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Research

Early Results in Octogenerian Patients Undergoing Endovascular Aortic Aneurysm Repair and its Effect on Karnofsky Scoring: A Single Center, Retrospective Study

Endovasküler Aort Anevrizmasi Onarımı Uygulanan Oktojeneryan Hastalardaki Erken Dönem Sonuçlar ve Karnofsky Skorlamasina Etkisi: Tek Merkezli, Retrospektif Çalışma

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ABSTRACT

Objective: With the increase in life expectancy, the octogenarian population is expected to increase in our country as well as in the whole world. We aimed to examine the periprocedural and early period mortality, morbidity, and functional status of the patients to whom we applied endovascular aortic repair (EVAR) electively.

Methods: The data of all patients aged 80 years and older who applied to our clinic with the diagnosis of abdominal aortic aneurysm (AAA) between January 2014 and December 2023, and who underwent elective EVAR, were analyzed retrospectively. Mortality and morbidity of all patients were evaluated during the periprocedural period and in the early postoperative period. Patients were evaluated according to the Karnofsky performance status scale and their quality of life.

Results: EVAR was applied to 36 patients. The mean age of the octogenarian patient group in our study was 84 (80-91) years. Patients are mostly male (83.3%). The procedure was performed under general anesthesia in all patients. One unit of erythrocyte suspension was used. it was observed that there was no endoleak on the 30th day. The procedure was completed successfully in all patients. There was no mortality in the 30-day follow-up. Improvement was observed with all patients in Karnofsky scoring both on the 2nd postoperative day and on the 30th day.

Conclusion: EVAR, which has equal success with open surgery in patients with AAA in the octogenarian, will significantly reduce operative morbidity, intensive care unit, and hospital stay and cost when performed in an experienced and high-volume center. In addition, we believe that these patients who are octogenarians improve their performance more quickly.

Keywords: Endovascular aortic repair, octogenerian, karnofsky scale, abdominal aortic aneursym

ÖZ

Amaç: Yaşam beklentisindeki artışla birlikte, tüm dünyada olduğu gibi ülkemizde de 80 yaş ve üzeri nüfusun artması beklenmektedir. Elektif olarak endovasküler aort onarımı (EVAR) uyguladığımız hasta grubunda hastaların periprosedürel ve erken dönem mortalite, morbidite ve fonksiyonel durumlarını incelemeyi amaçladık.

Gereç ve Yöntem: Ocak 2014 Aralık 2023 tarihleri arasında kliniğimize abdominal aortic aneurysm (AAA) tanısıyla başvuran ve elektif EVAR uygulanan 80 yaş ve üzeri tüm hastaların verileri retrospektif olarak incelendi. Tüm hastaların mortalite ve morbiditeleri periprosedürel ve erken dönemde değerlendirildi. Hastalar Karnofsky performans durum ölçeğine ve yaşam kalitelerine göre değerlendirildi.

Bulgular: Otuz altı hastaya EVAR uygulandı. Çalışmamızdaki 80 yaş ve üzeri hasta grubunun ortalama yaşı 84 (80-91) idi. Hastalar çoğunlukla erkekti (%83,3). Tüm hastalarda işlem genel anestezi altında yapıldı. Ortalama 1 ünite eritrosit süspansiyonu kullanıldı. Otuzuncu günde endoleak

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ÖZ

olmadığı görüldü. İşlem tüm hastalarda başarıyla tamamlandı. Otuz günlük takipte mortalite olmadı. Tüm hastalarda hem postoperatif 2. günde hem de 30. günde Karnofsky skorlamasında iyileşme gözlendi.

Sonuç: Seksen ve üzeri yaştaki AAA'lı hastalarda açık cerrahi ile eşit başarıya sahip olan EVAR, deneyimli ve yüksek hacimli bir merkezde yapıldığında operatif morbiditeyi, yoğun bakım ünitesini ve hastanede kalış süresini ve maliyeti önemli ölçüde azaltacaktır. Ayrıca, 80 ve üzeri yaştaki bu hastaların performanslarını daha hızlı iyileştirdiğine inanıyoruz.

Anahtar Kelimeler: Endovasküler aort onarımı, oktojeneryan, karnofsky skala, abdominal aort anevrizması

INTRODUCTION

Today, with the increase in life expectancy, the octogenarian population is expected to increase in our country as well as in the whole world (1). Abdominal aortic aneurysm (AAA) is a disease that is often asymptomatic, and its frequency increases with age. The annual risk of rupture in untreated AAA increases with vessel diameter. While the risk of 5-cm-and-above AAA rupture is 3-15%, the risk of 8 cm AAA rupture is more than 50%. Therefore, AAA with an aneurysm diameter of 5.5 cm or more should be treated (2,3).

Endovascular abdominal aortic replacement (EVAR) has been widely applied as an alternative to surgical treatment for AAA with the development of technology in endovascular treatments (4,5). The risk of mortality and morbidity is high in open AAA surgery therefore especially in elderly and frail patients the tendency to prefer EVAR is getting more (6). Considering the risk factors brought by EVAR in elderly asymptomatic patients , there is still no consensus on whether to treat the condition or not. We see that mid-term and procedural results are shared with octogenarian and non-agenarian patients at the studies in recent years (7-10).

In this study, we also examined octogenarians in our own clinic. We aimed to examine the periprocedural and early period mortality, morbidity and functional status of the patients to whom we applied EVAR electively in the patient group.

METHODS

This study University of Health Sciences Türkiye, Bakırköy Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (decision no: 2022-17-09, date: 05.09.2022). The data of all patients aged 80 years and older, who applied to our clinic with the diagnosis of AAA between January 2014 and December 2023, and who underwent elective EVAR were analyzed retrospectively. Patients aged 80 years and older were defined as octogenarians. Demographic information, intraoperative data, and postoperative results of the patients were collected through the hospital data processing system and from patient files (Table 1,2).

Coronary artery disease (CAD), hypertension, diabetes mellitus, chronic obstructive pulmonary disease (COPD), kidney disease (chronic kidney failure defined by serum creatinine >1.2 mg/dL in the last 3 measurements), smoking, congestive heart failure, history of cerebrovascular accident (stroke and/or transient ischemic attacks), history of cancer (current malignancy or any past incidence), dyslipidemia, and atrial fibrillation were considered as comorbidities.

EVAR procedures were performed on patients with few comorbidities, high surgical risk, and suitable aortic anatomy. Aneurysm size and anatomical features (aortic neck length and angulation, iliac artery diameter, calcification, and kinking) were determined preoperatively by computed tomography angiography. Patients were evaluated according to the Karnofsky performance status scale, and their quality of life was assessed separately (11,12).

Table 1. Inclusion and Exclusion criteria

Inclusion criteria;	Exclusion criteria;
Anatomically suitable patients for EVAR	Patients not eligible for the EVAR procedure.
High-risk patients for Open Surgery	Anatomically suitable patients.
	Patients with severe hemodynamic instability.
	Patients who cannot undergo CTA.
	Cases those needed open surgery during the EVAR procedure.
	Patients who have had open surgery or EVAR in the past.

EVAR: Endovascular aneurysm repair, CTA: Computed tomography angiography

Table 2. Baseline characteristics of octogenerians undergoing EVAR

		median (min.-max.)	n	%
Age , years		**84 (80-91)**		
Gender				
	Female		30	83.3
	Male		6	16.7
BMI		39.7-18.2) 24.7)		
Comorbidities				
	Smooking		21	58.3
	CHF		6	10
	Hipertension		32	88.9
	Diabetes mellitus		6	16.7
	COPD		5	8.3
	ESRD		8	13.3
	PAD		10	27.8
	CAD		20	55.5
	Prior PCI		14	38.9
	Prior CABG		6	16.7
Preoperative medications				
	Aspirin		22	61.1
	Statin		26	72.2
	ACE-i		32	88.9
	ß-blocker		21	58.3
	Clopidogrel		7	19.4
	Anticoagulation		2	5.5
Asymptomatic			22	61.1
Symptomatic			14	38.9
Laboratory				
	Hemoglobin	12.1 (7.1-15.2)		
	Hematocrit	36.2 (22.3-53.1)		
	Kreatinin	1.05 (0.6-2.4)		
	LDL-cholesterol	100 (30-205)		

Min.-max.: Minimum-maximum, BMI: Body mass index, CHF: Chronic heart failure, COPD: Chronic obstruction pulmonary disease, ESRD: End stage renal disease, PAD: Peripheral artery disease, CAD: Coronary artery disease, PCI: Percutaneous coronary intervention, CABG: Coronary artery bypass grafting, ACE-i: Angiotensin-converting-enzyme inhibitors, LDL: Low-density lipoprotein

Interventional Procedure

In endovascular cases, stent graft placement was performed via femoral access (openly prepared or percutaneously) under general anesthesia with Endurant™ II/IIs AAA stent graft system (Medtronic, USA). In case of emergency, endografts of appropriate diameter that can be used immediately are employed.

Outcomes

Primary outcomes are technical success and freedom from mortality in 30 days. Secondary endpoints consisted of surgical graft complications (graft thrombosis, graft infections, hemorrhage, aortoiliac pseudoaneurysms) and EVAR complications (endoleak, aneurysm enlargement, graft migration, AAA rupture, secondary interventions, and need of open surgical procedures). Perioperative complications were defined as myocardial infarction, stroke, visceral organ ischemia, arterial ischemia, renal failure, pulmonary complications, and entry site hematoma.

The technical success was defined as the secure fixation of the endograft, successful placement ensuring proper patency, and the absence of type I or III leakage within the first 24 hours. Clinical success was defined as successful

placement of the endovascular device at its intended site without complications such as type I or type III leak, graft infection or thrombosis, aneurysm enlargement (diameter >5 mm or volume >5 mL), aneurysm rupture, or death.

Renal dysfunction was defined as elevation of serum creatinine concentration more than 25% or 0.5 mg/dL (44 mmol/L) within 48 hours.

Secondary interventions to correct or prevent possible complications were also performed through endovascular procedures such as proximal cuff and stent implantation, distal lengthening implantation, catheter-based thrombolysis, iliac angioplasty, embolization of aortic branches, with coil and/or adhesive. When surgical intervention was required, open surgery was performed immediately.

Statistical Analysis

Statistical analysis was performed using the IBM SPSS version 21.0 (IBM Corp., Armonk, NY, USA). Continuous variables are expressed as the mean ± standard deviation or median [minimum-maximum (min.-max.)], while categorical variables are expressed as numbers and percentages.

RESULTS

There were 54 octogenarian patients diagnosed with AAA who applied to our clinic. EVAR was applied to 36 patients. The mean age of the octogenarian patient group in our study was 84 (80-91) years. Patients are mostly male (83.3%). Average body mass index was 28.1 (19.3-42.2). We observed that most of the patients smoke (58.3%). When it comes to accompanying diseases, most of the patients had CAD (55.5%) and almost all of them had hypertension (88.9%). Fourteen patients (38.9%) who presented to our clinic were symptomatic. Eight of them (22.2%) were presented with a pulsatile mass in their abdomen. Atypical abdominal pain was present in 6 patients (16.7%) (Table 2).

The procedure was performed under general anesthesia in all patients. One unit of erythrocyte suspension (ES) was used in patients. In one patient, graft interposition was applied to the common femoral artery due to calcification during surgical opening of the femoral artery. In addition, 3 units of ES were applied because of concomitant CAD. When the abdominal aneurysm diameters were measured, it was seen that it was 7 cm and above in 13 patients (36.1%). Type 1 endoleak was detected in 2 patients, and type 2 endoleak in 2 patients. The iliac stent was extended in 2 patients with type 1 endoleak. Patients with type 2 endoleak were followed up without any extra procedures. No patients needed open surgery or experienced mortality (Table 3).

The procedure was completed successfully in all patients. Eight patients (22.2%) needed inotropes to avoid

Table 3. Procedural factors for octogenarians undergoing EVAR

		Median (min.-max.)	n	%
Intraoperative factors				
	Anesthesia			
	General		36	100
	Spinal		0	0
	Local		0	0
	Estimated blood loss, mL	150 (50- 300)		
	RBC transfused, U	1 (0 - 3)		
	Total procedure time, m	110 (80- 220)		
AAA maximum diameter, mm		6.1 (5-8.6)		
	<7cm		23	63.9
	>7cm		13	36.1
EVAR technical factors				
	Graft body diameter,mm	136 (96-172)		
	Endoleak		4	11.1
	Conversion to open repair		0	0
	Concominant procedure		2	5.5
		Stenting	2	5.5
Peroperative mortality			0	0

RBC: Red blood cell, AAA: Abdominal aortic aneursym, EVAR: Endovascular aortic repair

hypotension as they had CAD. A transient ischemic attack developed in 1 patient. Three patients (8.3%), after arterial ischemia developed in the leg where the main body of stent was placed, nedeed embolectomy. Maceration developed at the local wound site in 5 patients. Three of these 5 patients had hematoma at the intervention site. Acute renal failure did not develop in any patient. Intubation time was prolonged in 2 patients (5.5%), and in these patients, lung infection due to pneumonia developed. During follow-up computed tomography scans of 2 patients with type 2 endoleak, it was observed that there was no endoleak on the 30th day. There was no mortality in the 30-day ollow-up (Table 4).

All patients were evaluated on the post-operative 2nd and 30th days according to the Karnofsky quality of life and performance status scale (Table 5). The patient, who developed a transient ischemic attack and was extubated on the 2nd day, needed help with mobilization during his intensive care stay. All other patients were able to provide their own self-care. Patients often had symptoms because of the femoral incision wound. Considering the follow-up controls on the 30th postoperative day, no complications were observed in 32 patients. In two patients, there was a hematoma at the femoral wound site. The hematoma in 1 patient was treated surgically. Improvement was observed in Karnofsky scoring both on the 2nd postoperative day and on the 30th day with all patients.

DISCUSSION

The fact that AAA patients are mostly asymptomatic creates difficulties in diagnosing the disease and determining its frequency. However, it is known that AAA increases with age. In addition, considering both the European and American populations, it is predicted that the elderly population is gradually increasing and the octogenarian population will be more than 2% of the society in the future. Therefore, we believe that AAA patients will be encountered more in daily practice. Therefore, it is important to determine the adequate treatment for elderly patients. In this study, we aimed to evaluate our early results, in the octogenarian population to whom we applied EVAR.

The most feared and lethal clinical outcome in AAA is ruptured AAA (13). We face a greater risk of rupture with advancing age (14). Therefore, it is very important to closely monitor the clinical picture of patients with AAA. Options for treatments in patients with AAA are medical treatment, open AAA repair, and endovascular treatment. While determining this type of treatment, the diameter of the aneurysm, the anatomical features of the area with the aneurysm, and the accompanying comorbidities are taken into consideration (15). In the octogenarian AAA patient group, there is hesitance to perform an interventional procedure due to the high risk of mortality. The presence of other risk factors accompanying octogenarian patients with AAA has a negative effect on mortality and morbidity. Therefore, it is important to accurately assess the risk of AAA

Table 4. Perioperative outcome and complications

		Median (min.-max.)	n	%
Morbidity				
Techical success			36	100
Inotrop required			8	22.2
All comlications				
	Myocardial ischemia		0	0
	Stroke		1	2.8
	Intestinal ischemia		1	2.8
	Arterial ischemia		3	8.3
	Renal		0	0
	Pulmonary		2	5.5
	Access-site hematoma		3	8.3
	ICU duration, day	1 (1-4)		
	Total stay time, day	4 (3-8)		
Endoleak in 30 days			0	0
Mortality in 30 days			0	0

Min.-max.: Minimum- maximum, ICU: Intensive care unit

Table 5. Preoperative, postoperative 2nd day and 30th day Karnofky Scale

Karnofsky Performance Status Scale	Rating (%)	Patients number (Pre-op)	Patients number (2nd day)	Patients number (30th day)
Normal no complaints; no evidence of disease	100	14	18	24
Able to carry on normal activity; minor signs or symptoms of disease	90	10	7	6
Normal activity with effort; some signs or symptoms of disease	80	8	6	2
Cares for self; unable to carry on normal activity or to do active work	70	3	3	3
Requires occasional assistance, but is able to care for most of his personal needs	60	1	1	1
Requires considerable assistance and frequent medical care	50	0	1	0
Disabled; requires special care and assistance	40	0	0	0
Severely disabled; hospital admission is indicated although death not imminent	30	0	0	0
Very sick; hospital admission necessary; active supportive treatment necessary	20	0	0	0
Moribund; fatal processes progressing rapidly	10	0	0	0
Dead	0	0	0	0

rupture and the mortality risk of performing the procedure on these patients (16). In a study comparing patients who underwent EVAR and patients who received best medical treatment, 4-year survival was 97% in the EVAR group, while it was 67% in the bone marrow transplant (BMT) group. In the EVAR group, 78% of patients were without major adverse events, compared to 28% in the BMT group (17). In our study, the EVAR procedure was successfully applied to 36 octogenarian patients who were anatomically suitable and had no access problems. No mortality in the 1-month period was observed. Transient ischemic attack occurred in 1 patient, without any sequelae. We like other studies in the literature observed that EVAR reduces mortality due to aneurysm in high-risk patients compared to BMT.

In a study of 3.1 million patients, risk factors for AAA were found to be smoking, overweight, male sex, family history, hypertension, and advanced age (18). Non-steroidal anti-inflammatory use, and COPD, and cardiovascular disease were evaluated as independent risk factors for AAA. It was also found that the use of statins reduced the growth of aneurysm diameter by 1.1 mm/year (19). In our study, the risk factors were hypertension 88.9%), smoking (58.3%), male gender (83.3%), CAD (55.5%) as similar to literature. In addition, most patients are prescribed anti-hypertensive, American Society of Anesthesiologists, and statins due to CAD.

Anatomical evaluation should be performed in all patients presenting symptomatic or asymptomatic AAA. To perform the EVAR procedure, anatomical evaluation should be done before making an EVAR decision. The feasibility of EVAR becomes technically difficult or even impossible in aneurysms involving renal arteries or visceral organ branches, or in the case of an aneurysm with a very large sac, a short, and an angled neck. In addition, an effective physical examination and preliminary evaluation should be performed to assess access in AAA patients. In the absence of suitability, open surgery or BMT should be considered primarily for these patients (20,21). In our study, open surgery was performed in 4 patients, and 14 patients were followed up with BMT, since the EVAR procedure was not applicable for the 18 patients over the age of 80 who applied to our clinic. As a result of the preoperative evaluation, 36 patients were found to be suitable for the EVAR procedure and the technique was successfully applied to all 36 patients.

The effects of anesthetic method on the mortality and morbidity of the patients while the EVAR procedure is being performed are known. The EVAR procedure can be performed under general anesthesia, local anesthesia, or local combined with sedation. The general condition of the patients and whether the procedure is urgent or elective are the parameters that determine the choice of anesthesia. The fact that the octogenarian patient group is considered to be at high risk perse and that additional pathologies frequently accompany these patients leads to the recommendation that many guidelines and current studies suggest that the appropriate anesthetic option is local or local anesthesia with sedation (22,23). In our study, all procedures were done under general anesthesia. Risk factors were evaluated preoperatively and 5 (8.3%) patients were evaluated as moderate COPD. EVAR was performed under general anesthesia with these 5 patients. Intubation time was prolonged in 2 (5.5%) of these patients. Although

EVAR was applied under general anesthesia in all patients in our study, we propose that choosing the appropriate anesthesia as local or local combined with sedation would be less risky in terms of pulmonary problems, especially in patients who have insufficient lung capacity.

Conversion to open surgery as a treatment option should be ready for any complications that may occur during EVAR procedure. If rupture occurs, the patient should be operated on urgently. When type 1 endoleak is present, it is also important to perform elective re-intervention or open surgery. We know that the mortality of patients treated as urgent is 10 times higher than elective patients (24). In a study that reviewed 13 articles, mortality rates in the case of conversion to open surgery in the early period ranged from 0% to 28.5%. Mortality was observed to be approximately 10% in patients who underwent open surgery in the late period (25). There was no perioperative mortality in our study. In addition, there were no complications that required conversion to open surgery in the early period. Interventional treatment was applied to the endoleak formed during the procedure.

In the octogenarian population, intensive care and hospital stays are longer compared to those of younger patients with the same disease. We know that patients who underwent open surgery also experience longer stays in intensive care. Prolonged hospitalizations have negative effects both on patients and on cost-effectiveness. The most valuable result of endovascular treatment is the significant reduction in early mortality. Additionally, the duration of intensive care and hospitalization is shorter with endovascular treatment (26). In our study, the length of stay in the intensive care unit was 1 (min.: 1-max.: 4) days, and the median value of the total hospitalization was 4 (min.: 3, max.: 8) days. The most important factor prolonging hospitalization time was COPD. Shortening these lengths of stay will have positive effects on both patients and cost-effectiveness.

Although open surgery is always the gold standard for AAA, it always carries the risk of mortality and morbidity (27). The high comorbidity of octogenarian patients and the high fragility of these patients further increase the risk of mortality and morbidity. There are many studies comparing short and long-term results of open surgery and EVAR procedure in elderly patients (28,29). When we look at the short-term results of meta-analyses, we find that the mortality rates of EVAR are lower than those of open surgery. On the other hand, analyzing the 10-year long-term results, the data indicates that the mortality of EVAR and open surgery are similar (30). Although the superiority of EVAR was accepted when short-term mortality rates were evaluated in most of the studies; long-term mortality was higher in the EVAR group (30). In our study, no mortality was observed in any of the 36 patients who were followed up in the short term.

Scorings related to performance status (such as Karnofsky scoring) are used to assess patients' general condition and quality of life (30). These scores are frequently used in studies and have been gradually incorporated into cardiovascular surgery. It has been observed in many studies of both cardiac and non-cardiac surgery that the postoperative Karnofsky score shows a significant decrease compared to the preoperative score (30). Incision-related pain and metabolic stress caused by the operation are factors that impair the quality of life of patients in the early postoperative period of open surgery. However, rapid mobilization and recovery can be achieved in patients after endovascular procedures. In our study, endovascular treatment in octogenarian patients led to a high Karnofsky score even on the second postoperative day.

CONCLUSION

EVAR, which has equal success with open surgery in patients with AAA in the octogenerian, will significantly reduce operative morbidity, intensive care unit and hospital stay and cost when performed in an experienced and high-volume center. In addition, we believe that these patients who are Octogenerians imp

rove their performance more quickly.

ETHICS

Ethics Committee Approval: This study University of Health Sciences Türkiye, Bakırköy Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (decision no: 2022-17-09, date: 05.09.2022).

Informed Consent: Since this study was a retrospective study, patient consent was not required.

FOOTNOTES

Authorship Contributions

Surgical and Medical Practices: G.T., M.A.Y., O.E.S., H.T., Y.K., S.T., A.A.K., Concept: G.T., M.A.Y., O.E.S., H.T., S.T., Design: G.T., M.A.Y., O.E.S., H.T., Y.K., A.A.K., Data Collection or Processing: G.T., H.T., Y.K., S.T., A.A.K., Analysis or Interpretation: G.T., M.A.Y., H.T., S.T., A.A.K., Literature Search: G.T., M.A.Y., O.E.S., H.T., Y.K., Writing: G.T., M.A.Y., O.E.S., Y.K.

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REFERENCES

1. Eurostat. Population projections. Avaible from: http://epp.eurostat.ec. europa.eu/statistics_explained/index.php/Population_projections
2. Wanhainen A, Verzini F, Van Herzeele I, Allaire E, Bown M, Cohnert T, et al. Editor's choice - European Society for Vascular Surgery (ESVS) 2019 clinical practice guidelines on the management of abdominal aorto-iliac artery aneurysms. Eur J Vasc Endovasc Surg. 2019;57:8-93.
3. Brewster DC, Cronenwett JL, Hallett JW Jr, Johnston KW, Krupski WC, Matsumura JS, et al. Guidelines for the treatment of abdominal aortic aneurysms. Report of a subcommittee of the Joint Council of the American Association for Vascular Surgery and Society for Vascular Surgery. J Vasc Surg. 2003;37:1106-17.
4. Paolini D, Chahwan S, Wojnarowski D, Pigott JP, LaPorte F, Comerota AJ. Elective endovascular and open repair of abdominal aortic aneurysms in octogenarians. J Vasc Surg. 2008;47:924-7.
5. EVAR trial participants. Endovascular aneurysm repair versus open repair in patients with abdominal aortic aneurysm (EVAR trial 1): randomised controlled trial. Lancet. 2005;365:2179-86.
6. Locham S, Lee R, Nejim B, Dakour Aridi H, Malas M. Mortality after endovascular versus open repair of abdominal aortic aneurysm in the elderly. J Surg Res. 2017;215:153-9.
7. Pasqui E, de Donato G, Giannace G, Panzano C, Setacci C, Palasciano G. Management of abdominal aortic aneurysm in nonagenarians: A single-centre experience. Vascular. 2021;29:27-34.
8. Alberga AJ, Karthaus EG, van Zwet EW, de Bruin JL, van Herwaarden JA, Wever JJ, et al. Outcomes in octogenarians and the effect of comorbidities after intact abdominal aortic aneurysm repair in the Netherlands: a nationwide cohort study. Eur J Vasc Endovasc Surg. 2021;61:920-8.
9. Fonseca R, Rockman C, Pitti A, Cayne N, Maldonado TS, Lamparello PJ, et al. Intermediate-term EVAR outcomes in octogenarians. J Vasc Surg. 2010;52:556-61.
10. Jacobs CR, Scali ST, Staton KM, Neal D, Cooper MA, Robinson ST, et al. Outcomes of endovascular abdominal aortic aneurysm repair conversion in octogenarians treated at a high-volume aorta center. J Vasc Surg. 2022;76:1270-9.
11. Kumar P, Zehr KJ, Chang A, Cameron DE, Baumgartner WA. Quality of life in octogenarians after open heart surgery. Chest. 1995;108:919-26.
12. Péus D, Newcomb N, Hofer S. Appraisal of the Karnofsky Performance Status and proposal of a simple algorithmic system for its evaluation. BMC Med Inform Decis Mak. 2013;13:72.
13. Louzada ACS, da Silva MFA, Portugal MFC, Stabellini N, Zerati AE, Amaro E, et al. Epidemiology of abdominal aortic aneurysm repair in Brazil from 2008 to 2019 and comprehensive review of nationwide statistics across the world. World J Surg. 2022;46:1485-92.
14. Golledge J, Morris DR, Pinchbeck J, Rowbotham S, Jenkins J, Bourke M, et al. Editor's choice - metformin prescription is associated with a reduction in the combined incidence of surgical repair and rupture related mortality in patients with abdominal aortic aneurysm. Eur J Vasc Endovasc Surg. 2019;57:94-101.
15. Giles KA, Pomposelli F, Hamdan A, Wyers M, Jhaveri A, Schermerhorn ML. Decrease in total aneurysm-related deaths in the era of endovascular aneurysm repair. J Vasc Surg. 2009;49:543-51.
16. Columbo JA, Kang R, Spangler EL, Newhall K, Brooke BS, Dosluoglu H, et al. Design of the PReferences for Open Versus Endovascular Repair of Abdominal Aortic Aneurysm (PROVE-AAA) Trial. Ann Vasc Surg. 2020;65:247-53.
17. Wigley J, Shantikumar S, Hameed W, Griffin K, Handa A, Scott DJ. Endovascular aneurysm repair in nonagenarians: a systematic review. Ann Vasc Surg. 2015;29:385-91.
18. Hynes N, Sultan S. A prospective clinical, economic, and quality-of-life analysis comparing endovascular aneurysm repair (EVAR), open repair, and best medical treatment in high-risk patients with abdominal aortic aneurysms suitable for EVAR: the Irish patient trial. J Endovasc Ther. 2007;14:763-76.
19. Kent KC, Zwolak RM, Egorova NN, Riles TS, Manganaro A, Moskowitz AJ, et al. Analysis of risk factors for abdominal aortic aneurysm in a cohort of more than 3 million individuals. J Vasc Surg. 2010;52:539-48.
20. Schouten O, van Laanen JH, Boersma E, Vidakovic R, Feringa HH, Dunkelgrün M, et al. Statins are associated with a reduced infrarenal abdominal aortic aneurysm growth. Eur J Vasc Endovasc Surg. 2006;32:21-6.
21. Antoniou GA, Georgiadis GS, Antoniou SA, Kuhan G, Murray D. A meta-analysis of outcomes of endovascular abdominal aortic aneurysm repair in patients with hostile and friendly neck anatomy. J Vasc Surg. 2013;57:527-38.
22. Armstrong RA, Squire YG, Rogers CA, Hinchliffe RJ, Mouton R. Type of anesthesia for endovascular abdominal aortic aneurysm repair. J Cardiothorac Vasc Anesth. 2019;33:462-71.
23. Moll FL, Powell JT, Fraedrich G, Verzini F, Haulon S, Waltham M, et al. Management of abdominal aortic aneurysms clinical practice guidelines of the European society for vascular surgery. Eur J Vasc Endovasc Surg. 2011;41 Suppl 1:S1-58.
24. Faizer R, Weinhandl E, El Hag S, Le Jeune S, Apostolidou I, Shafii SM, et al. Decreased mortality with local versus general anesthesia in endovascular aneurysm repair for ruptured abdominal aortic aneurysm in the Vascular Quality Initiative database. J Vasc Surg. 2019;70:92-101.e1.
25. Goudeketting SR, Fung Kon Jin PHP, Ünlü Ç, de Vries JPM. Systematic review and meta-analysis of elective and urgent late open conversion after failed endovascular aneurysm repair. J Vasc Surg. 2019;70:615-28.e7.
26. Moulakakis KG, Dalainas I, Mylonas S, Giannakopoulos TG, Avgerinos ED, Liapis CD. Conversion to open repair after endografting for abdominal aortic aneurysm: a review of causes, incidence, results, and surgical techniques of reconstruction. J Endovasc Ther. 2010;17:694-702.
27. Canning P, Tawfick W, Whelan N, Hynes N, Sultan S. Cost-effectiveness analysis of endovascular versus open repair of abdominal aortic aneurysm in a high-volume center. J Vasc Surg. 2019;70:485-96.
28. Becquemin JP, Pillet JC, Lescalie F, Sapoval M, Goueffic Y, Lermusiaux P, et al. A randomized controlled trial of endovascular aneurysm repair versus open surgery for abdominal aortic aneurysms in low- to moderate-risk patients. J Vasc Surg. 2011;53:1167-73.e1.
29. Antoniou GA, Antoniou SA, Torella F. Editor's choice - endovascular vs. open repair for abdominal aortic aneurysm: systematic review and meta-analysis of updated peri-operative and long term data of randomised controlled trials. Eur J Vasc Endovasc Surg. 2020;59:385-97.
30. Bulder RMA, Bastiaannet E, Hamming JF, Lindeman JHN. Meta-analysis of long-term survival after elective endovascular or open repair of abdominal aortic aneurysm. Br J Surg. 2019;106:523-33.