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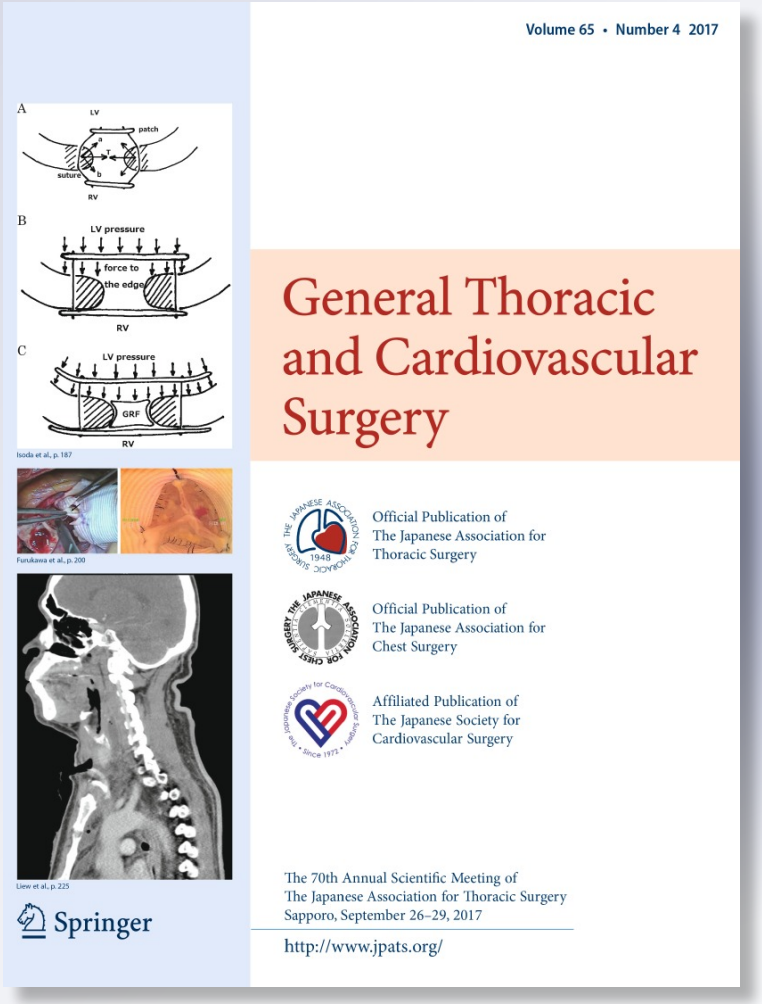

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CASE REPORT

Endovascular treatment of large and wide aortic neck: case report and literature review

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Abstract Large (24–34 mm) and wide (≥35 mm) aortic necks are a contraindication to endovascular aneurysm repair (EVAR). A 63-year-old man, unfit for conventional surgery, presented a 79 mm abdominal aortic aneurysm with 36.5 mm aortic neck and a 62 mm right common iliac artery aneurysm. He was treated endovascularly with standard commercially available stent-graft using the so-called 'funnel technique'; by placing a thoracic stent-graft inside a bifurcated device to achieve proximal sealing. The completion angiography and the 6 months follow-up with computed tomography showed no stent-graft migration, limb occlusion or endoleak. The literature review reported 179 cases of large aortic neck managed with EVAR, all cases treated with standard devices. Conversely a wide aortic neck was reported in 9; in 2 cases were employed custom-made devices and in 7 standard stent-graft. The use of EVAR with commercially available stent-grafts is feasible and it represents an option especially in non-elective setting.

Keywords Funnel technique · Large neck · Endoleak · Complications · Migration

Introduction

Endovascular aneurysm repair (EVAR) is the first line approach in abdominal aortic aneurysm (AAA) repair. When compared to conventional open repair, EVAR is a less invasive procedure with a lower perioperative morbidity and mortality rates [1]. Unfavorable anatomy is still one of the EVAR major limitations and adverse proximal neck morphology exclude up to 50 % of patients [2]. Large proximal neck diameter represents an uncommon finding and represents an EVAR anatomic contraindication [3–5]. Herein we report a case of EVAR using the so-called 'funnel technique' in a patient presenting an AAA with wide neck diameter. A review of the current literature is also reported.

Case report

A 63-year-old Caucasian male with medical history of hypertension, chronic heart failure, coronary artery bypass graft, ascending aorta and aortic valve replacement with composite graft, chronic obstructive pulmonary disease and morbid obesity (37.5 body mass index) was admitted at our institution. The preoperative computed tomography (CT) scan revealed a complex aorto-iliac aneurysm (Fig. 1). Anatomic measurements, performed with the OsiriX software (OsiriX Foundation, Geneva, Switzerland), showed a 79 mm abdominal aortic aneurysm (AAA) and a 62 mm right common iliac artery (CIA) aneurysm. A highly tortuous right and left iliac axis were also evident. Adequate landing zones were identified proximally in the aorta below renal arteries. Distal landing zones were in correspondence of the CIA for the left side and in the external iliac artery (EIA) for the right side. Proximal aortic neck was 36.5 mm in diameter and 29 mm in length; distal left CIA neck was 22 mm in diameter; and distal right EIA was 13 mm. The distance from the aorta, at the lowest (left) renal artery, to the aortic bifurcation was 166 mm; beyond the right EIA diameter was 285 and 220 mm in length to the left iliac

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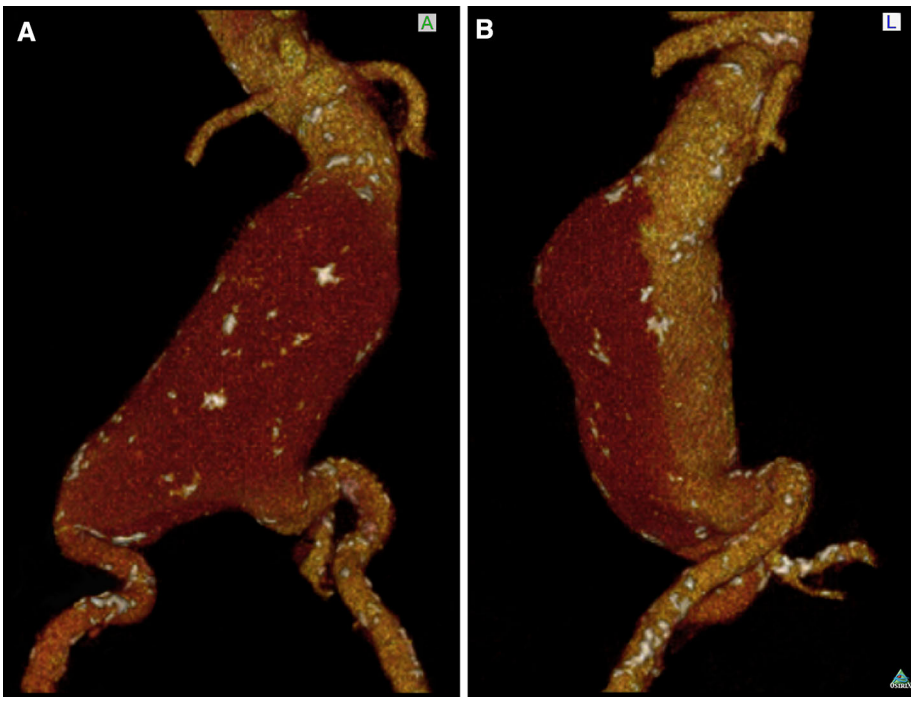

Fig. 1 Computed tomography 3D volume rendering showing complex aorto-iliac aneurysm. **a** Anterior view. **b** Lateral view

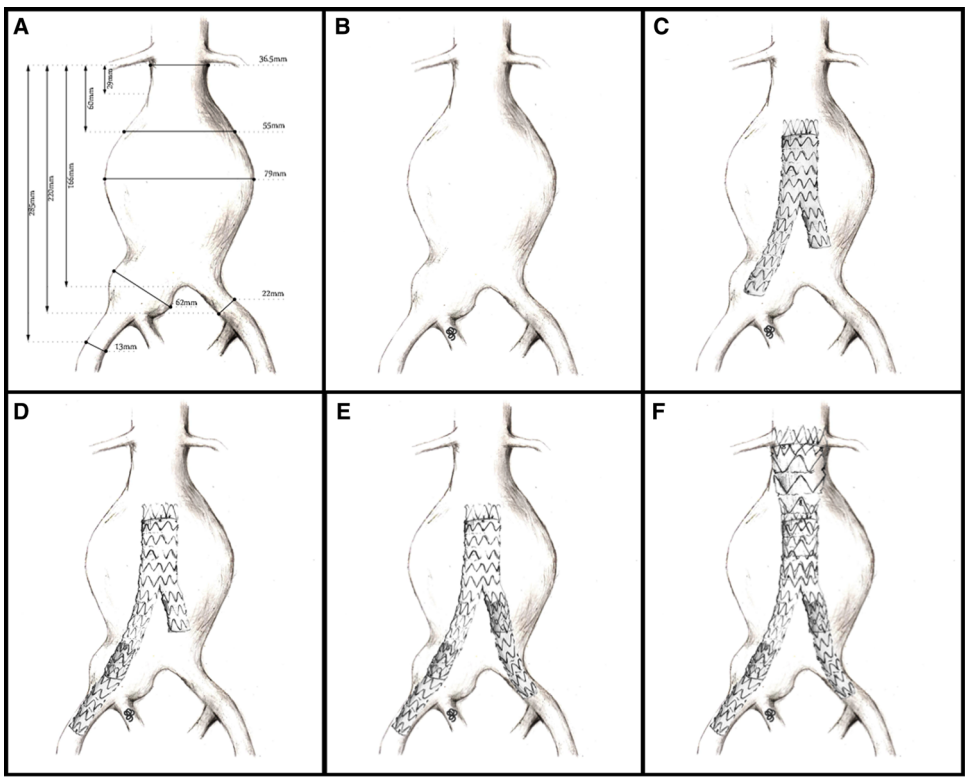

Fig. 2 Schematic drawings aorto-iliac measurements and stent-graft implantation steps. **a** Preoperative planning measurements. **b** Right internal iliac artery embolization. **c** Deployment of 36 × 16 × 166 mm Endurant II (Medtronic, Santa Rosa, CA) bifurcated stent-graft. **d** Right extension with (Medtronic) 16 × 16 × 93 mm branch. **e** Contralateral Endurant II 16 × 16 × 93 mm branch (Medtronic) deployment. **f** Proximal extension with 40 × 40 × 100 mm thoracic Valiant (Medtronic) stent-graft

bifurcation (Fig. 2a). The preopertaive American Society of Anesthesiologists score was 4. Due to high surgical risk, the informed consent was obtained for the procedure and the patient was scheduled for EVAR.

After bilateral femoral arteries surgical exposure, the right internal iliac artery (IIA) was embolized using a 18 × 40 Concerto Helix coil (ev3, Plymouth, MN) (Fig. 2b). According to the AAA measurements and

characteristics, a 36 × 16 × 166 mm Endurant II bifurcated stent-graft (Medtronic, Santa Rosa, CA) was introduced from the right femoral access and deployed 6-cm below the lower renal artery (Fig. 2c) under controlled systolic blood pressure (<120 mmHg). In this way, the distal right leg of the stent-graft main body deployed in correspondence of the origin of the EIA providing adequate main body fixation. At this level the contralateral gate deployed into the aneurysm sac where the AAA transverse maximal diameter was 57 mm. Immediately after the main body deployment, the right leg was extended up to the EIA with an Endurant II 16 × 16 × 93 mm branch (Medtronic), to support the main body stent-graft structure (Fig. 2d). The contralateral gate was cannulated from the left femoral access and a 16 × 24 × 93 mm Endurant II (Medtronic) contralateral limb was deployed to cover up to the left CIA (Fig. 2e).

Subsequently, a 40 × 40 × 100 mm thoracic Valiant (Medtronic) stent-graft was introduced from the left access and deployed below the left renal artery. This thoracic stent-graft achieved a >25-mm proximal sealing in correspondence of the aortic neck and a >35-mm distal sealing into the bifurcated stent-graft (Fig. 2f). Stent-graft junction points and sealing zones were ballooned with Reliant balloon (Medtronic).

The completion angiography revealed the complete AAA exclusion without any type of endoleak (Fig. 3). At 6 months follow-up, no stent-graft migration, limb occlusion or endoleak were registered (Fig. 4).

Fig. 3 Intraoperative completion subtraction angiography showing AAA exclusion and absence of any leakage

Fig. 4 Computed tomography 3D volume rendering, at 6-months follow-up, showing no stent-graft migration, limb occlusion or endoleak

Discussion

Limited literature data are available for large aortic necks, with no distinction from large to extra large diameter. A diameter neck from 24 to 34 mm is generally considered as 'large neck', but can be feasible inside the EVAR instruction for use (IFU). Neck diameter >35 mm (wide neck) is outside standard EVAR IFU. The EVAR Anatomical Factor Severity Score, an aortic neck diameter, assigns a score of 3 points to diameters >28 mm due to the high risk of endoleaks and/or stent-graft migration [6]. In fact, the largest commercially available standard devices for large neck treatment are 36 mm to treat aortic neck up to 32 mm. The literature review showed that large AAA neck was considered for diameters ranging from 24 to 34 mm while wide AAA necks for diameter ≥35 mm. Five papers report on 179 patients presenting large AAA neck aneurysm that were treated by commercially available stent-graft inside EVAR IFU. In these group of patients the type I endoleak incidence was reported in 8.9 % of cases and aortic stent-graft migration in 3.9 %. Early reinterventions related to endoleaks or migration issues were reported in 6.7 % of cases (Table 1) [7–11]. As expected all these findings compare unfavorably to AAA presenting conventional neck diameter.

Even more controversies exist with wide AAA necks (≥35 mm) treatment; in those cases, EVAR experience with standard stent-grafts is limited and, when technically feasible, outside the EVAR IFU.

Table 1 Literature review of EVAR in large and wide AAA treatment

References	Patients	Mean AAA neck diameter, mm (range)	Mean Follow-up, months	Aortic stent-graft		Endoleaks	Migrations	Endoleaks and migrations reinterventions
				Fabric	CM			
Large (between 24 and 34 mm) AAA aortic neck								
Lee et al. [10]	47	28 (24–34)	17	Talent	0	3 type I	7	6
Ingle et al. [7]	16	31 (30–32)	12	Talent	0	1 type I	0	1
Jordan et al. [8]	78	31 (25–32)	14	Powerlink	0	2 type I 3 Unknown	0	1
Perdikides et al. [11]	13	32 (26–34)	7	Endurant (4); Zenith (9); with Heli-FX EndoAnchor System	0	2 type I1/2[a]	0	1
Saha et al. [9]	25	31 (29–34)	72	Zenith	0	5 type I2/5[a]	0	3
Subtotal	179	30 (24–34)	22 (7–72)		0 (0 %)	16 (8.9 %)	7 (3.9 %)	12 (6.7 %)
Wide (≥35 mm) AAA aortic neck								
Grey et al. [12]	1	37.5	4	Talent	0	11/1[a]	0	0
Ronsivalle et al. [2]	4	38 (35–43)	24	Talent (2) E-vita CM (2)	2	0	0	0
Jim et al. [13]	4	36 (35–37)	7	Zenith	0	0	0	0
Subtotal	9	37 (35–43)	14 (4–24)		2 (22 %)	1 (11 %)	0	0
Total	188	30 (24–43)	21 (4–72)		2 (1 %)	17 (9 %)	7 (3.7 %)	12 (6.4 %)

Powerlink System (Endologix, Inc, Irvine, Calif); Zenith (Cook Medical, Bloomington, Ind); Talent and Endurant (Medtronic AVE, Santa Rosa, Calif); Heli-FX EndoAnchor System (Aptus Endosystems, Sunnyvale, Calif); E-vita Jotec GmbH, Hechingen, Germany)

EVAR endovascular aneurism repair, *AAA* abdominal aortic aneurysm, *CM* custom-made

[a] Resolved spontaneously

Grey et al. reported a 85 mm ruptured AAA, unfit for open surgery, with a 35 × 40 mm proximal aortic neck. This patient was treated with standard EVAR stent-grafts by deploying a 32–18–170 mm Talent bifurcated device (Medtronic, Santa Rosa, CA) in the lower part of the aneurysm; subsequently a 42–42–110 mm Talent thoracic tube graft (Medtronic, Santa Rosa, CA) was then deployed within the bifurcated device to create a proximal seal. After 6 days, the CTA revealed a type I endoleak, that solved spontaneously on 4th month follow-up CTA [12].

Ronsivalle et al. presented 4 cases treated by the same principle denominating the 'funnel technique' due to the presence of wide AAA neck. In these patients the mean proximal neck diameter was 38 (range 35–43) mm and the deployment of bifurcated stent-graft distally to the renal arteries preceded the proximal tube stent-graft deployment. In two cases the tube stent-grafts employed were custom made E-Vita (Jotec GmbH, Hechingen, Germany) thoracic stent-grafts; in other two cases a standard Talent thoracic stent-grafts (Medtronic, Santa Rosa, CA) was employed. At mean follow-up of 2 years no endoleaks or stent-graft migration were registered [2].

Jim et al. recently reported the use of Zenith TX2 (Cook Medical Incorporated, Bloomington, IN, USA) thoracic stent-graft for EVAR proximal sealing in 4 cases. Mean proximal neck diameter was 36 mm (range 35–37 mm). The reported technical success was 100 %. At 3 months follow-up, there was one (25 %) aneurysm-related death. The remaining three patients are alive at a mean of 25.7 (range 18–30) months follow up [13].

Surprisingly, the group of patients with large AAA neck presented a significant higher incidence of migrations (8.9 vs 0 %; $P < 0.001$) and reinterventions (6.7 vs 0 %; $P = 0.03$) when compared to patients with wide AAA neck. Although conclusions cannot be withdrawn due to the limited number of patients and follow-up, this finding seems related to a lower efficacy of standard EVAR for large AAA neck when compared to the funnel technique in wide AAA neck.

Using the funnel technique, more valuable deployment options consist of cannulation of the contralateral leg before the complete deployment of the main aortic stent-graft or alternatively the main body stent-graft deployment from the contralateral leg. These tools are employed to stabilize the main aortic stent-graft and reduce the risk of migration during the procedure. In our case these options were not used due to the highly tortuous left iliac artery suggesting for a higher risk during the main body implantation from the left access or eventually a difficult contralateral left gate cannulation. Moreover the deployment of the right leg of the main body in correspondence of the origin of the right EIA was adequate and supportive until the right iliac extension.

In our experience, only commercially available stent-grafts were employed to treat a complex aorto-iliac abdominal aneurysm presenting a wide neck of 36.5 mm. The reported patient was considered unfit for conventional surgery and thus a combination of commercially available stent-graft was employed outside IFU. Different papers have been reported for the Endurant II (Medtronic) use outside the IFU with regard to AAA neck length [14] but few reports exist on the use in wide AAA diameter. This tool combines commercially available stent-grafts and represent an option in cases unfit for conventional surgery especially in non-elective setting.

Conclusion

The lack of commercially available stent-grafts for wide AAA necks (>32 mm) represents an issue. The use of thoracic stent-grafts for EVAR in funnel configuration is a feasible tool in such condition. Custom devices can be employed in elective setting but time and cost efficiency are a limitation. This tool should be recognized in vascular surgeon armamentarium to treat patients with wide AAA neck especially in non-elective setting.

Compliance with ethical standards

Conflict of interest Felice Pecoraro and other co-authors have no conflict of interest.

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