CASE REPORT

'In-stock' fenestrated stent graft for the urgent repair of an abdominal aortic aneurysm

Sean A Crawford,^{1,2} Matthew G Doyle,³ Leonard W Tse,¹ Graham Roche-Nagle¹¹Toronto General Hospital, Toronto, Ontario, Canada²Institute of Biomaterials and Biomedical Engineering, University of Toronto, Toronto, Ontario, Canada³Mechanical and Industrial Engineering, University of Toronto, Toronto, Ontario, Canada

Correspondence to

Dr Graham Roche-Nagle, graham.roche-nagle@uhn.ca

Accepted 1 May 2016

SUMMARY

Endovascular aneurysm repair (EVAR) is a minimally invasive method for the treatment of abdominal aortic aneurysms; however, the implementation of this technique is often limited by the aortic pathology, especially in the urgent or emergent setting. An 82-year-old male with a 7.3 cm symptomatic juxtarenal aneurysm presented at our centre for assessment. He was diagnosed as a high-risk candidate for open repair and therefore, not suitable for a conventional EVAR. Fortunately, a custom two-vessel fenestrated stent graft, which was originally constructed for another patient, was available. This device was implanted with no complications and all branches remain unobstructed; clear of aneurysms at 1 year. We present the use of 'in-stock' fenestrated grafts as a potential option to be considered in the urgent or emergent repair of abdominal aortic aneurysms.

BACKGROUND

Endovascular aneurysm repair is a minimally invasive method for treatment of abdominal aortic aneurysms (AAAs) in which the diseased aortic segment is excluded from the circulation through the placement of a stent graft. While the majority of AAAs can be treated with a conventional stent graft, complex aneurysms (near or encompassing the visceral vessels) require the creation of a custom-made graft. This custom-made graft extends the proximal seal zone by incorporating patient-specific fenestrations (holes) that facilitate perfusion of the visceral vessels.¹ Custom-made fenestrated devices currently require a 6–12-week lead time for the preprocedural planning and manufacture of the stent graft. This lead time precludes the use of custom-made devices in the setting of ruptured or symptomatic AAAs. This limitation has led to the development of commercially available off-the-shelf devices, which are prefabricated devices designed to fit the anatomy of a large percentage of the population.² Other potential endovascular options include physician-modified stent grafts and parallel stenting.^{3–5}

This case report describes another potential option for the repair of a symptomatic AAA using an 'in-stock' custom-made stent graft. Occasionally, patients awaiting the manufacture of a custom-made stent graft may pass away prematurely for various reasons (including rupture of their aneurysm), leading to a custom-made device without a target patient. The use of these 'in-stock' stent grafts may be acceptable in the urgent setting despite small misalignments between the fenestration and target visceral artery.

CASE PRESENTATION

An 82-year-old male presented for assessment of a large symptomatic juxtarenal AAA-initially identified on an ultrasound—due to abdominal pain. His comorbidities included coronary artery disease (3-vessel coronary artery bypass surgery; 53% left ventricular ejection fraction), diabetes, dyslipidaemia, hypertension, gastro-oesophageal reflux, osteoarthritis and bilateral cataract surgery. A CT angiogram revealed a 7.3 cm juxtarenal AAA (figure 1) with no involvement of the thoracic aorta or the iliac arteries. There were no accessory renal arteries.

TREATMENT

Owing to the large size of this aneurysm, the abdominal pain, the lack of an infrarenal neck, and the expected manufacturing lead time for a custom-made graft, our initial inclination was to proceed with an urgent open repair. However, given this patient's comorbidities and underlying coronary artery disease, we felt that an endovascular strategy would be more appropriate. Fortunately, we had a custom-made two-vessel fenestrated Anaconda device in-house, which had been procured for a different patient. Based on comparisons between the locations of the fenestrations in the device and the locations of the renal arteries in the patient, we felt that this device could be used in our current patient.

Specifications for this two-vessel fenestrated Anaconda (Vascutek, Glasgow, UK) device are shown in figure 2. The available graft diameter was 30 mm resulting in 10% oversizing. With ideal placement of the right renal artery fenestration, the left renal artery fenestration would have a 27° misalignment horizontally and be 4 mm lower than the left renal artery. In the standard fashion, the Anaconda device was placed through a right femoral artery that was cut down and aligned with the right renal artery. Following deployment, the right renal artery was cannulated and an undeployed stent was placed; the left renal fenestration and artery were easily cannulated. The bilateral 7×22 mm Atrium covered stents (Atrium, Hudson, New Hampshire, USA) were then deployed within the renal arteries and the intragraft portion of the respective stents were flared using a 10×2 mm non-compliant balloon. The iliac limbs of the main body were then extended bilaterally, in the standard fashion, to the bifurcation of the common iliac arteries. The completion angiogram demonstrated a delayed type II endoleak, but no type I or type III endoleaks. The procedure duration was 181 min

CrossMark

To cite: Crawford SA, Doyle MG, Tse LW, et al. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2016-215093

Figure 1 Preoperative CT angiogram of (A) renal artery take-off (axial projection, 10 mm MIP), (B) the abdominal aortic aneurysm (coronal projection, curved MPR, 10 mm MIP), (C) coronal, and (D) sagittal projection of a three-dimensional reconstruction of the abdominal aortic aneurysm. MIP, maximum intensity projection; MPR, multiple plane reconstruction.

and the volume of contrast was 130 mL with a fluoroscopy time of 53.8 min. There was no postoperative renal impairment. The serum creatinine at the time of hospital admission and at the time of discharge was 96 $\mu\text{mol/L}$ and 84 $\mu\text{mol/L}$, respectively.

OUTCOME AND FOLLOW-UP

At 18 months, this patient is doing well with CT imaging showing no evidence of endoleak, patent renal arteries bilaterally, and a reduction in aneurysm sac size from 7.3 to 7.1 cm (figure 3). The final horizontal misalignment between the

fenestration and target artery was 22° for the left renal artery and 7° for the right renal artery. There was no discernible misalignment in the vertical direction of the right renal artery, and the left renal artery had a cranially oriented 11° misalignment.

DISCUSSION

The traditional surgical management of a juxtarenal AAA is through an open surgical repair either with a midline laparotomy or adoption of a retroperitoneal approach; however, the procedure carries a significant risk of morbidity and mortality.⁶

Figure 2 Device specifications for the Anaconda device used in the report. FEN, fenestration; LRA, left radial approach; RRA, right radial approach; SMA, superior mesenteric artery.

Figure 3 Postoperative CT angiogram of (A) renal artery take-off (axial projection, 10 mm MIP), (B) the abdominal aortic aneurysm (coronal projection, curved MPR, 10 mm MIP), (C) Coronal, and (D) Sagittal projection of a three-dimensional reconstruction of the abdominal aortic aneurysm.

Advances over the last decade have led to a number of less invasive endovascular options for patients with significant comorbidities. The current preferred method of endovascular treatment for this type of aneurysm in an elective setting is the placement of a custom-made fenestrated or branched stent graft. The main limitation associated with this approach is the 6–12-week manufacturing lead time, which is prohibitive in the scenario of a symptomatic or ruptured aneurysm. This limitation has led to the development of two commercially available ‘off-the-shelf’ fenestrated devices, the Cook p-branch and the Endologix Ventana.² Initial data supporting the use of the Cook p-branch device suggested that up to 70% of patients with complex AAAs would be appropriate for this device;⁷ however, more recent data suggests that based on strict adherence to the instructions for use (IFU) only ~30–40% of patients would be candidates for either the p-branch or Ventana devices.^{8,9}

Other methods for urgent endovascular repair of complex aneurysms include parallel stenting (ie, chimney/sandwich techniques) and physician-modified stent grafts. Greenberg *et al*³ were the first to describe the use of the chimney technique for the repair of a juxtarenal AAA. The chimney technique involves the use of off-the-shelf covered stents placed between the main body graft and the aortic wall to facilitate perfusion of the renal arteries. Chimney stenting has been shown to have higher mortality and have a higher incidence of renal impairment when compared with fenestrated EVAR; however, it is typically performed in more urgent cases.⁴ Physician-modified stent grafts involve the partial deployment of the stent graft, creation of the appropriate fenestrations and resheathing of the stent graft prior to the deployment within the patient. This approach requires a significant amount of institutional expertise not only in the planning, and also in the modification of the device which is only available at a few select centres world-wide; this greatly limits its implementation.⁵

With respect to the patient described in this report, it was felt that due to this patient’s age and comorbidities, the risks associated with open surgical repair were prohibitive. While both the Cook p-branch and t-branch devices are available at our institution, this patient’s anatomy did not meet their respective IFU criteria. Therefore, the remaining options for this patient

included a physician-modified stent graft, parallel stenting or as was the case in this report, an ‘in-stock’ fenestrated stent graft.

Many centres which routinely perform fenestrated EVAR will occasionally have custom-made devices in-stock, which are either awaiting implantation or no longer have a target patient. Previously, Barilla *et al*¹⁰ have reported their experience with a similar implantation of an ‘in-stock’ custom branched stent graft; however, this is to our knowledge the first reported implantation of an ‘in-stock’ fenestrated graft. The main concern with using this type of ‘in-stock’ custom graft is the potential misalignment between the fenestration and the target artery. The Anaconda device used in this patient has the theoretical advantage of an unsupported main body, which may allow it to better accommodate fenestration misalignment when compared with other types of stent grafts. The long-term implications of this misalignment on the durability of the aneurysm repair and on the proximal seal of the stent graft is not known; however, we propose this as a potential option to consider when approaching symptomatic or ruptured aortic pathology.

Learning points

- ▶ ‘In-stock’ custom fenestrated stent grafts can successfully be used in the urgent setting to repair a juxtarenal aneurysm.
- ▶ Options for the urgent repair of a juxtarenal aneurysm include: open surgical repair, parallel stenting, off-the-shelf stent grafts, and physician-modified stent grafts.
- ▶ Deciding between these options requires a careful consideration of the patient’s anatomy, comorbidities and the available devices.

Contributors SAC was the primary author. MGD, LWT and GR-N contributed to the writing and analysis.

Competing interests Both GR-N and LWT were involved with proctoring for Cook Medical and Vascutek. This in our opinion did not influence the results of this study in any way.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Di X, Ye W, Liu CW, *et al.* Fenestrated endovascular repair for pararenal abdominal aortic aneurysms: a systematic review and meta-analysis. *Ann Vasc Surg* 2013;27:1190–200.
- 2 Resch T. Pararenal aneurysms: currently available fenestrated endografts. *J Cardiovasc Surg* 2013;54(Suppl 1):27–33.
- 3 Greenberg RK, Clair D, Srivastava S, *et al.* Should patients with challenging anatomy be offered endovascular aneurysm repair? *J Vasc Surg* 2003;38:990–6.
- 4 Li Y, Hu Z, Bai C, *et al.* Fenestrated and chimney technique for juxtarenal aortic aneurysm: a systematic review and pooled data analysis. *Sci Rep* 2016;6:20497.
- 5 Georgiadis GS, van Herwaarden JA, Antoniou GA, *et al.* Systematic review of off-the-shelf or physician-modified fenestrated and branched endografts. *J Endovasc Ther* 2016;23:98–109.
- 6 Beck AW, Goodney PP, Nolan BW, *et al.* Predicting 1-year mortality after elective abdominal aortic aneurysm repair. *J Vasc Surg* 2009;49:838–44.
- 7 Sobocinski J, d'Utra G, O'Brien N, *et al.* Off-the-shelf fenestrated endografts: a realistic option for more than 70% of patients with juxtarenal aneurysms. *J Endovasc Ther* 2012;19:165–72.
- 8 Farber MA, Vallabhaneni R, Marston WA. 'Off-the-shelf' devices for complex aortic aneurysm repair. *J Vasc Surg* 2014;60:579–84.
- 9 Mendes BC, Oderich GS, Macedo TA, *et al.* Anatomic feasibility of off-the-shelf fenestrated stent grafts to treat juxtarenal and pararenal abdominal aortic aneurysms. *J Vasc Surg* 2014;60:839–47; discussion 47–8.
- 10 Barilla D, Guillou M, Maurel B, *et al.* Off-the-shelf branched endograft for emergent aneurysm repair. *Ann Vasc Surg* 2013;27:972.e11–15.

Copyright 2016 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit

<http://group.bmj.com/group/rights-licensing/permissions>.

BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- Submit as many cases as you like
- Enjoy fast sympathetic peer review and rapid publication of accepted articles
- Access all the published articles
- Re-use any of the published material for personal use and teaching without further permission

For information on Institutional Fellowships contact consortiasales@bmjgroup.com

Visit casereports.bmj.com for more articles like this and to become a Fellow