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Outcomes of endovascular aortic aneurysm repair in octogenarians with hostile iliac artery anatomy

Hasta iliyak arter anatomili oktogeneryanlarda endovasküler aort anevrizması tamiri sonuçları

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ABSTRACT

Objectives: This study aims to evaluate the outcomes following endovascular aortic aneurysm repair (EVAR) in octogenarian patients with hostile artery anatomy (HAA) and compare the one-year results of octogenarian patients with favorable artery anatomy (FAA) or HAA after EVAR.

Patients and methods: Thirty-one consecutive octogenarian male patients (mean age 82±1.8 years; range 81 to 89) operated between January 2013 and January 2017 for abdominal aortic aneurysm (AAA) were analyzed retrospectively and divided into two groups as FAA or HAA. HAA was defined as presence of aneurysm at any point in iliac arteries (≥17 mm in males, ≥15 mm in females), severe (≥50%) artery stenosis, or severe tortuosity of iliac artery. Patients' demographic data, operation details, 30-day, and one-year outcomes were recorded.

Results: Of the 31 patients, 14 (45%) had HAA. Technical success for both groups was 100%. Type 1a endoleak was not seen on control angiography in both groups. More adjunctive intraoperative procedures were necessary for type 1b endoleaks in patients with HAA (p=0.019). Total usage of contrast agent was higher in HAA group (p=0.014). At 30-day follow-up, creatinine level was higher in HAA group (p=0.009). Four patients with HAA developed acute kidney failure (p=0.034). Durations of operation and hospital stay were longer in HAA group (p=0.041, p=0.019). At one-year follow up, no significant difference was found between two groups in all-cause mortality. Three patients with HAA still undergo dialysis for chronic renal failure (p=0.042).

Conclusion: Abdominal aortic aneurysm repairs were found to be associated with more requirement of adjunctive procedures, more contrast agent usage, higher creatinine levels, more frequent development of kidney failure, and prolonged duration of hospital stay in octogenarian patients with HAA compared to those with FAA.

Keywords: Endovascular aneurysm repair; hostile artery anatomy; iliac artery; octogenarian.

ÖZ

Amaç: Bu çalışmada, hasta arter anatomisi (HAA) olan oktogeneryan hastalarda endovasküler aort anevrizması tamiri (EVAR) sonrası sonuçlar değerlendirildi ve normal arter anatomisi (FAA) veya HAA olan oktogeneryan hastaların EVAR sonrası bir yıllık sonuçları karşılaştırıldı.

Hastalar ve Yöntemler: Abdominal aort anevrizması (AAA) nedeniyle Ocak 2013 - Ocak 2017 tarihleri arasında ameliyat edilen ardışık 31 oktogeneryan erkek hasta (ort. yaş 82±1.8 yıl; dağılım 81-89 yıl) geriye dönük olarak incelendi ve FAA veya HAA olmak üzere iki gruba ayrıldı. HAA; iliyak arterlerde herhangi bir noktada anevrizma (erkeklerde ≥17 mm, kadınlarda ≥15 mm), arterde ciddi darlık (≥50%) bulunması veya iliyak arterde ciddi kıvrımlar olarak tanımlandı. Hastaların demografik verileri, ameliyat detayları, 30 günlük ve bir yıllık sonuçları kaydedildi.

Bulgular: Otuz bir hastanın 14'ünde (%45) HAA vardı. Teknik başarı her iki grup için %100 idi. Kontrol anjiyografide iki grupta da tip 1a kaçak izlenmedi. HAA'lı hastalarda tip 1b kaçaklar için daha fazla ameliyat sırası ek işlem gerekti (p=0.019). Total kontrast madde kullanımı HAA grubunda daha yüksekti (p=0.014). Otuzuncu gündeki izlemde kreatinin düzeyi HAA grubunda daha yüksekti (p=0.009). HAA'lı dört hastada akut böbrek yetmezliği gelişti (p=0.034). Ameliyat ve hastanede kalış süreleri HAA grubunda daha yüksekti (p=0.041, p=0.019). Bir yıllık izlem sonunda, tüm nedenlere bağlı ölümde iki grup arasında anlamlı farklılık bulunmadı. HAA'lı üç hasta kronik böbrek yetmezliği nedeniyle diyalize girmeye devam etmektedir (p=0.042).

Sonuç: Abdominal aort anevrizması tamirleri HAA'lı oktogeneryan hastalarda FAA'lı hastalara kıyasla daha fazla ek işlem gereksinimi, kontrast madde kullanımı, daha yüksek kreatinin değeri, daha sık böbrek yetmezliği gelişimi ve uzamış hastanede kalış süresiyle ilişkili bulundu.

Anahtar sözcükler: Endovasküler anevrizma tamiri; hasta arter anatomisi; iliyak arter; oktogeneryan.

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As life expectancies rise, octogenarians with abdominal aortic aneurysms (AAAs) will be seen more frequently in clinical practice.[1] Mortality rates for elderly patients (≥80 years) undergoing AAA repair remain higher than in younger patients.[2] Endovascular aortic aneurysm repair (EVAR) has been described as a safe and successful means to manage AAA in the elderly.[3,4]

Unfavorable morphology of the aneurysm, adverse anatomic characteristics of the infrarenal aortic neck, and hostile artery anatomy (HAA) have restricted the widespread applicability of EVAR.[5,6] Tortuous artery access makes the performance of conventional EVAR more difficult.[7,8]

Several groups have studied outcomes of EVAR in octogenarians. In one, authors reported that endovascular repair among elderly patients was associated with less morbidity and mortality compared with open repair.[1] Another study found that elective EVAR in patients aged ≥80 years was associated with significantly lower immediate postoperative mortality and morbidity than open repair and should be considered the treatment of choice in these frail patients.[9] Nevertheless, published data on outcomes of EVAR in octogenarians with HAA are insufficient. Therefore, in this study, we aimed to evaluate the outcomes following EVAR in octogenarian patients with HAA and compare the one-year results of octogenarian patients with favorable artery anatomy (FAA) or HAA after EVAR.

PATIENTS AND METHODS

A total of 31 octogenarian male patients (mean age 82±1.8 years; range 81 to 89) treated with elective EVAR between January 2013 and January 2017 were retrospectively analyzed from a prospective database maintained by the division of cardiovascular surgery at Medicine Faculty of Manisa Celal Bayar University. Endovascular treatment protocol of patients was adopted from a previous report.[10] Preoperatively, all patients underwent computed tomography (CT) imaging. Aneurysm stent planning maps were produced prior to EVAR using a Vital 3D Recon device (Toshiba Medical Systems, the Netherlands). For data analysis, patients were divided into two groups based on arterial access anatomy. Hostile artery anatomy was defined as presence of iliac artery aneurysm (≥17 mm in males or ≥15 mm in females) at any point, severe (≥50%) artery stenosis, or severe tortuosity of iliac artery ('S' appearance) (Figures 1 and 2).[11] If present, patients with hostile neck anatomy were excluded. Our clinical protocol is to preferentially perform EVAR in AAA patients over the age of 65 years. The Endurant II EVAR device (Medtronic Cardiovascular, Santa Rosa, CA, USA) was used in

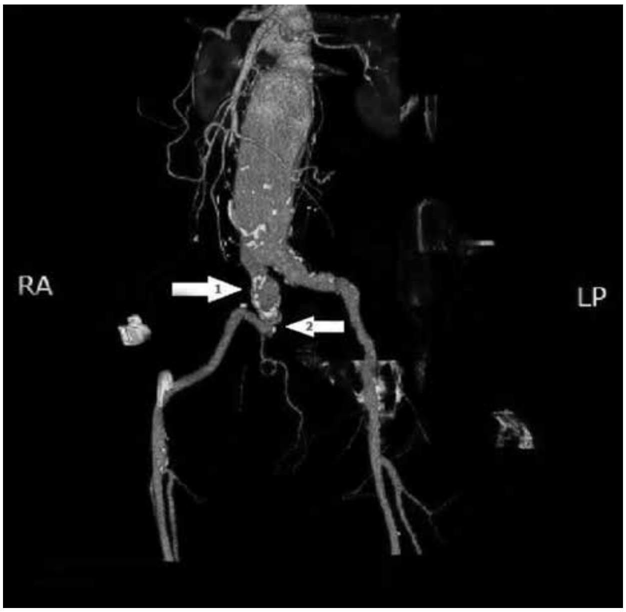


Figure 1. Preoperative three-dimensional computed tomography angiography reconstruction. Arrow 1: A right common iliac aneurysm; Arrow 2: A severely tortuous right iliac artery with "S" appearance.

Figure 2. Preoperative three-dimensional computed tomography angiography (reversed reconstruction). Arrow: Severe stenosis in left external iliac artery.

Table 1. Patient demographics and risk factors according to arterial access anatomy

Variables	Hostile artery anatomy (n=14)				Favorable artery anatomy (n=17)				
	n	%	Mean±SD	Min-Max	n	%	Mean±SD	Min-Max	p
Age (year)			82±1.8				82±1.6		0.312†
Gender									
Male	14				17				1.000‡
Previous angiography for any reason (in 6 months)	0/14	0			0/17	0			-
Heart rate (beats/min)			74±10				76±9		0.442†
Hemoglobin (mmol/L)			10.3±1.4				10.6±2.1		0.213†
Creatinine (mg/dL)			1.1±0.2	0.9-1.3			1.2±0.2	1.0-1.4	0.308†
Diabetes mellitus	1/14	7			1/17	6			0.547‡
Smoking	6/14	4			7/17	42			0.416‡
Hypertension	8/14	57			9/17	53			0.510‡
Hyperchlosteremia	3/14	21			5/17	29			-288‡
Ischemic heart disease	5/14	36			5/17	29			0.305‡
Peripheral artery disease	5/14	36			6/17	35			0.301‡
Cerebrovascular disease	3/14	21			5/17	29			0.288‡
Pulmonary disease	7/14	50			7/17	42			0.668‡
Chronic renal failure	0/14	0			0/17	0			-
Statin therapy	3/14	21			5/17	29			0.348‡
Antiplatelet therapy	8/14	57			9/17	53			0.621‡

SD: Standard deviation; Min: Minimum; Max: Maximum; † T-test; ‡ Fischer's exact test.

all patients. Iodixanol (Opakim AS, Istanbul, Turkey) was used as the contrast agent in all patients. The study protocol was approved by the Medicine Faculty of Manisa Celal Bayar University Ethics Committee. A written informed consent was obtained from each patient. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Technical success was defined as successful delivery and deployment of the endograft, without unintentional coverage of renal or visceral arteries, followed by successful removal of the delivery system and the absence of either a type 1 or 3 endoleak at the end of the operation. Completion angiography was performed to document any possible endoleak and other endograft-related complications. The duration of the operation was defined as the time between arterial cutdown and closure.

Baseline characteristics such as age, gender, heart rate, hemoglobin level, creatinine level, statin therapy, antiplatelet therapy, and lifestyle variables including smoking were recorded. Comorbidities such as ischemic heart disease, peripheral artery disease, chronic renal failure, hypertension, cerebrovascular disease (previous transient ischemic attack or stroke), hypercholesterolemia, chronic obstructive pulmonary disease, and diabetes mellitus (controlled by diet, tablet or insulin dependent types) were also recorded. Specific variables related to AAA were AAA diameter,

Table 2. Baseline aneurysm and artery access characteristics according to arterial access anatomy

Variable	Hostile artery anatomy (n=14)			Favorable artery anatomy (n=17)			
	n	%	Mean±SD	n	%	Mean±SD	*p*
Suprarenal angulation (°)			32±16			34±17	0.217†
Infrarenal angulation (°)			23±17			27±13	0.119†
Neck length (mm)			31±11			32±14	0.177†
Neck diameter (mm)			23±4			21±4	0.213†
Right iliac diameter (mm)			11±2			14±2	0.043†
Left iliac diameter (mm)			11±2			14±3	0.022†
Right femoral diameter (mm)			8±2			10±1	0.090†
Left femoral diameter (mm)			8±1			10±1	0.130†
Excessive (>50%) vessel stenosis	5/14	36		0/17	0		0.041‡
Iliac aneurysm	2/14	14		0/17	0		0.172‡
S-shaped iliac artery	7/14	50		0/17	0		0.007‡

SD: Standard deviation; † Fischer's exact test; ‡ T-test.

Table 3. Intraoperative results

Variables	Hostile artery anatomy				Favorable artery anatomy				
	n	%	Mean	Min-Max	n	%	Mean	Min-Max	*p*
Duration of procedure (min)			154	92-189			107	79-124	0.041†
General anesthesia	6/14	43			7/17	41			0.817‡
Regional anesthesia	8/14	57			10/17	59			0.614‡
Iodixanol (ml)			134	81-165			96	69-119	0.014†
Bifurcated endograft	9/14	64			16/17	94			0.021‡
Uniiliac endograft	5/14	36			1/17	6			0.043‡
Endoleaks									
Endoleak type 1a	0/14	29			0/17	26			-
Endoleak type 1b	6/14	43			0/17	0			0.019‡
Endoleak type 2	1/14	7			1/17	6			0.792‡
Endoleak type 3	0/14	0			0/17	0			-
Endoleak type 4	0/14	0			0/17	0			-
Balloon angioplasty	4/14	29			0/17	0			0.021‡
Intraoperative interventions									
Balloon dilatation	5/14	36			0/17	0			0.012‡
Graft extension	3/14	21			0/17	0			0.042‡

SD: Standard deviation; † T-test; ‡ Fischer's exact test.

symptoms and morphology. Medication history was including statin or antiplatelet therapy.

Patients who underwent EVAR were followed-up postoperatively at one and 12 months. At each follow-up appointment, CT scanning was performed, and adverse events and standard EVAR follow-up data (technical failure, endoleaks, migration, sac expansion, rupture, reinterventions, kidney failure, 30-day mortality) were recorded.[12,13] Our follow-up protocol was designed according to EVAR trial.

Statistical analysis

Follow-up data were analyzed using IBM SPSS software for Windows version 20.0 (IBM Corp., Armonk, NY, USA). Values were reported as mean ± standard deviation. Categorical variables were presented as frequencies with percentages. Fisher's exact test was used for categorical variables. Mean differences were assessed using independent t-test and p value <0.05 was considered statistically significant. The Kaplan-Meier method was used to estimate survival distributions (all-cause mortality) for both groups.

RESULTS

Of the patients, 14 had HAA while 17 had FAA. Demographic data, hemodynamic status, serum creatinine, hemoglobin, and baseline risk factors of

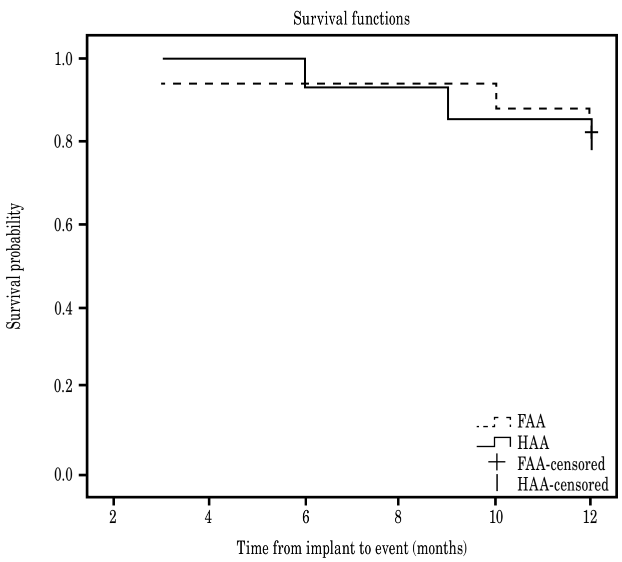
Table 4. Patient outcomes at postoperative 30-days, according to arterial access anatomy

Variables	Hostile artery anatomy (n=14)				Favorable artery anatomy (n=17)				
	n	%	Mean±SD	Min-Max	n	%	Mean±SD	Min-Max	*p*
Endoleak type 1a	0/14	0			0/17	0			-
Endoleak type 1b	0/14	0			0/17	0			-
Endoleak type 2	2/14	14			1/17	6			0.86*
Endoleak type 3	0/14	0			0/17	0			-
Endoleak type 4	0/14	0			0/17	0			-
Endograft occlusion	1/14	7			0/17	0			0.213*
Endograft migration	0/14	0			0/17	0			0.308*
Clinical outcomes									
Surgical procedure†	1/14	7			0/17	0	0.225*		
Endovascular procedure	0/14	0			0/17	0	-		
Aneurysm rupture	0/14	0			0/17	0	-		
All cause mortality	0/14	0			0/17	0	-		
Creatinine (mg/dL)			2.4±0.4	1.8-4.3			1.4±0.3	1.1-1.7	0.009¶
Acute kidney failure‡	4/14	29			0/17	0			0.034*
Duration of hospitalization (day)			5±1.3				3±0.4		0.019¶

SD: Standard deviation; Min: Minimum; Max: Maximum; † Cross-femoral bypass; ‡ Dialysis therapy; * Fischer's exact test; ¶ T-test.

the study groups were presented in Table 1. There was no significant difference between two groups in terms of age, gender, hemodynamic stability, or risk factors. Baseline aneurysm and artery access characteristics were listed in Table 2. Of the 14 patients, HAA was defined due to S-shaped iliac artery in seven, an excessively stenosed vessel in five, and iliac aneurysm in two.

Intraoperative results were displayed in Table 3. Operation time was significantly longer in patients with HAA (154 [92-189] min vs. FAA 107 [79-124] min p=0.041). Total amount of used contrast agent was significantly higher for HAA patients (HAA 134 [81-165] mL vs. FAA 96 (69-119) mL, p=0.014). Balloon angioplasty without stenting was used to address iliac artery stenosis for four patients with HAA (p=0.021). The necessity for an aorta uniiliac device was significantly higher in HAA patients (36% of HAA patients vs. 6% of FAA patients, p=0.043).



		One year
Favorable artery anatomy	N total	17
	N of events	3
	Kaplan-Meier estimate	0.824
	Standard error	0.092
Hostile artery anatomy	N total	14
	N of events	3
	Kaplan-Meier estimate	0.786
	Standard error	0.110

Figure 3. Kaplan-Meier survival curves representing at one year freedom from all cause mortality (log-rank, p=0.786). FAA: Favorable artery anatomy; HAA: Hostile artery anatomy.

Intraoperative type 1b endoleaks were more frequent in the HAA group (p=0.019). Type 2 endoleak was seen in two patients; one patient with HAA and one with FAA (p=0.792). All endoleaks were successfully managed during the initial procedure. Technical success was 100% for both groups.

Thirty-day outcome results were given in Table 4. No patient in either group died within 30-days of operation. Imaging at one month was performed in all 31 patients. An endograft limb occlusion was observed in one patient with HAA, which was corrected by a femoro-femoral bypass. Creatinine levels were significantly higher in the HAA group at one month (p=0.009). Four HAA (29%) and no FAA patients developed acute kidney failure (p=0.034). Hospital stay was significantly longer in the HAA group (HAA 5±1 [3-14] days vs. FAA 3±0 [3-5] days p=0.019).

Imaging at one year was performed for 25 patients (81%). No endoleak was detected in any patient. Freedom from all-cause mortality was similar in both groups (FAA 82% vs. HAA 78%, p=0.786, Figure 3). Three HAA (21%) versus no FAA patients were on dialysis for chronic renal failure (p=0.042). At one-year follow-up, three patients with HAA had died (one each from chronic obstructive pulmonary disease, cardiac failure, and sepsis of unknown origin). In the FAA group, three patients had also died (one each from chronic obstructive pulmonary disease, cardiac failure, and cancer).

DISCUSSION

Almost half of our octogenarians undergoing EVAR had HAA in their aortas; this was mostly due to iliac artery tortuosity and stenosis. Difficult iliac and aortic access remains a challenge in the endovascular management of abdominal and thoracic aortic aneurysms. Unfortunately, patients with severe comorbidities often have anatomically complex lesions that are not amenable to EVAR, which suggests that there is an association between other clinical problems and the anatomical complexity of the infrarenal aorta.[14] Despite advances in endograft design and lower-profile systems, many patients still have common and external iliac artery occlusive disease and tortuosity that preclude successful endovascular repair.[14]

In their study of preoperative angiography and open treatment of AAA, Brewster et al.[15] described that concomitant AAA and iliac occlusive disease occur in up to 40% of the patients. As age increases, iliac tortuosity and arterial calcifications also increase significantly. This situation increases the difficulty of EVAR in the elderly, the population that is most likely to experience the greatest benefit with EVAR.[14] Because of the retrospective design of this study, preprocedural planning was not taken into consideration. However, advancements in device and delivery system profiles, intraprocedural adjuncts and experience gained with EVAR continue to expand its clinical indications.

Slater et al.[16] found that increased tortuosity was associated with a more complex endovascular repair, as reflected by longer fluoroscopy time, use of more contrast agent, use of extender modules, and more frequent use of arterial reconstruction. Our results were similar to theirs, in that the mean duration of the operation, amount of contrast agent used, and use of balloon dilatation and graft extension were significantly greater in our HAA patients.

Our study has shown that patients with HAA can be treated adequately with EVAR with higher rates of early type 1b intraoperative endoleak (43% for HAA and 0% for FAA, p=0.019) and occasional other intraoperative interventions. Patients with endoleak should undergo reinterventions to correct the endoleak, which may be reflected in the increased aneurysm-related morbidity as reported before by Parıldar and Posacıoglu[17] in this group of patients.

In the present study, many patients had several comorbidities that precluded open repair. However, given the high number of secondary interventions in HAA patients, some clinicians may feel that it is more rational for these patients to undergo open repair if they are good-risk patients. Therefore, prospective randomized studies should be performed to compare EVAR with open repair before the routine use of EVAR in such elderly HAA patients.

Acute kidney injury after any type of intervention is associated with a mortality rate as high as 80%, as well as increased morbidity and longer hospitalizations.[18,19] Acute kidney injury after EVAR has been documented in several studies, with incidences ranging from 1% to 19% for elective repair and up to 23% in those with a ruptured AAA.[20-22] Beyond other factors, such as suprarenal fixation, accessory renal artery coverage, systemic inflammatory response, renal microembolization and blood loss, EVAR necessitates the administration of a considerable amount of contrast. Therefore, these patients have increased risk for developing acute kidney injury. During the repair of complex aneurysms, deployment of the EVAR device requires more operating time and results in greater blood loss and use of more contrast agent.[23,24] Indeed, in our study, about one-fourth (n=4) of our HAA patients developed acute renal failure, which required dialysis therapy. Three of them were still on dialysis therapy after one year. Compared to FAA patients, strategies to prevent acute kidney injury in HAA patients must be taken into consideration more seriously before proceeding with EVAR.

Current information for shared decision making is inadequate regarding proceeding with EVAR in patients with HAA. To date, no randomized prospective trial has investigated the association between specific HAA parameters and outcomes of EVAR vs. open AAA repair. In octogenarians with FAA, it is reasonable to perform EVAR, because better results can be achieved with fewer complications. In the study of ruptured AAA patients by van Beek et al.,[25] mortality after open repair was found comparable in those with friendly and hostile aortoiliac anatomy. In the study of Sailer et al.[24] on AAA patients, those with HAA needed an increased number of adjunctive procedures, which reflected the anatomic complexity and the requirement for advanced technical expertise and experience of the interventionalist. Although the mortality rate in our two patient groups was similar, patients with HAA had higher peri- and postoperative morbidity than FAA patients.

Our study has some limitations due to its retrospective design, small number of patients, and relatively short follow-up period. We should continue the surveillance of these patients to evaluate the long-term impact of performing EVAR for HAA. In addition, we excluded patients with hostile neck anatomy, which may have resulted in errors due to selection bias.

In conclusion, EVAR is increasingly being used in the HAA setting and is technically feasible and safe. Despite good technical success, AAA repair in octogenarians with HAA is associated with more adjunctive procedures, higher usage of contrast agent, higher creatinine levels, higher incidence of kidney failure, and longer hospitalizations compared to FAA patients. From the present analysis, it may be concluded that EVAR should be used more cautiously in elderly patients with HAA due to these complications.

The decision to undergo AAA repair should be made carefully, fully discussing the pros and cons of EVAR in elderly patients and their family.

Declaration of conflicting interests

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