Outcomes of open repair of postdissection abdominal aortic aneurysms

Vos, Cornelis G; van Lammeren, Guus W; Werson, Debbie A B; Wille, Jan; Kropman, Rogier H J; Vahl, Anco C; Voûte, Michiel T; de Vries, Jean-Paul P M

Published in:
Journal of Vascular Surgery

DOI:
10.1016/j.jvs.2019.04.483

Publication date:
2020

Outcomes of open repair of postdissection abdominal aortic aneurysms

Cornelis G. Vos, MD, PhD,[a] Guus W. van Lammeren, MD, PhD,[b] Debbie A. B. Werson, MPA,[b] Jan Wille, MD, PhD,[b] Rogier H. J. Kropman, MD, PhD,[b] Anco C. Vahl, MD, PhD,[c] Michiel T. Voûte, MD, PhD,[d] *and* Jean-Paul P. M. de Vries, MD, PhD,[e] *Groningen, Nieuwegein, Amsterdam, and Rotterdam, The Netherlands*

ABSTRACT

Background: Evidence to guide management of postdissection abdominal aortic aneurysms (PDAAA) is lacking. This study describes the outcomes of open repair of PDAAA.

Methods: A retrospective cohort study was conducted of all consecutive patients treated with open repair for PDAAA after a Stanford type A or type B thoracic aortic dissection between January 2006 and December 2017 in two vascular referral centers. Preceding type B dissection treatment could include conservative or surgical management. Primary outcomes were 30-day mortality, complication rates, survival, and reintervention-free survival. Survival and reintervention-free survival were analyzed using the Kaplan-Meier method. Reintervention was defined as any endovascular or surgical intervention after the index procedure.

Results: Included were 36 patients (27 men [75%]) with a median age of 64 years (range, 35-81 years). The 30-day mortality was 2.7%. The median follow-up was 16 months (range, 0-88 months). The postoperative course was uneventful in 21 patients (58%). The most frequent complications were postoperative bleeding requiring repeat laparotomy (n = 4), pneumonia (n = 3), congestive heart failure (n = 2), new-onset atrial fibrillation (n = 2), mesenteric ischemia requiring left hemicolectomy (n=1), and ischemic cerebrovascular accident (n = 1). Renal failure requiring hemodialysis developed in one patient. The overall survival at 1 year was 88.8%. Reintervention-free survival was 95.5% after 1 year and 88.6% after 2 years.

Conclusions: Open repair of PDAAA can be performed with a low mortality rate and an acceptable complication rate, comparable with elective open repair of abdominal aortic aneurysms without dissection. (J Vasc Surg 2020;71:774-9.)

Keywords: Aortic dissection; Abdominal aortic aneurysm; Aneurysm, dissecting; Open repair

Acute aortic dissection is a medical emergency and is associated with high mortality and morbidity rates if left untreated.[1] After surviving the acute phase, the long-term prognosis remains poor owing to progressive dilatation of the remaining dissected aorta and high reported 5-year mortality rates of up to 30%.[2]

In addition to adequate surgical and medical management of the dissection in the acute phase, patients require intensive medical management of risk factors and strict follow-up to identify progression of disease and those who are at increased risk for complications.[3,4] Guidelines recommend treatment of a postdissection thoracoabdominal aneurysm if the aortic diameter increases to greater than 5.5 cm. In patients with comorbidities and limited endovascular options, a threshold of greater than 6 cm is suggested.[3,4]

Open repair is preferred for chronic thoracic dissections in fit patients.[3] However, evidence and guidelines to support the management of postdissection abdominal aortic aneurysms (PDAAA) are lacking. Therefore, the aim of the present study was to describe the 30-day mortality and complication rates and survival after open repair of PDAAA.

METHODS

This study was approved by the Institutional Medical Ethics Review Board of the St. Antonius Hospital and the committee waived the requirement for informed consent.

Patient selection. This retrospective study included all consecutive patients who underwent open repair for a PDAAA between January 2006 and December 2017 in two vascular referral centers. Patients with Stanford type A or type B dissections preceding the open repair of the PDAAA were eligible for inclusion. The initial management of the thoracic component of the aortic dissection could be conservative, thoracic endovascular aneurysm repair, or any form of open repair. These preceding open or endovascular repairs did not involve the aorta distal to the celiac trunk. Therefore, open repair in this study could involve supraceliac or more distal cross-clamping.

From the Department of Surgery, Martini Hospital, Groningen[a]; the Department of Vascular Surgery, St. Antonius Hospital, Nieuwegein[b]; the Department of Surgery, Onze Lieve Vrouwe Gasthuis, Amsterdam[c]; the Department of Surgery, Erasmus Medical Centre, Rotterdam[d]; and the Division of Vascular Surgery, Department of Surgery, University Medical Centre Groningen, Groningen.[e]

Author conflict of interest: none.

Correspondence: Jean-Paul P.M. de Vries, MD, PhD, Division of Vascular Surgery, Department of Surgery, University Medical Centre Groningen, Postbus 30.001, 9700 RB Groningen, The Netherlands (e-mail: j.p.p.m.de.vries@umcg.nl).

The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

https://doi.org/10.1016/j.jvs.2019.04.483

Surgical technique. All patients received prophylactic antibiotics consisting of one intravenous dose of 2000 mg cefazolin. The aorta was exposed through a midline laparotomy. Heparin (5000 U) was routinely administered before clamping. After clamping, the aneurysm was opened, bleeding lumbar arteries were ligated, and the thrombus was removed. The septum of the dissection at the proximal anastomosis site was removed as proximally as possible.

An interposition graft was implanted using Crawford's inlay anastomosis for the proximal anastomosis. The proximal anastomosis was created distal to the end of the remaining septum (ie, the distal septum was not fixated to the aortic wall; Fig 1). The distal anastomosis was made distally to the termination of the dissection. Interposition grafts could include an aortic tube graft or bifurcated grafts with standard distal end-to-end anastomoses. Anastomoses were always created in nondilated aortic segments. A cell-saving device was used routinely. Hypothermic renal perfusion was not used routinely in cases of suprarenal clamping.

Data collection and follow-up. Patient demographics, baseline risk factors, comorbidities, medication use, imaging findings, intraprocedural data, periprocedural complications, and outcomes were collected retrospectively. Data were derived from electronic medical records, clinical records, and imaging reports. The primary outcome measure was 30-day mortality. Secondary outcome measures were complication rates (surgical site infection, cardiac events, cerebrovascular events, renal failure, temporary need for dialysis, incisional hernias, and reoperations), hospital length of stay, survival, and reintervention-free survival. Reinterventions were defined as any endovascular or open surgical procedure after the index procedure, including, for example, any aorta-related intervention, incisional hernia repair, or laparotomy for bowel obstruction.

Statistical analysis. Statistical analyses were performed using SPSS 20 software (IBM Corp, Armonk, NY). Survival was calculated from the date of the operation with the Kaplan-Meier method. Values are presented as mean ± standard deviation or median (range) as appropriate and unless stated otherwise.

RESULTS

Patient characteristics. Between January 2006 and December 2017, 36 patients (27 men [75%]) underwent open repair of a PDAAA in our centers. The median age was 64 years (range, 35-81 years). The median aortic diameter was 58 mm (range, 53-100 mm) for aortoiliac postdissection aneurysms and 43 mm (range, 31-53 mm) for isolated iliac postdissection aneurysms. In 26 patients (72%), a concomitant or isolated iliac artery aneurysm was present. One patient previously underwent endovascular repair of a degenerative AAA that, owing to a type B aortic dissection, lost proximal seal with subsequent aneurysm growth. The median interval between treatment of the preceding aortic dissection and treatment of the PDAAA was 88 months (range, 0-256 months). Patient characteristics are summarized in Table I. All included patients had a chronic dissection at the level of the PDAAA. To illustrate the combined annual volumes of the study centers the amount of elective repairs and the proportion of endovascular repair, open repair and PDAAA cases for 2015 to 2017 are summarized in Table II.

ARTICLE HIGHLIGHTS

- **Type of Research:** Multicenter retrospective cohort study
- **Key Findings:** Open repair of postdissection abdominal aortic aneurysms in 36 patients resulted in a 30-day mortality of 2.7%, overall 1-year survival of 88.8%, and a reintervention-free survival rate of 95.5% after 1 year and 88.6% after 2 years.
- **Take Home Message:** Open repair of postdissection abdominal aortic aneurysms can be performed with low mortality and complication rates, comparable with open repair of elective abdominal aortic aneurysms without dissection.

Operative results. Clamping below the renal arteries was performed in 24 patients (66%), suprarenal clamping was performed in 6 patients (17%), and a supraceliac clamping position was necessary in 5 patients (14%). An endovascular occlusion balloon was used to obtain proximal control in one patient. Unfortunately, clamping time was inconsistently recorded and could not be analyzed. Cold renal perfusion was used in one patient. A tube interposition graft was used in five patients (14%), and a bi-iliac graft was implanted in the remaining 31 patients (86%). The median operative time was 162 minutes (range, 110-300 minutes), and the median blood loss was 2300 mL (range, 900-10,500 mL). There were no intraoperative deaths.

Outcomes. One patient died on postoperative day 4. Severe postoperative hypovolemic shock developed owing to a tear in the native, severely calcified vessel wall at the distal iliac anastomosis caused by the suture. The tear was repaired during a repeat laparotomy. Because of severe neurologic impairment, the family requested that further treatment be withdrawn and the patient subsequently died. Thus, the 30-day (and in-hospital) mortality was 2.7%. Postoperative complications are summarized in Table III. Graft thrombosis occurred in one patient, with occlusion of both renal arteries, the superior mesenteric artery, and the celiac trunk, which was treated by surgical thrombectomy and

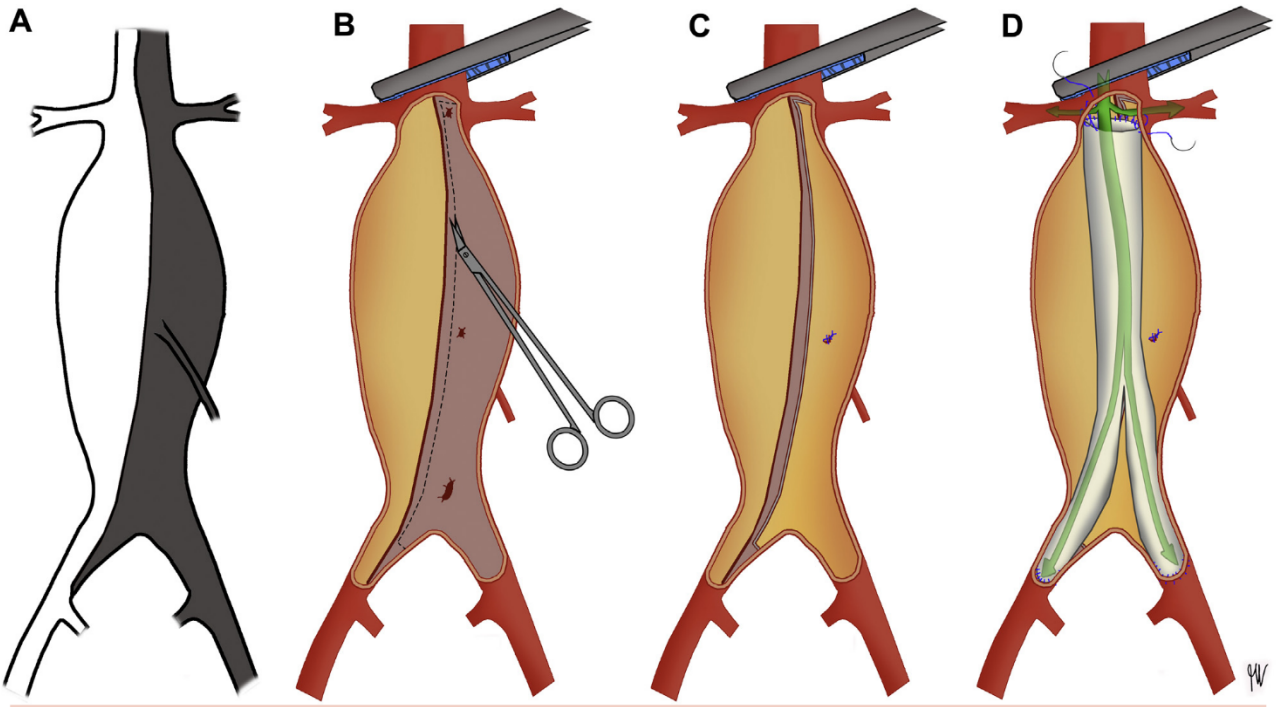

Fig 1. Schematic illustration of the surgical technique used. The aortic dissection extents to the iliac arteries **(A)**. After clamping the septum of the dissection is removed using scissors **(B)** to as proximal (ie, close to the clamp) as possible to allow adequate perfusion of the renal arteries **(C)**. After inserting an interposition graft distal to the remaining septum, the flow is restored to the renal and iliac arteries **(D)**.

left hemicolectomy because of nonreversible mesenteric ischemia. He developed renal failure and required permanent hemodialysis. He was alive at a follow-up of 2 years. The median hospital length of stay was 9 days (range, 5-64 days).

The median follow-up time was 16 months (range, 0-88 months). The overall survival at 1 year was 88.8%. The reintervention-free survival was 95.5% after 1 year and 88.6% after 2 years. A Kaplan-Meier analysis for overall survival and reintervention-free survival is provided in Figs 2 and 3. Secondary interventions were performed in five patients (14%) during follow-up. Three patients with progressive aneurysmal disease of the thoracic aorta were treated by thoracophrenolaparotomy and open repair of the descending thoracic aorta. Graft thrombosis occurred in two patients. In addition to the patient with complete graft thrombosis in the postoperative phase described, another patient developed thrombosis of one limb of an aortobi-iliac graft 3 years after the PDAAA repair, which was treated by surgical thrombectomy with additional stent graft placement in the iliac limb. During follow-up, one patient (2.7%) suffered from an abdominal cicatricial hernia and was treated conservatively.

DISCUSSION

Open repair of PDAAA can be performed with a 30-day mortality rate of 2.7% and acceptable complication rates. These results are similar to those obtained after elective open repair for degenerative, non-PDAAAs.[5,6]

There is a paucity of evidence regarding the treatment of PDAAA. A similar study published in 2002 reported open repair after aortic dissections in 14 patients and concluded that elective repair of PDAAA does not encompass a prohibitive surgical risk, with a 30-day mortality of 0% and a 1-year survival of 93%.[7] However, their sample size was small and event rates were low, limiting the conclusions that could be drawn from their data.

Other studies on postdissection aortic surgery predominantly address the management of postdissection thoracoabdominal aneurysms.[8,9] However, the outcomes of those studies, with mortality rates ranging from 4% to 31%,[8,9] cannot be compared with the outcomes of open PDAAA repair, such as in our study, because the extent of surgery is completely different and the risks of these more complex thoracoabdominal repairs are greater.

Bellosta et al[10] reported 15 patients treated for a synchronous AAA that was diagnosed at the same time as a type B dissection. The 30-day mortality was 6.7% (n = 1), and 11 patients (73%) underwent a staged repair consisting of treatment of the aortic dissection, followed by treatment of the abdominal aneurysm in a second procedure. However, only five patients in their small series were treated by open repair.[10] A systematic review and meta-analysis including data for 92 patients, mostly obtained from case reports, with isolated abdominal aortic dissections, reported a 30-day mortality of 2% (n = 1) in 46 patients treated with open repair.[11] The

Table I. Patient characteristics (N = 36)

Characteristic	No. (%) or median (range)
Demographics	
Age, years	64 (35-81)
Males	27 (75)
Preceding dissection	
Type A	13 (36)
Type B	23 (64)
Thoracic aortic surgery for dissection[a]	
Yes	25 (69)
No	11 (31)
Interval primary AoD—PDAAA repair, months	80 (0-256)
Interval thoracic aortic surgery-PDAAA repair, months	93 (0-256)
Comorbidities	
Smoking	5 (14)
Hypertension	33 (92)
Diabetes	4 (11)
Myocardial infarction	2 (6)
CABG	3 (8)
PTCA	2 (6)
PAOD	0 (0)
Cerebrovascular disease	4 (11)
COPD	6 (17)
Creatinine, mmol/L	91 (55-612)
On platelet inhibitors	30 (83)
On statins	22 (61)
Anatomic parameters	
Aortic diameter, mm	56 (31-100)
Iliac artery aneurysm	26 (72)
Follow-up	
Duration, months	10 (1-97)
Lost to follow-up	3 (8)

AoD, Aortic dissection; *CABG*, coronary artery bypass graft; *COPD*, chronic obstructive pulmonary disease; *PAOD*, peripheral arterial occlusive disease; *PDAAA*, postdissection abdominal aortic aneurysm; *PTCA*, percutaneous transluminal coronary angioplasty.
[a]Either open repair or endovascular treatment.

Table II. Annual volumes in study centers (2015-2017)

Center	Elective AAA repair	EVAR	OPEN	PDAAA
A				
2015	188	149 (79)	39 (21)	3 (2)
2016	204	156 (76)	48 (24)	3 (1)
2017	211	159 (75)	52 (25)	4 (2)
B				
2015	61	53 (87)	8 (13)	0 (0)
2016	55	44 (80)	11 (20)	0 (0)
2017	78	62 (79)	16 (21)	1 (0)

AAA, Abdominal aortic aneurysm; *EVAR*, endovascular aneurysm repair; *OPEN*, open aneurysm repair; *PDAAA*, postdissection abdominal aortic aneurysm.
Values are presented as number (%).

Table III. Postoperative complications (N = 36)

Complication	No. (%)
30-Day mortality	1 (2.7)
Wound infection	1 (2.7)
Pneumonia	3 (8.3)
Postoperative bleeding requiring repeat laparotomy	4 (11.1)
Cardiac events	4 (11.1)
Myocardial infarction	0 (0.0)
Congestive heart failure	2 (5.6)
Atrial fibrillation	2 (5.6)
Cerebrovascular event	1 (2.7)
Mesenteric ischemia	1 (2.7)
Renal replacement therapy	1 (2.7)
Other	
Spinal cord ischemia	0 (0.0)
Diaphragmatic hernia requiring reposition and repair	1 (2.7)

30-day mortality was 0% in the group of 19 patients treated with an endograft but was 8% in the 27 patients treated conservatively.[11]

Guidelines for the treatment of acute aortic dissections recommend acute interventions for Stanford type A dissections and complicated type B dissections.[3,4] Uncomplicated type B dissections can generally be treated with medical management and surveillance.[3,4] The primary goal of urgent interventions usually includes gaining control of the proximal dissected intima, either by fixation or removal of the septum or covering of the entry tear, and correcting malperfusion. More extended repair of the aorta in the acute phase is controversial owing to the associated increased operating time and complication risks, especially the risk of neurologic complications (ie, stroke and spinal cord ischemia).[4] Synchronously or during follow-up, the abdominal aorta can dilate to a diameter warranting treatment to prevent rupture. For cases where surgical management of the thoracic aorta is indicated, a staged approach, where the abdominal aorta is treated in a secondary procedure, is preferred in our centers and was used in all patients included in the present study.

Endovascular therapy is becoming available for more and more complex anatomies, allowing the treatment of thoracoabdominal aortic aneurysms. Also, more extensive arch disease can be treated with endografts. The main advantage of endovascular repair is the decreased invasiveness and anticipated lower 30-day mortality at the expense of a less durable repair requiring intensive follow-up and probably more reinterventions.[12]

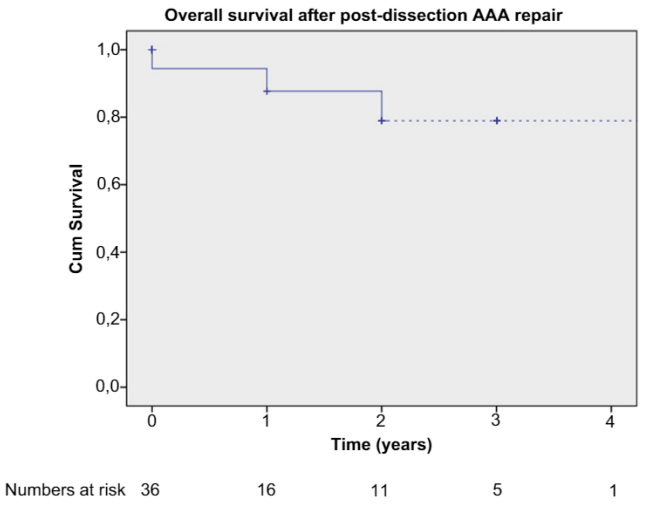

Fig 2. Kaplan-Meier analysis for overall survival after open repair of postdissection abdominal aortic aneurysms (PDAAAs). Beyond the 2-year follow-up numbers at risk were low and results less accurate, illustrated by the dotted line of the curve. *AAA*, Abdominal aortic aneurysm; *Cum*, cumulative.

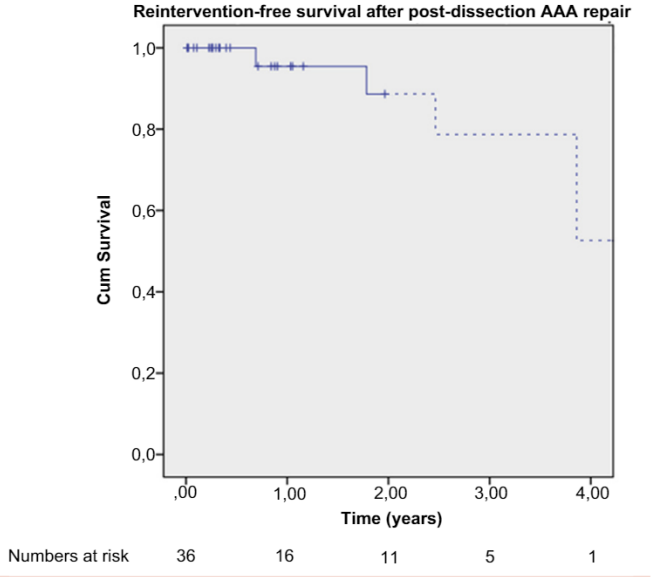

Fig 3. Kaplan-Meier analysis for reintervention-free survival after open repair of postdissection abdominal aortic aneurysms (PDAAAs). Beyond 2-year follow-up numbers at risk were low and results less accurate, illustrated by the dotted line of the curve. *AAA*, Abdominal aortic aneurysm; *Cum*, cumulative.

Endovascular treatment of postdissection aneurysms can be complex, however. In the chronic phase, the septum is more rigid and cannot easily be readjusted to the aortic wall. Attention to both the true and false lumen is therefore necessary to treat postdissection aneurysms. To treat false lumen perfusion at the thoracic level, endovascular false lumen occlusion techniques, such as the "candy-plug" technique and comparable alternatives, have been described.[13] In the abdominal aorta, however, treatment is more difficult owing to anatomic limitations. There is generally less space, and the origins of the visceral vessels limit the options for the deployment of occlusion devices.

A recent study reported midterm results of fenestrated or branched endovascular repair of postdissection thoracoabdominal aneurysms in an expert endovascular center with a 30-day mortality of 5.6%, 18.3% major complications, and a reintervention-free survival of 52.6% after 3 years.[14] Although the patients were not similar to those of the present study, these results indicate the technical difficulties and problems with durability of complex endovascular repairs. The low mortality and complication rates for open repair of PDAAA and acceptable reintervention rates illustrated by the present study support our preference for open (and mostly staged) repair of PDAAA. Open repair seems a valid option for all patients with PDAAA and definitely those who are young and fit for surgery.

Our study has some limitations, and the retrospective design warrants careful interpretation of our findings. Retrospective analyses of complication data are prone to under-reporting. There is a risk of selection bias, because the patients undergoing open repair represented in this study could be relatively healthier or more fit. The sample size is relatively small; however, there is a lack of data in the currently available literature, and this series contributes significantly to the available evidence.

The follow-up for 30-day mortality is complete. However, we registered a loss to follow-up of 8% (n = 3). Therefore, the long-term follow-up (>1 year) in our study is less reliable. However, the present series represents relevant new data from a relatively homogenous group of patients treated with open repair for a PDAAA.

CONCLUSIONS

Open repair of PDAAA can be performed with low 30-day mortality rate and acceptable complication rates, comparable with open repair of degenerative AAAs. Therefore, the presence of an aortic dissection should not preclude open surgical treatment in these patients.

AUTHOR CONTRIBUTIONS

Conception and design: CV, JV
Analysis and interpretation: CV, GL, JW, RK, AV, MV, JV
Data collection: CV, GL, DW
Writing the article: CV
Critical revision of the article: CV, GL, DW, JW, RK, AV, MV, JV
Final approval of the article: CV, GL, DW, JW, RK, AV, MV, JV
Statistical analysis: CV, GL, DW, RK
Obtained funding: Not applicable
Overall responsibility: JV

REFERENCES

1. Hagan PG, Nienaber CA, Isselbacher EM, Bruckman D, Karavite DJ, Russman PL, et al. The International Registry of Acute Aortic Dissection (IRAD): new insights into an old disease. JAMA 2000;283:897-903.
2. Nienaber CA, Kische S, Rousseau H, Eggebrecht H, Rehders TC, Kundt G, et al. Endovascular repair of type B aortic dissection: long-term results of the randomized investigation of stent grafts in aortic dissection trial. Circ Cardiovasc Interv 2013;6:407-16.
3. Hiratzka LF, Bakris GL, Beckman JA, Bersin RM, Carr VF, Casey DE Jr, et al. 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM guidelines for the diagnosis and management of patients with thoracic aortic disease. Circulation 2010;121:e266-369.
4. Erbel R, Aboyans V, Boileau C, Bossone E, Bartolomeo RD, Eggebrecht H, et al. 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases: document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC). Eur Heart J 2014;35:2873-926.
5. Stather PW, Sidloff D, Dattani N, Choke E, Bown MJ, Sayers RD. Systematic review and meta-analysis of the early and late outcomes of open and endovascular repair of abdominal aortic aneurysm. Br J Surg 2013;100:863-72.
6. Wanhainen A, Verzini F, Van Herzeele I, Allaire E, Bown M, Cohnert T, et al. 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.
7. Anand RJ, Williams DM, Proctor MC, Eagleton MJ, Henke PK, Deeb GM, et al. Operative mortality rate for elective abdominal aortic aneurysm repair is not increased by the presence of a previous or concurrent thoracic or thoracoabdominal aortic dissection. J Vasc Surg 2002;36:690-5.
8. Assi R, Bavaria JE, Desai ND. Techniques and outcomes of secondary open repair for chronic dissection after acute repair of type A aortic dissection. J Cardiovasc Surg (Torino) 2018;59:759-66.
9. Alfonsi J, Murana G, Smeenk HG, Kelder H, Schepens M, Sonker U, et al. Open surgical repair of post-dissection thoraco-abdominal aortic aneurysms: early and late outcomes of a single-centre study involving over 200 patients. Eur J Cardiothorac Surg 2018;54:382-8.
10. Bellosta R, Gelpi G, Lomazzi C, Romagnoni C, Castelli P, Trimarchi S, et al. Surgical treatment of synchronous type B acute aortic dissection and abdominal aortic aneurysm. Ann Vasc Surg 2018;49:107-14.
11. Jonker FH, Schlösser FJ, Moll FL, Muhs BE. Dissection of the abdominal aorta. Current evidence and implications for treatment strategies: a review and meta-analysis of 92 patients. J Endovasc Ther 2009;16:71-80.
12. Rocha RV, Friedrich JO, Elbatarny M, Yanagawa B, Al-Omran M, Forbes TL, et al. A systematic review and meta-analysis of early outcomes after endovascular versus open repair of thoracoabdominal aortic aneurysms. J Vasc Surg 2018;68:1936-45.e5.
13. Spanos K, Kölbel T, Rohlffs F, Heidemann F, Giannoukas AD, Debus SE, et al. Intentional targeted false lumen occlusion after aortic dissection: a systematic review of the literature. Ann Vasc Surg 2018;51:207-16.
14. Oikonomou K, Kasprzak P, Katsargyris A, Marques De Marino P, Pfister K, Verhoeven ELG. Mid-term results of fenestrated/branched stent grafting to treat post-dissection thoraco-abdominal aneurysms. Eur J Vasc Endovasc Surg 2019;57:102-9.

Submitted Jan 23, 2019; accepted Apr 20, 2019.