One-year follow-up after total endovascular repair of a contained-ruptured thoracoabdominal aortic aneurysm with the sandwich technique

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We report the case of a 68-year-old woman who was referred to our clinic due to a contained-ruptured type III thoracoabdominal aortic aneurysm 9 cm in diameter. The patient was not a candidate for an open repair because of her comorbid conditions, including dialysis, heart insufficiency requiring pacemaker support, chronic obstructive pulmonary disease, coronary artery disease, and previous abdominal aortic repair. Owing to her hemodynamic instability, we performed a totally endovascular repair with off-the-shelf devices by means of the sandwich technique. An intraoperative gutters-associated endoleak occurred but resolved after 2 months. The 1-year follow-up confirmed the safety of the technique, showing aneurysm shrinkage, absence of any endoleak, and patent visceral vessels. (J Vasc Surg 2013;58:482-5.)

Surgical treatment of ruptured thoracoabdominal aortic aneurysms (rTAAAs) in patients with multiple morbidities remains a challenging task in vascular surgery. Open repair is associated with considerably high morbidity and mortality rates. However, clinical experience is still lacking in the less harmful total endovascular repair with off-the-self branched endografts (Zenith T-branch; Cook Medical Inc, Bloomington, Ind).[1,2] Hence, the controversial chimney and sandwich endovascular techniques with off-the-shelf devices remain the only valid alternatives.[3,4] Herein, we report our 1-year experience in a high-risk patient with a rTAAA, treated by means of sandwich technique.

CASE REPORT

A 68-year-old woman was referred to our department with the diagnosis of a contained rTAAA. Her medical history revealed an abdominal aortic repair with a bifurcated prosthesis 10 years before, severe chronic obstructive pulmonary disease, three-coronary vessel disease with heart insufficiency at New York Heart Association class IV (pacemaker-dependent), and end-stage renal failure requiring dialysis.

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The physical examination revealed an alert and oriented obese woman with unstable vital signs and in acute distress. At the time of referral, the patient required noradrenaline for blood pressure support. Her abdomen was slightly tender, with normal active bowel sounds and without any abdominal bruits. Both extremities were cold, with palpable pulses and monophasic Doppler signals in the femoral arteries.

Contrast-enhanced computed tomography angiography (CTA; Fig 1) revealed a contained-ruptured type III TAAA (9-cm diameter), with severe aortoiliac occlusive disease and high-grade stenosis of both renal arteries. The contained rupture was at the level of the celiac trunk.

Considering the patient's comorbid conditions and her hemodynamic status, we decided to perform a total endovascular repair with off-the-shelf devices by means of sandwich technique. The technique consists of the deployment of Viabahn stents (W. L. Gore & Associates, Flagstaff, Ariz) between at least two endografts to maintain perfusion of the visceral arteries (Figs 2 and 3). Revascularization of the renal arteries was not necessary because the patient required chronic dialysis.

After selective angiography of the superior mesenteric artery (SMA), no collateral supply of the celiac trunk was observed; thus, both visceral vessels required revascularization. First, a Zenith-LP thoracic endograft (ZTEG-2P-34-152; Cook Medical Inc) was implanted after open exposure of the right femoral artery in the descending aorta down to celiac trunk. The introduction of the stent graft through the highly calcified right iliac vessels was only possible after "paving and cracking" of the external iliac artery and implantation of an endoconduit using two Viabahn stent grafts (10 × 100 mm). After surgical exposure of the left axillary artery, two 8F sheaths were introduced, and thereby, the SMA and the celiac trunk were catheterized. A Viabahn stent graft (8 × 150 mm) was implanted in each visceral artery, and one SMART stent (8 × 120 mm; Cordis Corp, Bridgewater, NJ) was implanted into each Viabahn stent as a bridging endograft.

The next step was the deployment of three abdominal Endurant tubes (ENTF3636C70; Medtronic Inc, Minneapolis, Minn), ensuring a good overlapping zone with the thoracic endograft and covering both renal arteries. The procedure was completed after

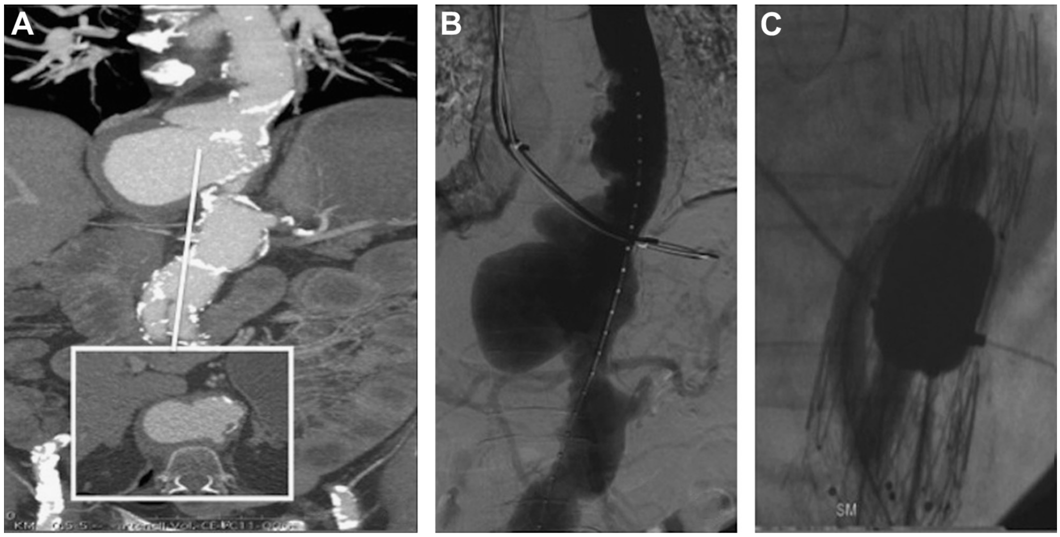

Fig 1. A, Preoperative contrast-enhanced computed tomography (CT) scan shows a contained-ruptured thoracoabdominal aortic aneurysm (rTAAA) (9-cm diameter) and the highly calcified iliac arteries. **B,** Intraoperative angiography before the intervention. **C,** Intraoperative kissing-balloon technique of the bridging endografts, the proximal abdominal tube, and the thoracic endograft.

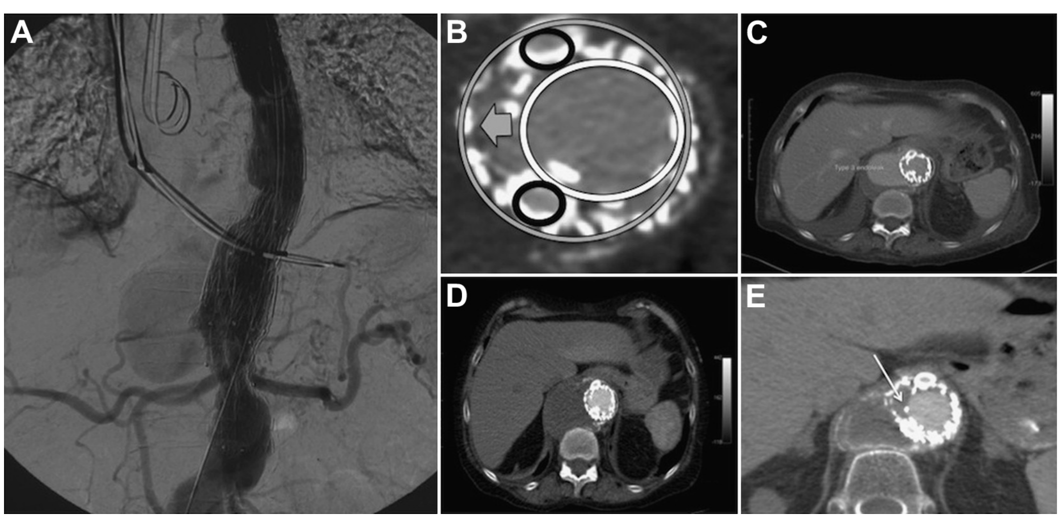

Fig 2. A, Evidence of endoleak is seen in the intraoperative completion angiography. **B,** The space (*gray arrow*) between the coaxial Viabahn grafts (*black circles*) and the abdominal cuff (*white circle*) and the main stent graft (*gray circle*) is defined as the gutter. After the coaxial grafts were molded into the thoracic endograft, the blood still found an exit to the aneurysm sac, leading to gutter-associated endoleak. **C,** A contrast-enhanced computed tomography (CT) scan on postoperative day 7 confirmed the endoleak. **D,** A contrast-enhanced CT scan at 2 months shows the persistent endoleak has disappeared. **E,** A contrast-enhanced CT scan at 12 months shows shrinkage of the aneurysm, thrombosis of the gutter (*white arrow*), and absence of endoleaks.

a kissing-balloon technique (Fig 1) at the level of the bridging endografts. The operation time was 73 minutes, and dose area product was 52,309.0 Gym.[2] The completion angiography showed a low-flow gutters-associated endoleak between the bridging endografts (Fig 2). The SMA and celiac trunk were patent.

The patient's postoperative course was uneventful, and a control CTA scan on postoperative day 7 confirmed the presence of the endoleak. We monitored the patient with a control CT scan at 2 months, and no endoleak was found, the visceral arteries were patent, and the aneurysm was successfully excluded (Fig 2). Finally, the CTA scan at 1 year showed 3-cm shrinkage of the aneurysm sac, no endoleak, thrombosis of the gutters, and patent visceral arteries (Fig 3). The patient was doing well at 14 months of follow-up.

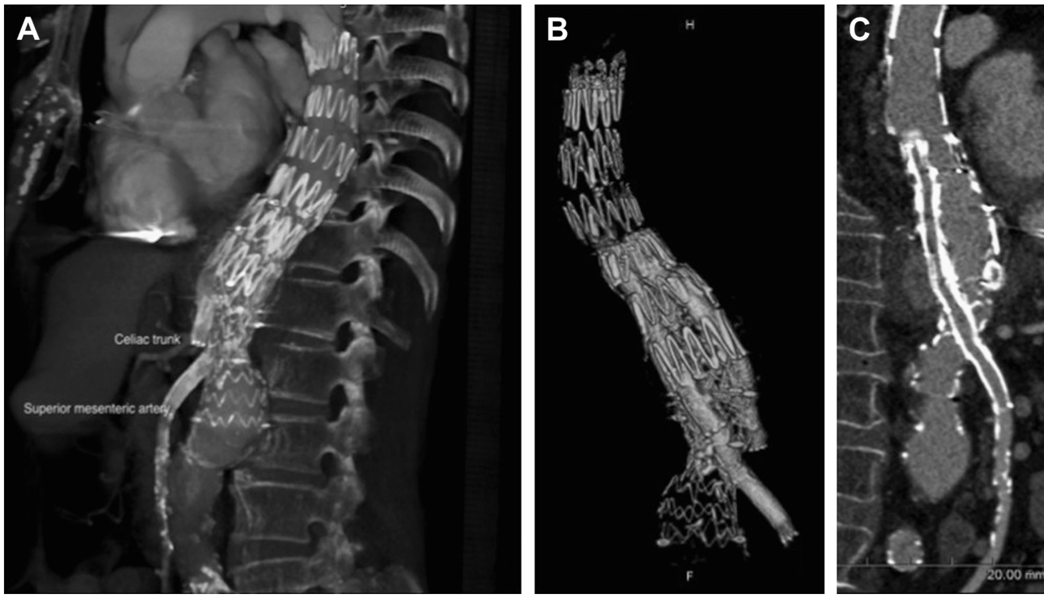

Fig 3. A three-dimensional reconstruction of a contrast-enhanced computed tomography (CT) scan at 12 months shows **(A)** the total exclusion of the aneurysm, no endograft migration, and the patent superior mesenteric artery (SMA) and celiac artery; **(B)** the relationship among the coaxial abdominal tubes, bridging stents, and the thoracic endograft; and **(C)** the exact position of the bridging endograft into the SMA.

DISCUSSION

Symptomatic or rTAAAs are routinely treated by means of in situ aortic repair or a hybrid approach.[1] The latter option seems less harmful than a surgical TAA repair but has been also associated with considerable morbidity and mortality rates.[2] Our patient was not an appropriate candidate for either approach considering her comorbid condition and the previous abdominal aortic repair. Thus, total endovascular repair by means of sandwich technique was performed, and the results justified our decision.

The main challenge of a total endovascular repair of rTAAAs is the lack of off-the-shelf branched or fenestrated endografts.[3] Currently, the Zenith t-branch (Cook Medical, Inc) has received the Conformité Européene mark for the world's first off-the-self branched endograft, but clinical experience and performance are still lacking. Of note, current establishment of surgeon-modified fenestrated-branched stent grafts also requires further investigation.[5] Nevertheless, there are various anatomic features where these devices will not be suitable for use, including very tortuous iliac or highly calcified iliac vessels, angulation at the level of the aneurysm neck, descending aorta diameter >34 mm, and lack of previous experience with branched or fenestrated endografts.[6]

Our case confirms, in addition to the existing literature,[4,7,8] the feasibility and effectiveness of this sandwich technique in the midterm period. However, the following technical considerations, based on our institutions' experience[9] with this technique, should be noted:

1. Combination of Zenith-LP thoracic endograft and Endurant abdominal tubes: We combined these devices for the "sandwich area" due to the stiffness of the Zenith endograft and the flexibility and high radial force of the Endurant cuffs, which better mold to the Viabahn stent grafts and reduce the size of the gutters (Fig 2).[10] However, a short thoracic device might have the same result.
2. Use of Viabahn and SMART stents as bridging stents: The self-expandable 15-cm Viabahn stent graft was preferred due to its length and excellent flexibility. A long overlapping zone of >5 cm with the aortic stent graft and an insertion zone of >2 cm into the visceral arteries were preferred. In addition, 12-cm SMART stents were used to stabilize the Viabahn into the visceral artery segment, to prevent kinking through the sandwich maneuver (high radial force), and to optimize the poor fluoroscopic visibility of the Viabahn stent graft. Considering the maximal 12-cm length of the SMART stent, we avoid the implantation of a second SMART stent to cover the very proximal portion of the Viabahn stent graft.
3. Open exposure of the axillary artery: An important issue is the introduction of two 8F sheaths through the axillary artery. The distance of at least 2 cm between the two puncture positions of the sheaths is essential to avoid great artery defects after sheath removal.
4. Gutters-associated endoleaks: Our policy concerning the treatment of gutters-associated endoleaks has

evolved from our extensive experience in treating symptomatic and ruptured juxtarenal aortic aneurysms by means of the chimney technique.[3] In this case, the completion angiogram revealed a low-flow endoleak, as defined by Pecoraro et al.[11] Hemorrhage can effectively be controlled in low-flow endoleaks once the disturbed coagulation due to aortic wall rupture normalizes.[11] No data regarding embolization of the gutters have been reported. In this context, the use of a liquid embolic agent, such as Onyx (ev3 Endovascular, Inc, Plymouth, Minn), might prevent gutters-associated endoleaks, but this requires further investigation.

Noteworthy in this patient is that only two vessels needed revascularization; however, in most patients with similar pathology, three or four vessels must be revascularized. In such cases and according to our experience with chimney grafts in four vessels, a 20% oversizing of the endograft is mandatory. Yet, published data regarding this issue and the respective prevention of persistent gutters-associated endoleaks are still lacking.

CONCLUSIONS

This case shows that in carefully selected high-risk patients, the sandwich technique might be an effective therapeutic option. Longer surveillance and a greater number of patients are needed to confirm whether this technique could be a valid alternative to treat symptomatic or rTAAAs when self-branched endografts are not available or are unsuitable.

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