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10.20960/angiologia.00711

04/24/2025

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Received: 17/11/2024
Accepted: 3/3/2025

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Conflicts of interest: The authors declared no conflicts of interest.
Artificial intelligence: The authors declare that they have not used artificial intelligence (AI) or any AI-based tool for writing this article.

ABSTRACT

Introduction and objectives: the objective is to compare the results and complications between urgent endovascular repair (EVAR) of symptomatic abdominal aortic aneurysms (AAA) versus elective EVAR of asymptomatic AAA.

Materials and methods: data were collected from patients who underwent EVAR for symptomatic and asymptomatic AAA between the years 2009 and 2020 at our center (Hospital General Universitario

Gregorio Marañón). Exclusion criteria: ruptured AAA, complex endovascular repair, and surgical repair.

Results: data were collected for 26 patients in the symptomatic AAA group (group A) and 262 in the asymptomatic AAA group (group B). The median follow-up was 49.5 months. No statistically significant differences were found between the two groups in the following study variables: 30-day mortality (0 % in group A, compared to 1.9 % in group B; *p* 0.47); reintervention rate (7.7 % vs 2.3 %; *p* 0.11) and major complications (23.1 % vs 13.7 %; *p* 0.07). During the medium to long-term follow-up, no differences were found between group A and group B (respectively) in the detection of endoleaks: 42.3 % vs 29.6 % (*p* 0.34), or branch thrombosis: 7.7 % vs 9 % (*p* 0.77). Despite finding a higher long-term mortality rate in group A (53.8 % vs 38.9 %; *p* 0.14), no differences were found in the aneurysm-related mortality rate: 7.7 % vs 3.8 % (*p* 0.32).

Conclusions: symptomatic aneurysm is a surgical emergency with less planning, optimization, and surgical preparation time for the patient compared to scheduled surgery. Despite this, our study did not find significant differences in most morbidity, mortality, and surgery-related complications variables in patients undergoing urgent EVAR compared to scheduled patients. Although it is a study with limitations (retrospective nature, small sample size in group A, etc.), it leads us to conclude that urgent EVAR in patients with symptomatic AAA can be an effective and safe surgery for the patient.

Keywords: Aneurysm. Aorta. Symptomatic. Endovascular.

RESUMEN

Introducción y objetivos: el objetivo es comparar los resultados y las complicaciones sintomáticos entre la reparación endovascular (REVA) urgente del aneurisma de aorta abdominal (AAA) con la REVA electiva de AAA asintomáticos.

Resultados: se recogieron 26 pacientes sintomáticos en el grupo AAA (grupo A) y 262 en el grupo AAA asintomáticos (grupo B) intervenidos de REVA entre el 2009 y el 2020.

No se encontraron diferencias estadísticamente significativas entre ambos grupos en las siguientes variables a estudio: mortalidad a 30 días (0 % en el grupo A; 1,9 % en el grupo B; $p = 0,47$); tasa de reintervención (7,7 % frente a 2,3 %; $p = 0,11$) y complicaciones mayores (23,1 % frente a 13,7 %; $p = 0,07$). Durante el seguimiento a medio-largo plazo no se encontraron diferencias entre los dos grupos en detección de endofugas (42,3 % frente a 29,6 % [$p = 0,34$]) o en trombosis de rama (7,7 % frente a 9 % [$p = 0,77$]). A pesar de encontrar una mayor tasa de mortalidad a largo plazo en el grupo A (53,8 % frente a 38,9 %; $p = 0,14$), no se encontraron diferencias en la tasa de mortalidad relacionada con el aneurisma (7,7 % frente a 3,8 % [$p = 0,32$]).

Conclusiones: el aneurisma sintomático se trata de una urgencia quirúrgica con menor tiempo de planificación, de optimización y de preparación quirúrgica del paciente que la cirugía programada. A pesar de esto, en nuestro estudio no encontramos diferencias significativas en la mayoría de las variables de morbimortalidad y complicaciones relacionadas con la cirugía en ambos grupos. Aunque es un estudio con limitaciones, nos lleva a concluir que el REVA urgente en pacientes con AAA sintomáticos puede ser una cirugía eficaz y segura para el paciente.

Palabras clave: Aneurisma. Aorta. Sintomático. Endovascular.

INTRODUCTION

Infrarenal abdominal aortic aneurysm (AAA) can be repaired either with ruptured or intact aortic wall. Within this latest mentioned group, we can identify two types of patients, asymptomatic and symptomatic AAAs (1).

Since the introduction of endovascular aneurysm repair (EVAR) for AAAs treatment in the early 1990's, the management of the patients has completely changed with its minimally invasive technique, less painful and faster recovery (1-3).

Even in the knowledge that the prevalence and incidence have been reduced over the last decades (both ruptured and non-ruptured), it still is one of the leading causes of death in most Western populations (1,4,5).

According to the majority of the literature, those patients with symptomatic, intact, urgent treated AAAs have higher morbidity and mortality rates in comparison with those undergoing elective repair (2,6,7), although there have been controversial results in some studies and the optimal timing of treatment is debated (3,8,9,10).

The purpose of this study is to report the outcomes, mortality and morbidity of two groups: urgent EVAR (u-EVAR) in symptomatic intact AAA and elective EVAR (e-EVAR), in order to analyze our experience.

METHODS

The type of research is a single-center, retrospective cohort study. It's been collected a database of patients with asymptomatic (e-EVAR) and symptomatic non-ruptured AAA (u-EVAR) who underwent endovascular repair between January 1, 2009 and December 31, 2020 at the Hospital General Universitario Gregorio Marañón (Madrid, Spain).

First of all, in this study, patients were considered symptomatic if they presented hemodynamic stability associated with acute abdominal or back pain, tenderness over aneurysm or distal thromboembolism, all of those symptoms attributed to the aneurysm. CTs with intravenous contrast infusion were performed in all of the patients (emergency CT examination in those cases of symptomatic AAA) and there were no CT signs of extravasation of blood outside the wall of the aneurysm. Another preliminary requirement is to assess the aneurysm anatomy. In cases of infrarenal aneurysm, it will be treated urgently.

Conversely, for complex anatomies (juxtarenal, suprarenal) without evidence of rupture, surgical management is typically deferred, with each case being evaluated on an individual basis.

Once the diagnosis of non-ruptured infrarenal AAA was confirmed, the patient was taken either to the operating room for u-EVAR or to the intensive care unit for further optimization. U-EVAR were performed on all the patients within the first 48 hours of admission.

Patients with any evidence of ruptured AAA (including contained rupture AAA) were excluded as well as open aneurysm repair, suprarenal and thoracoabdominal AAA or aortic dissection.

Demographic data, cardiovascular risk factors, baseline laboratory, operative and anesthesiologist reports, discharge summaries, results and postoperative clinical data were recorded.

Primary outcome events that were compared included: 30-day or in-hospital mortality and morbidity, length of hospital stay, endoleaks, reinterventions and long-term mortality and morbidity.

The follow-up protocol consisted of routine CT at 1 and 12 months, Doppler Ultrasound at 6 months, and hereafter, in absence on further complication, controls by Doppler Ultrasound every year and CT every 5 years for patients treated with EVAR.

Statistical analysis

Normal distribution was not assumed. Continuous variables are presented as mean (range), whereas demographical data are expressed as absolute values and percentages (%). Statistical analyses were performed comparing u-EVAR and e-EVAR repairs for the entire cohort using IBM SPSS Statistics software. p values < 0.05 were considered statistically significant. χ^2 test and Fisher's exact test were used for the comparison of discrete variables and the Mann Whitney test was used for continuous variables. Multivariate analysis of potential complications and risk factors was performed.

The study received approval from the local ethics committee.

RESULTS

From 2009 to 2020, a total of 288 with intact AAA underwent EVAR in our hospital, of whom 262 (91 %) were asymptomatic (e-EVAR), whereas 26 (9 %) had symptoms and were treated urgently (u-EVAR). Compared with those with u-EVAR, asymptomatic patients were similar in most of the demographic characteristics (Table 1) such as age, they also were more likely to be male, non-diabetic, non-smokers, present hypertension and there were no differences between both cohorts of suffering from chronic obstructive pulmonary disease, chronic kidney disease, coronary artery disease or peripheral arterial disease. Over the e-EVAR group, patients were more likely to take Statins regularly (79 % vs 61.5 %; p 0.04).

When comparing the operative characteristics of the entire cohort (Table 2), there were no differences between patients with u-AAA and e-AAA in terms of surgical vs percutaneous access (similar in both groups) and a greater tendency to aorto-bi-iliac over aorto-uni-iliac stent-graft. Conversion to open repair was observed in the e-AAA group, but difference did not reach statistical significance. In contrast, aneurysm diameter was significantly smaller in asymptomatic patients (62.9 ± 10.5 mm) compared with the symptomatic ones (75 ± 19.9 mm; $p < 0.001$).

Primary freedom from endoleaks (all types, perioperatively, based on angiography or CTA imaging before discharge) for asymptomatic patients was 65.7 %; for the symptomatic ones, the rate was 57.7 % (p 0.031). Distinction among the different types of perioperatively endoleaks may be seen in figure 1; despite the higher rate of type IA and IB endoleaks in the symptomatic group, these results did not reach statistical significance (p 0.23). Comparing EVAR for asymptomatic and symptomatic presentations, symptomatic patients were less likely to have a procedure under general anesthesia (46.2 % vs 94.8 %; $p < 0.001$) and were more likely to have unilateral hypogastric artery covered, either intended occlusion in order to

avoid endoleaks or unintended hypogastric coverage (38.5 % vs 16 %; *p* 0.05).

Analyzing perioperative morbidity (Table 3), the rate of postoperative morbidity was higher in the symptomatic group than in the asymptomatic group (23.1 % vs 13.7 %, respectively). However, this difference did not reach statistical significance. Early complications in the study were considered: acute myocardial infarction, stroke, acute lower limb ischemia, respiratory infection, sacral pressure ulcer, ischemic colitis, respiratory failure, surgical wound infection, inguinal hematoma, others.

The perioperative reintervention rate in the asymptomatic group was lower than in symptomatic group (2.3 % vs 7.7 %), although once again, this difference did not reach the level of statistical significance (*p* 0.11).

No symptomatic patient who underwent urgent surgery died in early postoperative period. Early mortality rate in the asymptomatic group was 1.9 % (5 patients), causes of death included: cardiac failure (2 patients), multiorgan failure (1 patient), respiratory insufficiency (1 patient) and bowel ischaemia (1 patient).

Long-term analysis of morbidity and mortality following EVAR in both groups (Table 4) reveals an all-cause mortality rate over the follow-up period (median follow-up: 49.5 months) of 53.8 % (14/26) in the symptomatic group and 38.9 % (102/262) in the asymptomatic group. AAA-related mortality accounted for 2 deaths of u-EVAR cohort and 10 deaths of e-EVAR cohort. However, these differences were not statistically significant. Endoleaks occurred in both groups similarly (30.7 % vs 29.6 %, *p* 0.34).

Also graft thrombosis (7.7 % vs 9 %, *p* 0.77). Nevertheless, graft infection rate was significantly more likely to be seen in the symptomatic group (15.4 % vs 3.8 %, *p* 0.009), this may be attributable to the fact that 3 out of the 4 patients with graft infection of the u-EVAR group were diagnosed with mycotic aneurysm. The

overall reintervention rate was similar in both groups: 30.8 % vs 24.4 %, (p 0.48).

Long-term survival was investigated with Kaplan-Meier analysis (Fig. 2), which demonstrated similar long-term mortality in u-EVAR compared with patients with e-EVAR.

DISCUSSION

Symptomatic, non-ruptured infrarenal aortic aneurysms represent a distinct clinical entity whose early recognition, accurate diagnosis, and timely intervention are essential for optimizing patient outcomes and reducing the risk of rupture (1).

In our study, the comparison of outcomes from endovascular repair surgery for symptomatic abdominal aortic aneurysms treated urgently (u-EVAR) versus asymptomatic patients undergoing elective surgery (e-EVAR) has revealed intriguing and significant results.

First of all, our study confirms previous findings indicating significant differences in aneurysm diameter between symptomatic and asymptomatic patients. This observation aligns with the literature, which has demonstrated an association between acute symptomatology and larger aneurysm diameter (2,7,8,11).

As previously reported, there was a greater tendency to aorto-bi-iliac over aorto-uni-iliac stent-graft, with most aorto-uni-iliac stent-graft implanted in the early years. From 2013, the distribution shifted predominantly towards aorto-bi-iliac stent-grafts, with only a few exceptions.

Regarding rates of endoleak and hypogastric artery occlusion, our study reveals a significantly higher incidence in symptomatic patients. These results may be attributed to the urgency of intervention and altered vascular anatomy in these cases (7,11). The presence of acute symptoms may hinder proper surgical planning and increase the risk of technical complications during the procedure. It is highly probable that in some cases, it could have been prevented if the procedure had been performed electively.

Conversion to open repair occurred in three cases of e-EVAR group: two were due to access-related complications (arterial rupture), and one was attributed to the inability to cannulate the contralateral branch.

In the u-EVAR group, there were two cases of early reintervention (within the first 30 days postoperatively). The first was due to femoro-femoral bypass thrombosis, and the second required nephrostomy due to acute renal failure in the postoperative period. Regarding long-term reinterventions, the main causes were endoleaks, endograft migration, kinking thrombosis and/or stenosis of an endograft limb and explantation of the endograft due to graft infection.

The greater use of local anesthesia in symptomatic patients may reflect the need for quicker, less invasive procedures in emergency situations. Besides, literature provides information on the advantages of local instead of general anesthesia in symptomatic and ruptured aneurysms: to avoid the relaxation of abdominal wall and tissues and release of tamponade, and the haemodynamic effects of general anesthesia, including loss of vascular tone, all of which may be exacerbated and lead to shock (12).

The higher rate of infection in symptomatic patients may be related to the presence of preoperative complications, exposure to prior medical treatments, and compromised immune response (3,7). In our study, this increase in the infection rate among the u-EVAR group may also be attributed to the fact that the majority of those cases were mycotic aneurysms (three patients out of four cases), in which prosthetic material implantation is performed over an infected tissue. Among these four cases of prosthetic infection in surgically treated patients, three exhibited low virulence, with stability during long-term follow-up using PET-CT and multidisciplinary management in collaboration with the Microbiology department. One case developed an aortoenteric fistula as a complication eight months after EVAR, leading to death due to this condition.

Diagnosis approach to assess infectious involvement was based on clinical presentation, laboratory findings (inflammatory parameters CRP, ESR, leucocitosis, blood cultures) and imaging tests (irregular wall thickening, thrombi formation, fluid and gas accumulation).

The most frequently involved pathogens were Gram-positive cocci (*Staphylococcus, Enterococcus and Streptococcus pneumoniae)*, although approximately 30 % of the blood cultures were negative.

In those cases where clinical suspicion is high, a preoperative dose of intravenous antibiotic is administered, then it is maintained during the postoperative period, subsequently adjusted based on culture results. Treatment duration is finally set according to the recommendations of the hospital's Microbiology department.

It is important to note that despite these differences in clinical presentation and vascular anatomy, our conclusions regarding the effectiveness and safety of endovascular surgery in both patient groups are consistent with previous literature (3,8), even better than in other studies (5-7), which mortality and morbidity of u-EVAR are higher compared to e-EVAR.

This observation, although unexpected, is not entirely unique. A growing trend towards similar outcomes among symptomatic and asymptomatic patients undergoing AAA surgery has been documented in the existing literature (2,3,8,10). Previous studies have suggested that improvements in surgical techniques and perioperative management have led to a significant reduction in complication rates and mortality, regardless of the patient's symptomatic status at the time of intervention.

It is crucial to recognize that our study has inherent limitations, including its retrospective nature and limited sample size. These limitations may impact the generalizability of our findings and should be considered when interpreting the results.

Prospective, multicenter studies of larger scale are needed to validate our findings and further explore the factors contributing to differences in outcomes between symptomatic and asymptomatic patients.

This study does not implement a specific management algorithm for symptomatic AAA. However, based on the observed results, the development of such an algorithm is being considered.

Additionally, future research could focus on optimizing perioperative strategies and developing personalized therapeutic approaches to improve long-term outcomes in patients with abdominal aortic aneurysms.

CONCLUSIONS

The symptomatic aneurysm represents a surgical emergency with less time for planning, optimization, and surgical preparation of the patient compared to scheduled surgery. Despite this, in our study, we did not find significant differences in most of the variables of morbidity, mortality, and surgery-related complications in patients undergoing urgent EVAR. Our findings contribute to this body of evidence by highlighting that even in emergency situations where patients present with acute symptoms, EVAR can achieve outcomes comparable to those obtained in electively selected patients. This reinforces the notion that, regardless of initial symptomatology, endovascular surgery remains a viable option for abdominal aortic aneurysm treatment.

Table 1. Demographic characteristics

	u-EVAR	**e-EVAR**	***Sign. (p)***
Age	75.6 ± 10	75.2 ± 6	0.85
Male gender	26 (100 %)	252 (96.2 %)	0.31
Hypertension	19 (73.1 %)	199 (76 %)	0.74
Diabetes	2 (7.7 %)	66 (25.2 %)	0.13
Statins	16 (61.5 %)	207 (79 %)	0.04

Smoker	9 (34.6 %)	64 (24.4 %)	0.07
Chronic obstructive pulmonary disease	6 (23.1 %)	62 (23.7 %)	0.94
Chronic kidney disease	6 (23.1 %)	51 (19.5 %)	0.66
Coronary artery disease	9 (34.6 %)	88 (33.6 %)	0.33
Peripheral arterial disease	1 (3.8 %)	30 (11.5 %)	0.23

Table 2. Operative characteristics

	u-EVAR	**e-EVAR**	***Sign. (p)***
Aneurysm diameter (mm)	75 ± 19.9	62.9 ± 10.5	*< 0.001*
Aorto-bi-iliac stent-graft	18 (69.2 %)	211 (80.5 %)	0.39
Percutaneous access	11 (42.3 %)	89 (34 %)	0.39
Conversion	0	3 (1.1 %)	0.58
Endoleak	11 (42.3 %)	90 (34.3 %)	*0.031*
General anesthesia	12 (46.2 %)	239 (91.2 %)	*< 0.001*
Hypogastric coverage	10 (38.5 %)	42 (16 %)	*0.05*

Table 3. Perioperative morbidity and mortality (30 days)

	u-EVAR	**e-EVAR**	***Sign. (p)***
Complications	6 (23.1 %)	36 (13.7 %)	0.07
Reinterventions	2 (7.7 %)	6 (2.3 %)	0.11
Hospital stay (days	9.88	7.12	0.57

range)			
30 days mortality	0	5 (1.9 %)	0.47

Table 4. Long-term data

	u-EVAR	**e-EVAR**	***Sign. (p-value)***
Long term mortality	14 (53.8 %)	102 (38.9 %)	0.14
Endoleak	8 (30.7 %)	75 (29.6 %)	0.34
Graft thrombosis	2 (7.7 %)	23 (9 %)	0.77
Graft infection	4 (15.4 %)	10 (3.8 %)	*0.009*
Reintervention	8 (30.8 %)	64 (24.4 %)	0.48

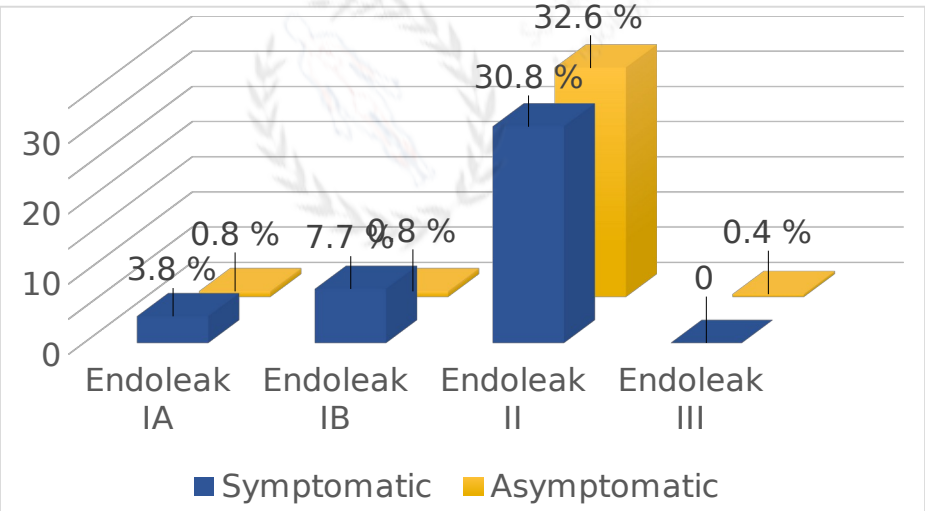
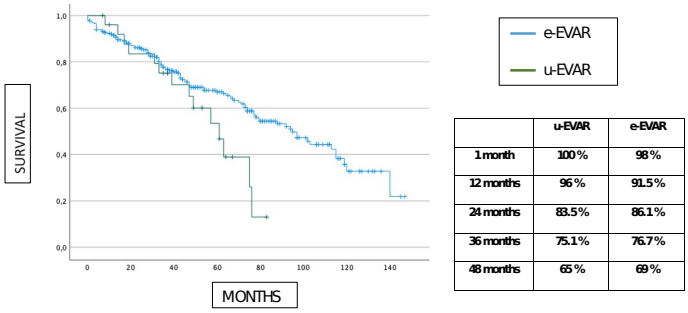


Figure 1. Perioperatively classified endoleaks.



	u-EVAR	e-EVAR
1 month	100%	98%
12 months	96%	91.5%
24 months	83.5%	86.1%
36 months	75.1%	76.7%
48 months	65%	69%

Figure 2. Long-term survival after EVAR. e-EVAR, elective abdominal aortic aneurysms; u-EVAR, urgent (symptomatic) abdominal aortic aneurysms.

Figure 2. Long-term survival after EVAR. e-EVAR: elective abdominal aortic aneurysms; u-EVAR: urgent (symptomatic) abdominal aortic aneurysms.

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