 33
Endoleak, n (%)	
Type I	1 (3.0)
Type II	2 (6.1)
Type III	1 (3.0)
Peripheral vascular ischemia, n (%)	1 (3.0)
Stent migration, n (%)	1 (3.0)
Rupture, n (%)	1 (3.0)
Requirement for secondary intervention, n (%)	4 (12.1)
Occlusion in the graft leg, n (%)	1 (3.0)
Healing problem in femoral incision, n (%)	1 (3.0)
Length of ICU stay, hours	13 (7-19)
Length of hospital stay, days	3 (1-7)
Mortality, n (%)	-

Values are shown as mean±SD or median (IQR) or number (%). Abbreviations: ICU, intensive care unit

Discussion

Advanced age, male gender, tobacco use, and the presence of additional diseases have been identified as the predominant risk factors for AAA.[8] In the management of AAA, EVAR presents as a superior alternative to conventional surgery, especially for elderly patients with elevated surgical risks and accompanying comorbidities.[5,9] Consistent with AAA risk factors, the mean age of patients who underwent EVAR was in the seventh decade. Predominantly male, these patients frequently had with comorbidities like hypertension and CAD. In this high-risk group, EVAR provides significant advantages such as eliminating the need for aortic clamping, reduced tissue trauma, feasibility under local or sedation anesthesia, shortened intensive care and hospital stay durations, and a diminished requirement for blood transfusions.[10] However, EVAR, compared to open surgery, has potential downsides such as a persistent risk of rupture, the likelihood of additional interventions, and a continual need for surveillance. The results from our single-center study indicate that a substantial fraction of patients are susceptible to complications during the early postoperative period.[11]

Endoleaks, which play a significant role in the progression of an aneurysm and carry a risk of rupture and mortality, are serious complications that require careful management. Previous studies have indicated endoleak incidences ranging from 4.1% to 26.4%.[12-14] In the current study, the endoleak rate was 12%, consistent with the literature. Type I endoleak, resulting from the graft's poor fit against the aorta, often requires stent adjustment through balloon dilation or an aortic extension.[10] It has been reported that Type 1 endoleak is responsible for 74% of all rupture cases after EVAR.[15] Hence, close monitoring of these cases after the procedure is paramount. In this study, one patient with a Type 1 endoleak underwent balloon dilation, and no rupture was observed over the course of one year. Type II endoleak, the most common leak type, arises following retrograde filling from the lumbar and mesenteric arteries. However, the endoleaks in these cases resolved over the course of the follow-up, consistent with previously reported studies.[12,16] Following EVAR, Type III endoleak, indicative of the aneurysm's inadequate defense against systemic pressure, emerges as a rare yet potentially fatal complication.[17] For a patient who developed a Type III endoleak, stent migration was identified as the cause. Stent migration can prompt the metal components to

interact with the fabric, thus making it a contributing factor to Type III endoleak.[18] The EUROSTAR registry has shown that patients with a late Type III endoleak are at a 9-fold higher risk of rupture compared to other types.[19] Eng et al.[20] previously reported that, for Type III endoleaks, endovascular intervention was applied in 68% of cases, open surgical repair in 10%, and hybrid procedures were chosen for 18%. When Type III endoleaks are identified early during completion angiography, immediate intervention is advised. This frequently involves redo ballooning at zones where components overlap or positioning an additional endograft to improve the overlap.[21] An additional iliac artery stent graft was placed in the patient who developed a Type III leak, and no rupture occurred during the one-year follow-up period.

A neck diameter exceeding 28 mm is identified as a risk factor for Type I endoleaks, while an enlarged aneurysm diameter presents a risk for Type III endoleaks.[22-24] In a previous study, a threshold value of >66 mm of aneurysm diameter was reported as predictive for a second EVAR intervention.[25] Both the aneurysm and neck diameters in patients with Type 1 and Type 3 endoleaks matched the descriptions provided above. On the other hand, in patients undergoing EVAR, the rate of secondary interventions stands at 12.1%, aligning with the 6-16% range highlighted in previous studies.[26,27] While endoleaks are frequently implicated in necessitating secondary interventions, other factors, notably rupture and peripheral vascular ischemia, can also mandate subsequent procedures.[28,29] However, over a one-year observation period post-EVAR, no mortality was observed among the entire cohort, encompassing those subjected to secondary interventions. Although the early postoperative survival rate was more favorable for EVAR than for open surgery, the findings from the EUROSTAR study indicated no marked distinction between the two procedures over a two-year observation period.[30] Similar results were also supported by several studies.[31-33]

This study has some significant limitations. It is primarily a retrospective analysis conducted at a single center. Additionally, long-term data for patients could not be obtained, as many patients continued their follow-ups at alternative centers. However, the primary objective of this study was to assess the early outcomes in patients who underwent EVAR. Lastly, the effectiveness of different graft brands could not be evaluated in this study.

Conclusion

EVAR, in older patients with coexisting comorbidities, offers advantages in diminishing durations in intensive care and hospital stays, potentially boosting early survival outcomes. However, it was determined that a significant portion of patients who underwent EVAR are at risk of complications even in the early stages. Hence, every patient treated with EVAR must be meticulously monitored, incorporating both the intraoperative completion arteriography and subsequent examinations.

ETHICAL DECLARATIONS

Ethics Approval: The study was performed in accordance with the Declaration of Helsinki, and was approved by the Bolu Abant Izzet Baysal University Clinical Resarches Ethics Committee (Date: 18.09.2023, Decision No: EA-1568)

Informed Consent: The need for informed consent was waived under the approval of the Local Ethics Committee due to the retrospective design.

Conflicts of Interest Statement: The authors declare they have no conflicts of interest.

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Availability of Data and Material: The data that support the findings of this study are availale on request from the corresponding author.

Author Contributions: All of the authors delare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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