Ruptured abdominal aortic aneurysm: Endovascular treatment

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Abstract: *Aim:* The elective endovascular treatment of abdominal aortic aneurysm (AAA) is nowadays a daily routine practice in selected patients. The traditional treatment of ruptured abdominal aortic aneurysm (rAAA) has a peri-operative mortality of 40–50% that has not changed in the last 20 years. Nowadays, the endovascular repair may reduce mortality, hospitalization and sanitary costs. *Methods:* The study included 14 patients affected by AAA who came to the Emergency Department because of hemodynamic shock (nine patients) or back pain (five patients). All patients underwent a CT angiography before surgery. Forty-two percent of the patients presented with shock (systolic pressure ≤70 mm Hg) in the operating room, and they underwent an endovascular aortic repair (EVAR) as an emergency procedure. Five bifurcated endoprotesis and nine uniliac protesis making a femoro-femoral bypass to revascularize the excluded limb were made. Patients underwent a follow up with CT angiography one month and then six months after surgery and if no problems were detected, patients underwent a follow-up every year. *Results:* Two cases were immediately converted to open surgery because of failed EVAR. Four patients (28%) died after surgery because of multi-organ failure (MOF). The mean hospitalization was 12 days (range 3–21 days). We observed only one case of first-type endoleak at the 1-month follow up and we successfully treated it with a proximal cuff. *Conclusion:* In our experience, the intention-to-treat protocol for rAAA offered acceptable results in terms of mortality rates. Multicenter studies are necessary to establish the role of endovascular treatment in patients with rAAA.

Keywords: rAAA, EVAR, high surgical risk

Introduction

The rupture of abdominal aortic aneurysm (AAA) is a lethal condition. If patients do not undergo surgery, the mortality rate is 100% [1] and only 36% of patients with ruptured AAA (rAAA) reach the hospital alive [2]. Despite rapid prehospital transportation and important progress in diagnosis, anesthesiology and surgery, the mortality rate of patients who underwent emergency open repair remains unacceptably high [3]. All these rates result in an overall mortality rate of 90% [3].

In 1994, Yusuf et al. first described endovascular repair of a rAAA [4]. Since 1990, when Parodi first implanted an aortic stent-graft, a new method of minimally invasive treatment of AAA has become available, especially in patients with high surgical risk [5].

The endovascular aortic repair (EVAR) for asymptomatic AAA has steadily increased in the last decade with the improvement of devices and the growing experience of the operators. Fifteen years of practice with this endovascular technique showed the feasibility of the stent graft repair as a promising treatment option, not only for the elective repair of AAA but also for ruptured aneurysm [2].

Many centers have chosen EVAR to treat rAAA with different results. Several groups have developed standard protocols of management of rAAA and have used EVAR, whenever possible, achieving good outcomes. Other authors have used EVAR only in selected rAAA and did not report better results compared with traditional open repair [6].

In the study, we present our personal experience of emergency endovascular treatment of AAAs, compared to our experience of open repair of rAAAs and comparing our results to those reported in the literature.

Materials and Methods

Data from patients presented at the Emergency Department with severe abdominal or back pain and/or acute circulatory shock, defined as systolic blood pressure ≤70 mm Hg, were collected prospectively and evaluated retrospectively. Informed consent was obtained whenever possible.

During the period between November 2003 and April 2010, we selected 250 patients for the implantation of stent-grafts to exclude AAAs. Fourteen patients (12 men and 2 women), with a mean age of 76 years (range 65–88 years), were treated on an emergency basis. Major co-

Table I Criteria adopted to select patients for the emergency treatment

Clinical criteria	*n*
Hypotension (systolic pressure ≤90 mm Hg)	8
Hemorrhagic shock (systolic pressure ≤70 mm Hg)	6
Lumbar pain	7
Retroperitoneal hematoma	6
Radiological signs of impeding rupture of AAA	2

morbidities included hypertension (ten cases), coronary artery disease (eight cases), chronic obstructive pulmonary disease (seven cases), diabetes (six cases) and chronic renal failure (two cases). Given the severe comorbidities and urgent nature of their problem, nine patients were classified as American Society of Anesthesiologists (ASA) status IV; five patients were graded status III.

The criteria used to select patients for the emergency treatment were hypotension (systolic pressure ≤90 mm Hg) or hemorrhagic shock (systolic pressure ≤70 mm Hg) and/or lumbar pain in a patient with AAA associated with retroperitoneal hematoma or radiological signs of impending rupture of the aneurysm *(Table I)*.

The preoperative diagnosis and the evaluation of indications favoring endovascular treatment, choice of endoprothesis size, and planning of the easiest route of arterial access, were carried out in all patients using CT angiography. More specifically, the investigations were carried out with a multislice CT scanner using scans obtained in the basal, arterial, and venous phases and following maximum intensity projection (MIP) and volume rendering (VR) reconstructions. CT angiography ranged from the celiac trunk to the common femoral arteries. Treatment decisions were made collaboratively with vascular surgeons and interventional radiologists. Our policy was to use EVAR in all patients who were anatomically suitable, if appropriate staff and endografts were available. The exclusion anatomical criteria for emergency EVAR procedures were, according to literature [7], proximal neck length <5 mm; proximal neck diameter >30 mm; proximal neck angulation >90°; distal neck diameter >20 mm, and stenosis and/or occlusion of both iliac arteries.

The average aneurysm diameter was 61 mm (range 47–104 mm), the mean proximal aneurysm neck length was 24 mm (range 15–35 mm), the average proximal neck diameter was 24 mm (range 21–30 mm), and the mean proximal neck angulation was 60° (range 20–80°), as we can see in *Table II*. In eight patients, the

Table II Anatomical characteristics of abdominal aneurysms emergency-treated

Aneurysm diameter	61 mm (range 47–104 mm)
Proximal neck length	24 mm (range 15–35 mm)
Proximal neck diameter	24 mm (range 21–30 mm)
Proximal neck angulation	60° (range 20–80°)

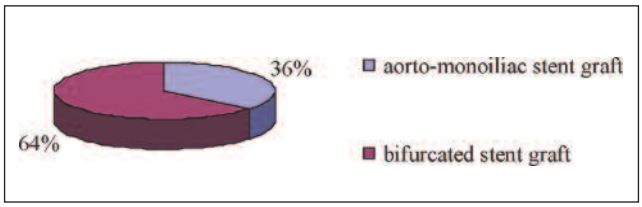

Fig. 1. Endograft used

aneurysm involved only the abdominal aorta, in two patients the aneurysm involved both the common iliac arteries, and in two cases it involved only one iliac artery. The CT scan showed the presence of hematoma (extravasation of blood outside the aortic wall) in nine cases. In five patients, CT angiography showed contrast penetration of the mural thrombus in the abdominal aneurysm.

The procedure was performed under general anesthesia in all patients by a team of vascular surgeons and interventional radiologists in the operating room using a mobile C-arm fluoroscopic guide. In six unstable patients, a transfemoral supraceliac occlusion balloon was inflated under fluoroscopic control. All patients were treated with commercially available stent grafts. In five cases, we used bifurcated stent grafts (four Talent and one Endurant, Medtronic Inc.) and in nine patients we implanted a Talent (Medtronic Inc.) aorto-monoiliac stent graft *(Fig. 1)*. In these nine cases, the procedure was completed with the insertion of an occluder in the controlateral common iliac artery and the construction of an extra-anatomic femoro-femoral surgical bypass. The devices were introduced through a bilateral mini-surgical exposure of the common femoral arteries.

Antibiotic short-term prophylaxis (vancomycin 1 g, intravenously) was administered to all patients at the same time as the induction of anesthesia to obtain an adequate drug concentration at the time of stent-graft introduction. Before starting the procedure of endoprothesis positioning, 2500 IU heparin sodium was administrated intravenously. After the procedure, all patients were transferred to an ICU. According to EUROSTAR protocol, all patients underwent CT angiography at 1, 6, and 12 months and yearly thereafter [8–9].

Results

The procedures required a mean operating time of 128 ± 28 min (range 90–290 min). Nine patients presented a clear rupture of AAA with hemorrhagic shock and their average time between clinical suspicion of rAAA and endovascular procedure was 125 ± 60 min (range 55–250 min). The time of delay was spent to perform a TC angiography, to plan the procedure, and to measure neck's length and diameters while the operating room was prepared. The other five patients presented a symptomatic AAA with radiological signs of impending rupture; they had a bifurcated endograft after a mean time of

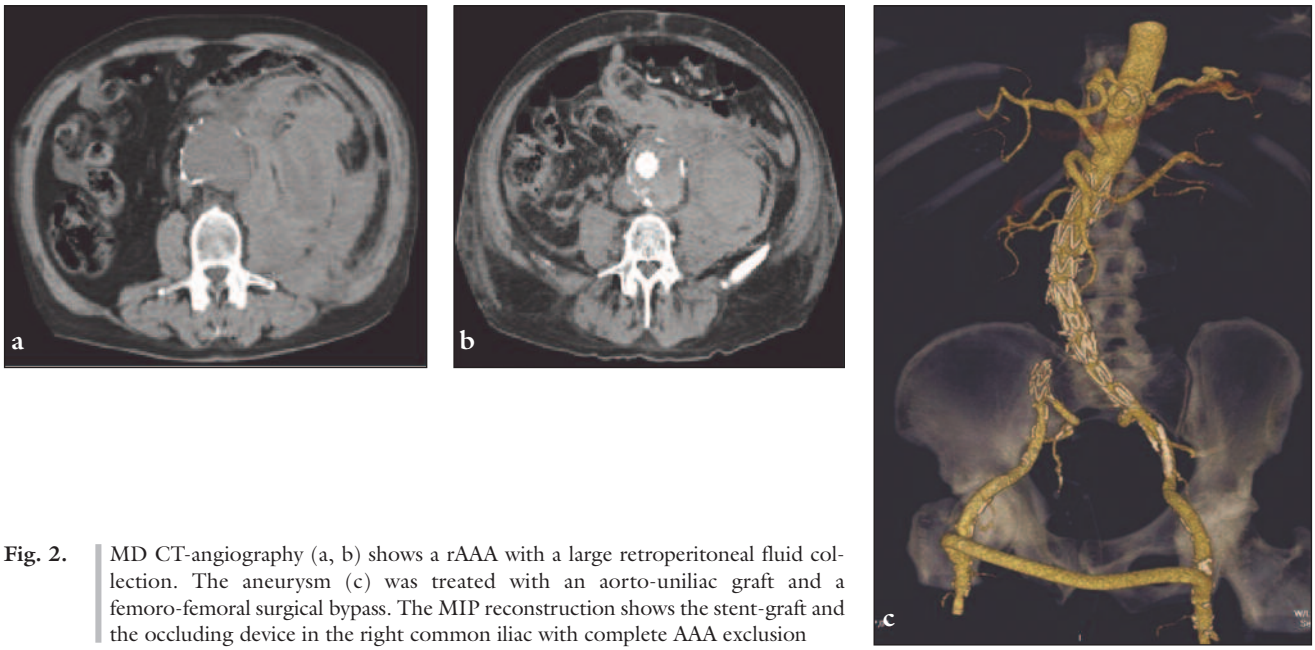

Fig. 2. MD CT-angiography (a, b) shows a rAAA with a large retroperitoneal fluid collection. The aneurysm (c) was treated with an aorto-uniliac graft and a femoro-femoral surgical bypass. The MIP reconstruction shows the stent-graft and the occluding device in the right common iliac with complete AAA exclusion

2 days, because of the time needed to order and receive prosthesis from the factory.

In our hospital, the average delay in treating rAAA with open surgery depends on the patient's condition. No delay is allowed if the patient's situation is critical.

The time of the CT scan is the only delay, when the patient's condition allows performing it.

A total of four patients (28%) died during the first 30 perioperative days. All deaths occurred in patients who had been admitted in an unstable hemodynamic condition. Two of them had to be converted to open surgery during the endovascular procedure because of acute drop-migration of the endoprosthesis (type I endoleak). The two remaining patients died on the second and fourth postoperative day because of a multi-organ failure (MOF). Two patients (14%) showed a mild increase in serum creatinine (>2 mg/dL) but did not require hemodialysis. We did not observe any abdominal compartmental syndrome (ACS) that would require open abdominal treatment (OAT); three patients (21%) suffered postimplant syndrome characterized by fever, leukocytosis, and backache, which disappeared before discharge.

A comparison between our results in endovascular treatment and open repair of rAAA shows a mortality almost double; in fact our mortality after open repair of rAAA is 47%.

Mean hospitalization was 12 days (range 3–21 days) and mean ICU stay was 3 days (range 1–7 days). One patient underwent an additional endovascular procedure for

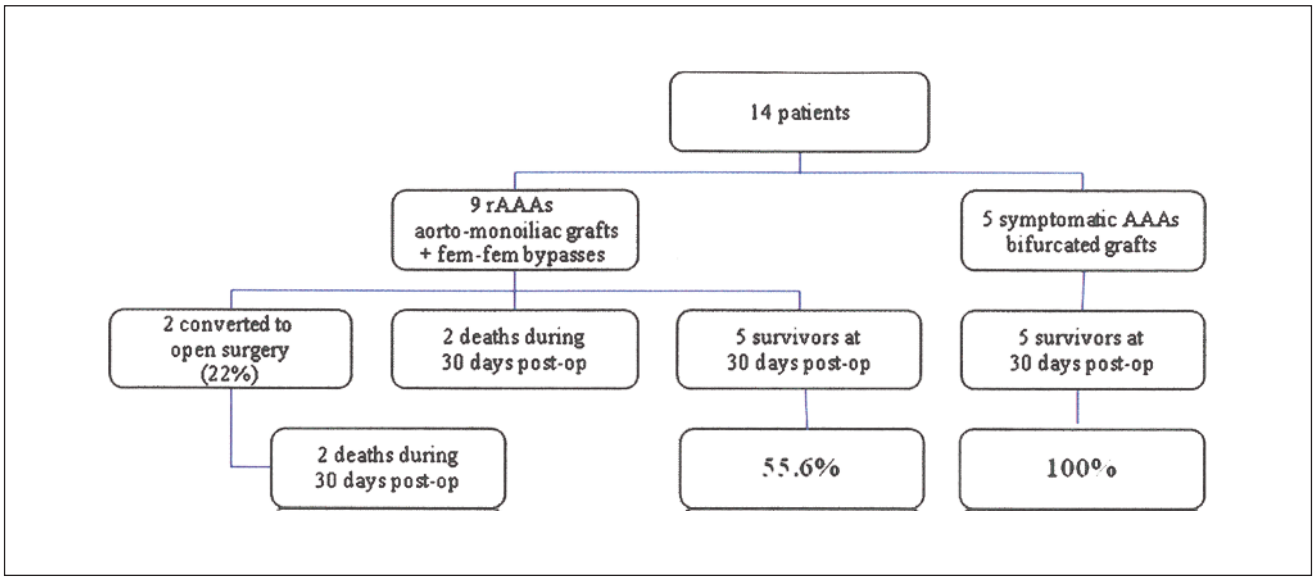

Fig. 3. A diagram explaining our experience, the devices used and the outcomes

a proximal type I endoleak observed at the 1-month CT control. It was treated successfully with an aortic extension on the 34th postoperative day.

Figure 3 explains our experience with rAAA and symptomatic AAA, endovascular graft choices, and outcomes.

Discussion

Although the first endovascular repair of rAAA was described by Yusuf et al. in 1994, small case series with selected patients appeared in the literature later [10]. The development of increasingly versatile devices and the growing knowledge of the operators had the result that nowadays endovascular repair of rAAA has become a routine practice and, in a few experienced centers, it represents the first-line treatment option [11–14]. Although the overall evidence is that EVAR may improve the outcome of rAAA [15–16], some groups have not been able to confirm the advantage of EVAR over open repair [12, 17, 18].

The endovascular approach is similar to the modern approach to a serious hemorrhage. The primary goal is the rapid control of the bleeding source using the less invasive procedure, in order to reduce hypoperfusion, hypothermia, coagulopathy and acidosis [19]. In six patients hemosthasis was reached using an intra-aortic balloon at the beginning of the procedure. Patients affected by rAAA present with many comorbidities and may present in extremis. Adverse pathophysiologic changes observed during open surgery, such as sudden decompression of intra-abdominal pressure, third-space, and blood losses, are minimized by adopting an endovascular approach [10].

In the literature, many centers limited the use of EVAR to "stable" rAAA patients or even those with "contained" rupture. Hemodynamic instability is associated with a higher risk of procedural mortality. Therefore, it is not correct to compare lower procedural EVAR mortality rates with those of open repair [21]. Therefore, we divided our cases into two groups: stable patients with contained rupture and instable patients with documented rupture. In the first group, the 30-day mortality was 0% and stent-graft insertion was successful in all cases. We observed a 30-day mortality rate of 44% among instable patients with a confirmed rAAA. This value may seem rather high to represent progress compared with the best series of open rAAA repair, but several reasons could be found. The cases reported here are on the basis of little experience that represents the early phase of our learning curve, which seems to be different from and longer than the elective cases [10]. In addition, it is also possible that we intuitively moved toward offering endovascular treatment to some hemodynamic instable patients who previously would have very bad prognosis. These patients normally underwent open repair with worst results and they are perhaps those who have the most to gain from endovascular approach [17].

Finally, four patients (28%) died in the first 30 perioperative days. In two patients (14%), we observed a slight increase of serum creatinine, which never required treatment. Three patients (21%) suffered a postimplant syndrome that vanished before hospital discharge.

It is mandatory that experienced staff in both endovascular or open repair and an adequately equipped operating room are necessary conditions to treat rAAA with EVAR. An appropriate inventory of suitable grafts and accessories must be stocked in the operating room and be available for the procedure and unexpected contingencies [6].

In addition, in a time of budget constraints, costs, or cost-effectiveness of a new therapy compared with a traditional one may influence treatment policy. Of note, a recently performed study about the costs of endovascular repair versus those of open surgery in patients with rAAA showed that endovascular repair was cost saving compared with open surgery, even after 1-year follow-up [12]. Unfortunately, at the moment we have no data available in Italy concerning the costs of the two different procedures.

Conclusion

Endovascular procedure without laparotomy, retroperitoneal dissection, and aorta cross-clamping is a very attractive alternative to open repair for rAAA.

Our results suggest that endovascular treatment is feasible in the emergency setting, and our early experience is promising. The technique seems suitable not only for stable patients but could be considered as the procedure of choice for all patients irrespective of hemodynamic condition.

In conclusion, it is possible to state that the endovascular approach is a valuable and promising therapeutic resource for the emergency treatment of rAAA. Further studies with a longer follow-up and a higher number of patients are necessary in order to evaluate the long-term results of endovascular treatment and to enable a comparison with surgical treatment in terms of mortality, morbidity, and long-term technical success.

References

1. Dalanais I, Nano G, Bianchi P, Dtegher S, Casana R, Malacrida G, Tealdi D: Endovascular techniques for the treatment of ruptured abdominal aortic aneurysms: 7-year intention-to-treat results. World J Surg 30, 1809–1814 (2006)
2. Kubin K, Sodeck G, Teufelsbauer H, Nowatschka B, Kretschmer G, Lammer J, Schoder M: Endovascular therapy of ruptured abdominal aortic aneurysm: mid- and long-term results. Cardiovasc Intervent Radiol 31, 496–503 (2008)
3. Wilmink AB, Quick CR, Hubbard CS, Day NE: Effectiveness and cost of screaning for abdominal aortic aneurysm: results of a populatin screening program. J Vasc Surg 38, 72–77 (2003)
4. Yusuf SW, Whitaker SC, Chuter TA et al.: Emergency endovascular repair of leaking aortic aneurysm. Lancet 344, 1645 (1994)

5. Parodi JC, Palmaz JC, Barone HD: Transfemoral intraluminal graft implantation for abdominal aortic aneurysm. Ann Vasc Surg 5, 491–499 (1991)
6. Veith F, Lachat M, Mayer D, Malina M et al.: Collected world and single center experience with endovascular treatment of ruptured abdominal aortic aneurysm. Ann Surg 250, 818–824 (2009)
7. Mayer D, Pfammatter T, Rancic Z, Hechelhammer L, Wilhelm M, Veith F, Lachat M: 10 years of emergency endovascular aneurysm repair for ruptured abdominal aortoiliac aneurysms: lessons learned. Ann Surg 249, 510–515 (2009)
8. Peppelenbosch N, Buth J, Harris PL et al.: Diameter of abdominal aortic aneurysm and outcome of endovascular aneurysm repair: does size matter? A report from EUROSTAR. J Vasc Surg 39, 288–297 (2004)
9. Van Marrewijk C, Buth J, Harris PL et al.: Significance of endoleaks after endovascular repair of abdominal aortic aneurysms: the EUROSTAR experience. J Vasc Surg 35, 461–473 (2002)
10. Gerassimidis T, Karkos C, Karamanos D, Papazoglou K, Papadimitriou D, Demiropoulos, Malkotsis D, Kamparoudis A: Endovascula management of ruptured abdominal aortic aneurysm: an 8-year single-centre experience. Cardiovasc Intervet Radiol 32, 241–249 (2009)
11. Veith FJ, Ohki T: Endovascular approaches to ruptured infrarenal aorto-iliac aneurysms. J Cardiovasc Surg 43(3), 369–378 (2002)
12. Visser JJ, Bosch JL, Hunink MG, van Dijk LC, Hendriks JM, Poldermans D, van Sambeek MR: Endovascular repair versus open surgery in patients with ruptured abdominal aortic aneurysms: clinical outcomes with 1-year follow-up. J Vasc Surg 44(6), 1148–1155 (2006)
13. Acosta S, Lindblad B, Zdanowski Z: Predictors for outcome after open and endovascular repair of ruptured abdominal aortic aneurysms. Eur J Vasc Endovasc Surg 33(3), 277–284 (2007)
14. Visser JJ, van Sambeek MR, Hamza TH, Hunink MG, Bosch JL: Ruptured abdominal aortic aneurysms: endovascular repair versus open surgery–systematic review. Radiology 245(1), 122–129 (2007)
15. Mastracci TM, Garrido-Olivares L, Cina CS, Clase CM:- Endovascular repair of ruptured abdominal aortic aneurysms: a systematic review and metaanalysis. J Vasc Surg 1, 214 –221 (2008)
16. Lovegrove RE, Javid M, Magee TR, Galland RB: A meta-analysis of 21,178 patients undergoing open or endovascular repair of abdominal aortic aneurysm. Br J Surg 6, 677–684 (2008)
17. Hinchliffe RJ, Bruijstens L, MacSweeney ST, Braithwaite BD: A randomized trial of endovascular and open surgery for ruptured abdominal aortic aneurysm: results of a pilot study and lessons learned for future studies. Eur J Vasc Endovasc Surg 5, 506–513 (2006)
18. Ockert S, Schumacher H, Bockler D, Megges I, Allenberg JR: Early and midterm results after open and endovascular repair of ruptured abdominal aortic aneurysms in a comparative analysis. J Endovasc Ther 3, 324–332 (2007)
19. Treska V, Cechura M, Molacek J et al.: Rupture of abdominal aortic aneurysm (RAAA): Predictors of the early postoperative mortality. Zentralbl Chir 128, 557–560 (2003)
20. Veith FJ, Ohki T, Lipsitz EC et al.: Endovascular grafts and other catheter-directed techniques in the management of ruptured abdominal aortic aneurysms. Semin Vasc Surg 16, 326–331 (2003)
21. Coppi G, Silingardi R, Gennai S et al.: A single centre experience in open and endovascular treatment of hemodynamically unstable and stable patients with ruptured abdominal aortic aneurysms. J Vasc Surg 44, 1140–1147 (2006)