Endovascular treatment of ruptured pararenal abdominal aortic aneurysm using the Chimney technique

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Abstract:

Aim: To demonstrate the feasibility of emergent endovascular repair of a ruptured pararenal aneurysm using chimney grafts.

Case Report: We report the treatment of 3 patients with rupture of a pararenal abdominal aortic aneurysm by using the chimney technique to extent the proximal landing zone above the renal arteries. All patients were operated under local anesthesia. Target vessels included 5 renal and 1 superior mesenteric artery. Technical success was achieved in all patients, with no 30-day complications. During follow-up all target vessels were patent with no sign of endoleak.

Conclusion: The use of chimney technique in a ruptured pararenal aneurysm is feasible. More robust data on chimney EVAR in ruptured cases are, however, required. The technique described here could reduce the number of patients with ruptured AAAs who are deemed unsuitable for EVAR based on anatomical criteria.

INTRODUCTION

Abdominal aortic rupture (rAAA) comprises a potentially fatal situation needing immediate treatment. Although for decades open repair has been considered the treatment of choice nowadays endovascular repair (EVAR) is becoming increasingly popular in rAAA treatment.[1] Both the Society of Vascular Surgery (SVS) and the European Society of Vascular Surgery guidelines recommend endovascular repair (EVAR) over open repair for a rAAA if anatomically suitable,.[2, 3] The presence of an adequate proximal landing zone has been contemplated mandatory to achieve a sufficient seal. Aortic rupture in patients with pararenal aneurysm has been considered a challenge as open repair require in most cases supraceliac clamping associated with high mortality and morbidity rates.[4] The use of parallel grafts for the splanchnic vessels to extent the proximal landing zone above the renal arteries (chimney EVAR/chEVAR) has been reported as a less invasive therapeutic solution for such patients, though not adequately studied so far.[4] We report 3 cases of pararenal AAA rupture (rAAA) treated with the chimney technique.

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CASE 1

A 68-year-old patient was referred to the emergency department because of acute back pain and loss of consciousness. He had a history of an AAA treated by endovascular means 10 years previously. The patient had underwent coronary angioplasty earlier that year, was a heavy smoker and therefore conventional aneurysm repair was regarded as highly unfavorable. The patient was hemodynamically stable. The department's protocol followed in each rAAA case has been described.[5] Computed tomography angiography revealed an abdominal aortic rupture with a large hematoma and active bleeding in the psoas major muscle. The previous aortic endograft was migrated due to significant aortic neck dilatation. Because of the absence of an adequate infrarenal neck, the deployment of a conventional stent-graft was infeasible without extending the proximal landing zone above the renal arteries. Based on preoperative imaging, the distance between the distal renal artery and the superior mesenteric artery was 22 mm, which would be sufficient to provide adequate proximal seal when using an endograft in conjunction with two chimneys to the renal arteries. The aortic diameter at the suprarenal level was 29 mm, which would allow deployment of a 36mm endograft and two chimneys for the renal arteries. For parallel running chimney-grafts a significant degree of oversizing is necessary to allow the main aortic body to surround the chimney and to prevent the occurrence of gutters, that may predispode for type I endoleak. We usually prefer an oversize of at least 20% for the main endograft, trying not to exceed 30% to avoid the risk of endograft folding.

The patient was operated under local anesthesia and antibiotic prophylaxis. Access was acquired to both common femoral arteries and the left axillary artery. Two long 7-F sheaths were advanced through the subclavian artery and positioned in the descending aorta. Both renal arteries were cannulated and Be-graft balloon-expandable covered stents (Bentley, Hechingen, Germany; 6×38-mm and 6×58-mm for the right and left renal artery, respectively) were positioned using both 7-F sheaths from the axillary approach. Subsequently, an 8F long sheath was positioned through the femoral artery, and angiography in lateral position was performed to determine the position of the superior mesenteric artery.

An Endurant endograft (Medtronic, Santa Rosa, CA, USA) was deployed just distal to the superior mesenteric artery, followed by placement of both chimney grafts. After chimney deployment, kissing balloon of the chimney grafts and the aortic endograft was accomplished. After positioning of both iliac limbs, final angiography showed complete exclusion of the aneurysm without endoleak and patent renal arteries and superior mesenteric artery. The procedure duration was 110 minutes, with 18 minutes of fluoroscopy time and an estimated blood loss of 150 mL. The patient was admitted to the intensive care unit for 24 hours. Three days after the procedure, CTA showed a small endoleak type I probably gutter-related. At 6 months follow-up the patient was well without any complications, while CTA showed patent stents and no evidence of endoleak any more (Figure 1).

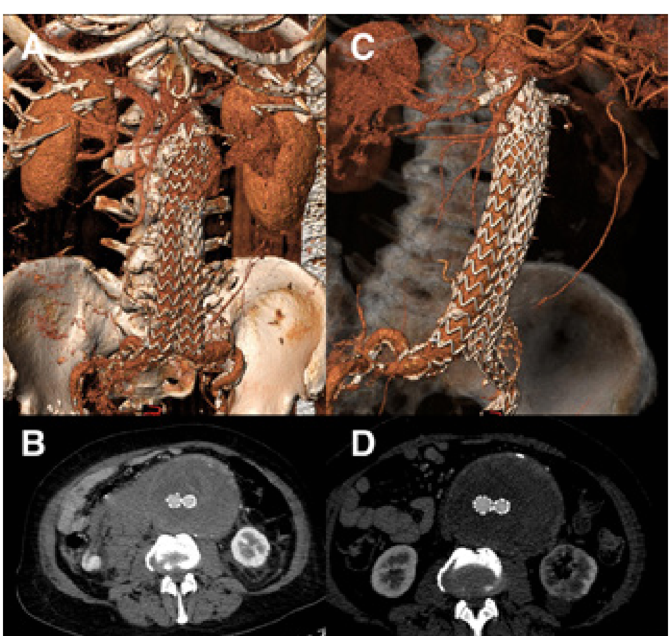

Figure 1. 3D reconstruction (A) and axial (B) computed tomography angiography showing the ruptured pararenal abdominal aortic aneurysm. 3D reconstruction (C) and axial (D) computed tomography angiography 6 months after double chimney showing patent renal arteries with no sign of endoleak.

CASE 2

A 77-year-old man with a 6 cm diameter pararenal rAAA was referred from a district Hospital. Patient's history included severe comorbidities, including chronic obstructive pulmonary disease, hypertension and a previous myocardial infarction. Computed tomography angiography (CTA) showed a rAAA starting 3 mm distally from the lowest renal artery. The distance between the two renal arteries was 4 mm and in case of a double chimney the sealing zone obtained was inadequate reaching 14 mm. When choosing 3 chimneys, two for the renal arteries and one for the superior mesenteric artery, proximal landing zone was 24 mm in length (Figure 2). The aortic diameter in the visceral segment was 27 mm.

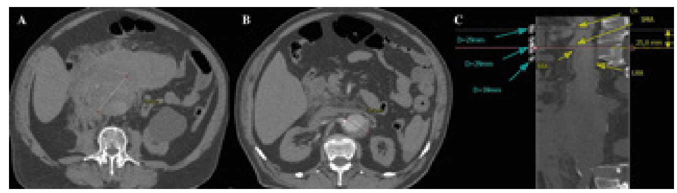

Figure 2. A,B. Computed tomography angiography depicting a ruptured pararenal aneurysm with a 72mm maximum diameter and an infrarenal neck 40mm in diameter C. Center lumen line showing the distances between the three target vessels for planning a 3x chEVAR.

After cutdown of the left axillary artery, two 7 Fr Shuttle (Cook, Bloomington, IN, USA) sheaths were advanced into the renal arteries, while with an additional cutdown of the right axillary artery a 7 Fr sheath was advanced for the catheterization of the SMA. After bilateral femoral cutdown, a 36mm diameter Endurant II bifurcated endograft (Medtronic, Santa Rosa, CA, USA) was advanced and deployed at the orifice of the coeliac trunk. Two balloon expandable covered stents (Bentley, Hechingen, Germany) 6 mm in diameter and 57 mm in length were deployed in each renal artery, and one 7 mm diameter and 38 mm in length stent in the SMA. Finally, a prolonged kissing balloon of chimney stents and the Endurant stent graft was performed to minimize the risk of gutters and improve the conformability of the devices. Completion angiography showed complete exclusion of the aneurysm without endoleak and patent splanchnic vessels (Figure 3).

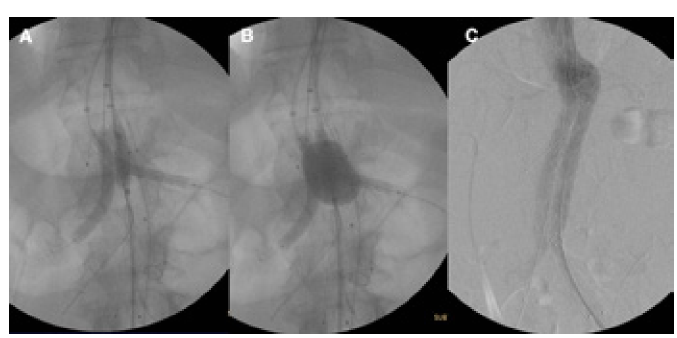

Figure 3. A,B. Intraoperative images showing the inflation of the balloons inside the target vessels and the aortic endograft after chimney deployment. C. Final angiogram showing patent splachnic veessels with no sign of rupture or endoleak.

The patient was admitted to the intensive care unit for one day. He passed gas and mobilized from the first postoperative day. Three days after the procedure, CTA confirmed the adequate endograft position and the exclusion of the aneurysm sac. The patient was discharged on the fifth post-operative day. At 1st month follow-up the patient was well without any complications, while CTA showed patent stents and no evidence of endoleak (Figure 4).

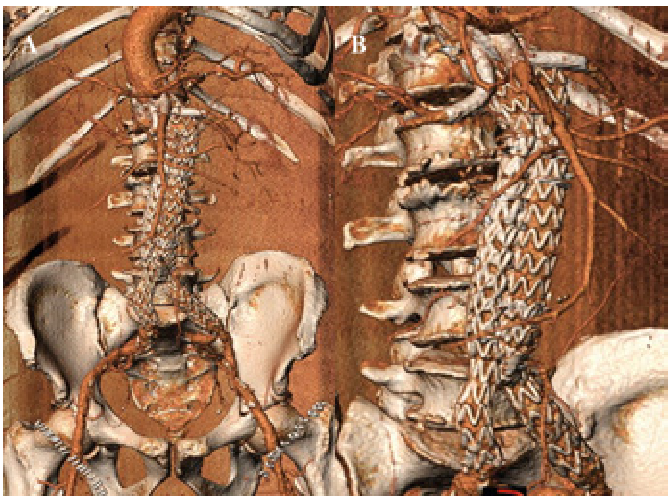

Figure 4. A,B. 3D reconstruction computed tomography angiography 1 month after triple ch-EVAR showing the patent target vessels with no sign of endoleak.

CASE 3

A 70-year-old patient was referred to the emergency department from another district hospital with the diagnosis of a rAAA. The patient was hemodynamically stable. He had a history of abdominal aortic aneurysm treated by endovascular means 8 years previously. The previous aortic endograft was migrated due to significant aortic neck dilatation (Figure 5). The infrarenal aortic neck proximally from the migrated endograft was 6mm in length, while the distance between the lowest renal artery and the highest was 19 mm. An endograft in conjunction with one chimney to the left renal artery was considered sufficient to provide adequate proximal seal.

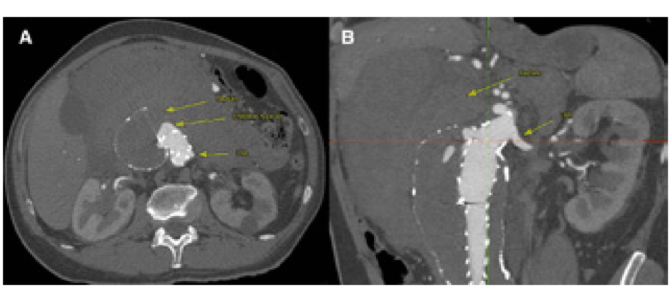

Figure 5. A. Axial computed tomography angiography showing the ruptured pararenal abdominal aortic aneurysm B. 2D reconstruction computed tomography angiography depicting the rupture and the presence of an endoleak type I.

The procedure was performed the same manner as mentioned above. Under local anesthesia and access to both common femoral arteries and the left axillary artery, an Endurant (Medtronic, Santa Rosa, CA, USA) endograft was deployed just distal to the right renal artery, followed by deployment of a chimney graft. After chimney deployment, kissing balloon of the chimney grafts and the aortic endograft was accomplished. After deployment of both iliac limbs, final angiography showed complete exclusion of the aneurysm without endoleak and patent renals and superior mesenteric artery (Figure 6).

Figure 6. A. Intraoperative image showing the AAA rupture (black arrow) and the distal migration of the previous endograft. B. The deployment of one chimney into the left renal artery. Note the proximal markers of the previous (black arrow) and the current (white arrow) aortic endograft. C. Final angiogram showing patent renal artery with no sign of rupture or endoleak.

Three days after the procedure, CTA showed patent chimneys and no evidence of endoleak. At 1 month follow-up the patient remains well without any complications (Figure 7).

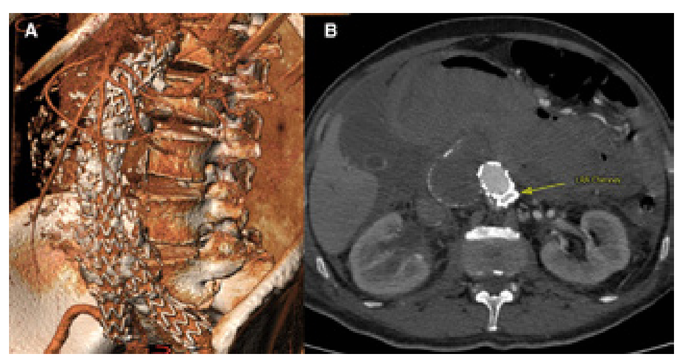

Figure 7. 3D reconstruction (A) and axial (B) computed tomography angiography showing 1 month after single ch-EVAR showing the patent renal artery with no sign of endoleak

DISCUSSION

This case series demonstrates the feasibility of using the chimney technique to treat ruptured juxtarenal aneurysms, providing a theoretically valuable alternative to patients deemed unfit for emergency open aortic aneurysm repair. Based on our limited experience with these 3 patients and considering their favorable outcome we now prefer to treat patients with ruptured pararenal aneurysm with the chimney technique given also the immediate availability and the minimal invasiveness of the procedure. Certainly technical issues as the need of local anesthesia combined with the need of upper auxiliary approach in a prolonged procedure and the device/material availability should be considered in the set up although as it shown from our series can be successfully accomplished.

In most cases pararenal rAAAs are anatomically challenging and time is needed preoperatively for adequate planning and sizing. We always measure the aneurysm using a dedicated three-dimension programme (3Mensio, Pie Medical Imaging B.V., Maastricht, Netherlands), creating a center lumen line for the aorta and each target vessel separately. In this way we can easily and reliable measure the diameters and the lengths and chose the right endografts.

Although the instructions of use of the endograft deployed in this case series recommend a minimum landing zone of at least 15mm, we usually intend for a sealing zone of at least 20mm when treating pararenal patients with the chimney technique. The suprarenal part of the aorta does not seem to dilate significantly over time.[6] Recent studies showed that using a longer proximal suprarenal landing zone was not associated with an increase in perioperative mortality and morbidity, though required longer procedure and fluoroscopy duration.[7] By using an extended proximal sealing zone we may have a better long-term durability of the procedure, as we rely on the theoretically healthier part of the diseased aorta.

Several aortic endografts have been used for treating patients with chimney EVAR. Due to logistic reasons, in our department we use the Endurant endograft when treating aortic ruptures as it is available in a large variety of sizes in our hospital stock. Nevertheless, this endograft constitutes the sole endograft with a CE mark for the chimney EVAR technique. The choice of the optimal chimney graft is also a matter of debate. In the Pericles registry, balloon-expandable stents were deployed in nearly half of the target vessels, while almost 40% were self-expanding stents.[8] There was a trend toward balloon-expandable covered stents having improved patency and fewer type Ia endoleak; however self expanding stent were deployed in more tortuous and challenging anatomies.[8] We usually choose a balloon-expandable covered stent, but self-expanding covered stents could also be used. Having the target vessel sheaths inside and after marking the edge of the proximal sealing zone we deploy the main endograft at first and then deploy the balloon expandable stents accurately just in the middle portion of the bare suprarenal stent of the main endograft. In a second step and by leaving the balloons inside the target vessel grafts, simultaneous kissing balloon inflation is easy without the need of material exchange. Self-expandable stents can be used instead especially in cases when longer lengths are needed, although the need for additional balloons deployment should be acknowledged.

The presence of a type I endoleak remains the main problem of the chimney technique. Although the majority of those endoleaks detected intraoperatively diminish or even resolve with prolonged balloon inflation, still a few patients will have a type I endoleak, propably gutter related, in the final angiogram. Our strategy is to wait for the postoperative CTA, as most of these endoleaks spontaneously disappear given the absence of heparinization after the first postoperative day. Embolization possibilities (coils or Onyx) for the remaining endoleaks that persist and may lead to sac expansion have been used with encouraging results.[9,10]

CONCLUSION

The use of chimney technique in a ruptured pararenal aneurysm is feasible. More robust data on chimney EVAR in ruptured cases are, however, required. The technique described here could reduce the number of patients with ruptured AAAs who are deemed unsuitable for EVAR based on anatomical criteria.

No conflict of interest.

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