BRIEF REPORT

Endovascular Treatment of Aortic Aneurysm Rupture

Tratamiento endovascular del aneurisma de la aorta roto

L. MARIANO FERREIRA[1, 3, 4], SERGIO ESCORDAMAGLIA[1], GERMÁN CASTILLO[1], JULIO C. ROSEMBERG[1], CARLOS INGINO[MTSAC, 2], RICARDO A. LA MURA[1, 3, 4]

ABSTRACT

Introduction: Endovascular repair of aortic aneurysm emerges as a less invasive option for patients with high operative risk, constituting a feasible and safe treatment due to technical advances. For this reason, our institution considers endovascular treatment as the "first line therapy" in patients with very high operative risk, as those with ruptured abdominal aortic aneurysm.
Objective: The goal of this study is to report the experience with our surgical treatment protocol of patients with ruptured abdominal aortic aneurysm.
Methods: Seventeen patients were treated based on the protocol "endovascular approach first". The population was classified according to systolic blood pressure (SBP) at admission in: hemodynamically stable (SBP ≥ 80 mm Hg) or hemodynamically unstable (SBP < 80 mm Hg during > 10 minutes). The outcomes included mortality at 30 days and during follow-up and complications after the procedure. The statistical analysis was performed using Fisher's test.
Results: Mortality at 30 days was 23.5%. Technical success was achieved in 94.1% of patients. Despite both groups had similar comorbidities, mortality in stable patients, operated on under local anesthesia, was 7.7% ($p < 0.02$).
Conclusion: Endovascular treatment of ruptured abdominal aortic aneurysm, following a strict clinical and surgical management, is feasible and safe, particularly in stable patients under local anesthesia.

Key words: Abdominal Aortic Aneurysm - Ruptured Aneurysm - Endovascular Treatment

RESUMEN

Introducción: El tratamiento endovascular del aneurisma de la aorta surge esencialmente como una alternativa menos invasiva para pacientes de riesgo quirúrgico alto, que con los avances tecnológicos se ha hecho factible y segura. Ello ha llevado a nuestra Institución a brindar el abordaje endovascular como "primera opción de tratamiento" en pacientes de riesgo quirúrgico más alto aún, como son los pacientes con aneurismas de la aorta abdominal rotos.
Objetivo: Presentar la experiencia con nuestro protocolo quirúrgico de tratamiento del paciente con aneurisma de la aorta abdominal roto.
Material y métodos: Diecisiete pacientes fueron tratados bajo el protocolo de "abordaje endovascular primero". La población se clasificó en función de la presión arterial sistólica (PAS) de ingreso: hemodinámicamente estables (PAS 80 mm Hg) e inestables (PAS < 80 mm Hg durante > 10 minutos). Los resultados incluyeron la mortalidad a los 30 días y en el seguimiento y las complicaciones posprocedimiento. El análisis estadístico se realizó con la prueba de Fisher.
Resultados: La mortalidad a los 30 días fue del 23,5%. El éxito técnico se logró en el 94,1%. Si bien ambos grupos tuvieron comorbilidades similares, los pacientes estables, operados bajo anestesia local, presentaron una tasa de mortalidad del 7,7% ($p < 0,02$).
Conclusión: El tratamiento endovascular del aneurisma de la aorta abdominal roto, siguiendo un manejo clínico-quirúrgico estricto, es factible y seguro, especialmente en pacientes estables bajo anestesia local.

Palabras clave: Aneurisma de aorta abdominal - Aneurisma roto - Tratamiento endovascular

Abbreviations

rAAA	Ruptured abdominal aortic aneurysm	**Hd-unstable**	Hemodynamically unstable
CT- angio	Computed tomography angiography	**SBP**	Systolic blood pressure
Hd-stable	Hemodynamically stable	**EVAR**	Endovascular aneurysm repair

REV ARGENT CARDIOL 2015;83:50-53. http://dx.doi.org/10.7775/rac.v83.i1.4620

Received: 06/16/2014 *Accepted:* 10/29/2014

Address for reprints: L. Mariano Ferreira - Av. Del Libertador 5878 - 4º - (C1428ARO) Ciudad Autónoma de Buenos Aires - e-mail: drferreira@yahoo.com

FMTSAC Full Member of the Argentine Society of Cardiology
[1] Department of Cardiovascular Surgery, Clínica La Sagrada Familia
[2] Department of Cardiology, Clínica La Sagrada Familia
[3] School of Medicine, UCES
[4] Hospital de Clínicas, UBA, School of Medicine

INTRODUCTION

A meta-analysis published in 2002 demonstrated that open surgical repair of ruptured aneurysm is associated with an average mortality of 48%, and that such number could not be modified in the last 20 years. (1) Endovascular aneurysm repair (EVAR) emerges as a less invasive option for patients with high operative risk. Therefore, it is difficult to imagine a patient with a higher operative risk than that presenting with a ruptured abdominal aortic aneurysm (rAAA).

The goal of this study is to report our experience in endovascular treatment of patients with rAAA performed by a team of specialists focused on such treatment.

METHODS

Seventeen patients with rAAA underwent endovascular repair during a 3-year period. Data were prospectively incorporated into a database and were retrospectively analyzed. All the patients or their representatives signed an informed consent form to undergo the protocol "endovascular approach first", which was applied to patients transferred from other institutions and to those presenting in the emergency room. A computed tomography angiography (CT-angio) was performed to hemodinamically stable patients in whom the emergency room physicians suspected a rAAA. All the patients were managed using a reanimation protocol called "hemostatic hypotension" which restricts aggressive reanimation with fluids as long as the patient remains "conscious" with a systolic blood pressure above 80 mm Hg. This protocol was only used in stable patients.

On the contrary, hemodynamically unstable patients were immediately transferred to the operating room and resuscitated using blood derivatives and expansion.

The selection criterion for "endovascular approach first" was strictly anatomical. When CT-angio or intraoperative angiography determined the possibility of endovascular treatment, this approach was performed even if broad anatomic indications were present. The adequate morphologic characteristics of these patients with rAAA were modified with respect to the "instructions for use" of the different endoprostheses. The size of the proximal neck of the aneurysm should be < 34 mm, the neck angulation should not be > 90 degrees and the length should be > 5 mm. The visceral branches, the iliac arteries and the vascular approaches were evaluated.

The patients were classified into two groups according to systolic blood pressure (SBP) at admission in hemodynamically stable (Hd-stable; $n = 13$; SBP ≥ 80 mm Hg) and hemodynamically unstable (Hd-unstable; $n = 4$; SBP < 80 mm Hg during > 10 minutes).

All patients were transferred to the intensive care unit after the procedure.

The severity of the clinical presentation was recorded at admission as well as other in-hospital parameters. Other outcomes included in-hospital mortality, procedure-related complications, the need for secondary interventions and half-term mortality.

Due to sample size, the statistical analysis was performed using Fisher's exact test.

RESULTS

In-hospital mortality was 23.5%. The endoprosthesis was successfully implanted in 16 patients (94%), and conversion to open surgery was due to endoleak. Four patients died during the first 30 days after the procedure: two patients within 24 hours due to severe hypovolemic shock, one due to compartment syndrome and one due to type I endoleak that was not treated owing to the high risk of the patient.

Both Hd-stable and Hd-unstable groups had similar comorbidities (Table 1). All the Hd-stable patients underwent CT-angio before the intervention (6 were transferred to our institution with a CT scan performed at another institution). All the patients were operated on under local anesthesia. Only one patient (7.1%) died because it was not possible to exclude the aneurysm proximal neck (type I endoleak treated using the chimney graft technique); this patient died 8 days after the procedure.

On the contrary, all the patients in the Hd-unstable group were operated on under general anesthesia; an occluder balloon was used in two patients for stabilization, and in-hospital mortality was 75% ($p < 0.02$).

The other variables are shown in Table 2. The patients were followed-up with CT-angio (Figure 1); no procedure-related complications were detected. The mortality rate unrelated with the procedure was 33% at 2 years.

DISCUSSION

The anatomic and particularly logistic limitations seen when the endovascular technique was initially developed made the procedure difficult to implement for the treatment of patients with complicated aneurysms. However, the recent technological advances have made this less invasive option feasible and safe. (2, 3) The position of the Institution is to provide the endovascular approach as "first line therapy" for patients with ruptured aneurysms. The results were very promising, particularly in stable patients. On the contrary, in unstable patients, the outcome was determined by the patient's general status; this does not mean that endovascular treatment was not indicated or had been particularly detrimental in this group, as the patients probably died as a consequence of their poor preoperative general condition and not due to a surgical-related complication.

Endovascular repair of rAAA was first reported by Marin et al. in 1995. In a recently published meta-analysis using data of USA Medicare in a population treated for rAAA during the period 2001-2009, 30-day mortality for EVAR was 33.8% vs. 47.7% for open surgery. (4) In 2008, a systematic review performed by Mastracci et al. reported a mortality of 21% in EVAR for rAAA. (5) As in our investigation, he emphasized the importance of a strict preoperative protocol for patient management, a key point when analyzing treatment results.

After several unsuccessful attempts due to ethical issues that hindered the possibility of performing a randomized trial, three research studies were designed to compare EVAR with open surgery for rAAA.

Table 1. Demographic characteristics of the population

Characteristics	Group Hd-stable (%)	Group Hd-unstable (%)	p
Average age, years	75.7 ± 3.9	78.7 ± 2.2	0.17
Gender (M/F)	12 (92.3)	4	0.76
Renal failure	3 (23.1)	2 (50)	0.32
Diabetes	2 (15.4)	0	0.06
Hypertension	11 (84.6)	4	0.57
Coronary artery disease	9 (69.2)	2 (50)	0.55
Brain disease	2 (15.4)	0	0.06
COPD	8 (61.5)	3 (75)	0.44
Aneurysmal sac size	73.7 ± 9.7	77 ± 7.7	0.54

Hd-stable: Hemodynamically stable. Hd-unstable: Hemodynamically unstable M: Male F: Female COPD: Chronic obstructive pulmonary disease.

Table 2. Technical details

	Hd-stable group	Hd-unstable group	p
In-hospital mortality	1 (7.7)	3 (75)	0.02
Preoperative PCI	13	1 (25)	0.00
EVAR beyond IFU	7 (53.8)	2 (50)	0.66
Technical success	12 (92.3)	3 (75)	0.42
Conversion	0	1 (25)	0.23
Bifurcations	13	2 (50)	0.04
Cuff	1 (7.7)	0	0.76
Occluder balloon	0	2 (50)	0.04
Chimneys	1 (7.7)	1 (25)	0.42

Hd-stable: Hemodynamically stable. Hd-unstable: Hemodynamically unstable PCI: Percutaneous coronary intervention. EVAR: Endovascular aneurysm repair. IFU: instructions for use

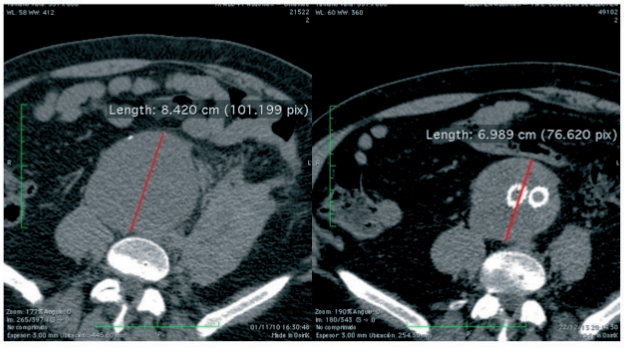

Fig. 1. Computed tomography angiography before the intervention (left) and at 2-year follow-up (right) showing reduction of the aneurysmal sac.

The first one was the Amsterdam Acute Aneurysm Trial (AJAX), followed by the ECAR trial performed in France and the recently published IMPROVE trial (Immediate Management of the Patient with Rupture: Open Versus Endovascular repair) from the United Kingdom. The objective of the three randomized studies was to compare EVAR vs. open surgery in rAAA patients.

In the IMPROVE study (Charing Cross, London, April 5, 2014), in 54% of 612 patients treated with an endovascular approach, mortality was 25%. Fifty percent of the patients were stable; however, 6% died before undergoing treatment. There were no significant differences between both groups in 30-day mortality (intention to treat, endovascular 35% vs. open surgery 37%). On the contrary, two variables specifically related with mortality were identified: intraoperative pressure < 70 mm Hg (unstable patients) and the type of anesthesia used. The procedures performed under general anesthesia were associated with a mortality rate of 36%, 31% for those with local anesthesia followed by general anesthesia, and 13% for those with local anesthesia exclusively. (6)

There are three fundamental aspects to consider in EVAR for rAAA: the arterial anatomy, the need to perform a CT-angio before the procedure and logistics, which involves technology, experience and the necessary devices for EVAR.

Different studies have determined that arterial anatomy suitable for EVAR ranges between 20% and 83%. These differences may be related with the selection criteria used. Often, the indications are broader in high risk cases, particularly at the level of the proximal neck. Probably, the more precise and adaptable

novel devices may lead to a better success rate. The role of the treating team experience is fundamental.

Several studies have determined that the average in-hospital time between patient admission and death due to rupture is > 2 hours, leaving sufficient time to prepare or evaluate the patient and the operating room to provide the best care. In our experience, there were no deaths before the patient entered the operating room.

Nowadays, the "endovascular first" protocol has become more common in these very high-risk patients. In Latin America, it is not possible for many centers to have access to the necessary supplies. Therefore, the formation of regional centers with a staff of specialists available during 24 hours and a stock of the most representative vascular supplies (endoprostheses, iliac extensions, contralateral branches, aortic cuffs, balloon expandable stents with large diameters, and intravascular occluders, among others) should be considered.

A protocol should be developed for the management of the patient with rAAA, which should include CT-angio to analyze its morphology when the condition is suspected and the patient has an acceptable clinical status. In stable patients, local anesthesia reduces the operative risks.

A critical patient should be transferred to an endovascular suite. A surgical protocol should be prepared, and "hemostatic hypotension" should be maintained. In case of shock, a distensible balloon is advanced into the thoracic aorta via the femoral artery or the brachial artery. Achieving patient stability is essential to perform a baseline angiography and define whether the patient is a candidate for EVAR or open surgery due to the anatomic findings.

CONCLUSIONS

Endovascular repair of rAAA, following a strict clinical and surgical management, is feasible and safe, particularly in stable patients under local anesthesia.

Conflicts of interest

None declared.
(See author´s conflicts of interest forms in the web / Supplementary Material)

REFERENCES

1. Dillon M, Cardwell C, Blair PH, Ellis P, Kee F, Harkin DW. Endovascular treatment for ruptured abdominal aortic aneurysm. Cochrane Database Syst Rev. 2007(1).
2. Yusuf SW, Whitaker SC, Chuter TA, Wenham PW, Hopkinson BR. Emergency endovascular repair of leaking aortic aneurysm. Lancet 1994;344:1645. http://doi.org/fwxm88
3. Mehta M, Taggert J, Darling III C, Chang BB, Kreinberg PB, Paty PS, et al. Establishing a protocol for endovascular treatment of ruptured abdominal aortic aneurysms: Outcomes of a prospective analysis. J Vasc Surg 2008;48:227-36.
4. Moore R, Nutley M, Cina CS, Motamedi M, Faris P, Abuznadah W. Improved survival after introduction of an emergency endovascular therapy protocol for ruptured abdominal aortic aneurysms. J Vasc Surg 2007;45:443-50. http://doi.org/c758r4
5. Schermerhorn ML, Bensley RP, Giles KA, Hurks R, O'Malley AJ, Cotterill P, et al. Changes in abdominal aortic aneurysm rupture and short-term mortality, 1995-2008: a retrospective observational study. Ann Surg 2012;256:651-8. http://doi.org/xqt
6. Mastracci TM, Garrido-Olivares L, Cinà CS, Clase CM. Endovascular repair of ruptured abdominal aortic aneurysms: a systematic review and meta-analysis. J Vasc Surg 2008;47:214-21. http://doi.org/ft4ncf
7. Thompson SG, Ulug P. Observations from the IMPROVE trial concerning the clinical care of patients with ruptured abdominal aortic aneurysm. Br J Surg 2014;101:216-24. http://doi.org/xqv