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CASE REPORT

A Very Unlucky Intraoperative Event During a Chimney Technique for Juxtarenal Aneurysm Exclusion

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Abstract A two-vessel Ch-EVAR procedure was scheduled within the instructions for use of the devices. After deploying, it appeared that the long sheath inserted through an arm access was discovered to be trapped behind the aortic stentgraft barbs. Trying to remove the sheath, the graft was displaced upward and the procedure was converted for a three-vessel Ch-EVAR incorporating the superior mesenteric artery. Simultaneous ballooning of the target vessels and the stentgraft permitted to exert a strong pullback traction on the blocked sheath, allowing its removal. A segment of the sheath distal end was left trapped in the aortic stentgraft. At 12 months follow-up, the patient is free of any complications and there are no occlusions of the abdominal visceral branches or embolic events in peripheral arteries.

Keywords Juxtarenal aortic aneurysm · Chimney technique · Endovascular aneurysm repair

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Introduction

The chimney technique endovascular aneurysm repair (Ch-EVAR) is now considered a valuable alternative for the treatment of juxtarenal aortic aneurysms [1]. Low rates of early complications combined with acceptable rates of late endoleaks were reported in experienced and high-volume centers [1, 2]. Following the results of the PROTAGORAS study [1], the Medtronic Endurant II stentgraft (Medtronic, Santa Rosa, CA) associated with balloon expandable covered stents has received both Food and Drug Administration (FDA) and Commission Européenne (CE) approvals to treat abdominal aortic aneurysms (AAA) with short proximal necks [2, 3].

Technically, performing Ch-EVAR according to the instructions for use (IFUs) mandates routing balloon expandable stent(s) toward long sheath(s) coming from the upper limb(s), and deploying them at the level of an uncovered barbed aortic stent intended to provide secure suprarenal fixation. We aimed to report the intraoperative blockage of a long renal sheath between the barbs of the stentgraft suprarenal stent and the aortic wall during a Ch-EVAR case scheduled within the IFUs and the successful management of this potentially serious intraoperative issue.

Case Report

An 83-year-old man was admitted in our center with a 56-mm diameter juxtarenal aortic aneurysm (Fig. 1A, B). Patient comorbidities included hypertension and dyslipidemia. He had no other medical history and was classified American Society of Anesthesiologists (ASA) 2. Anatomically, the aortic neck was 2 mm in length and a neo-neck

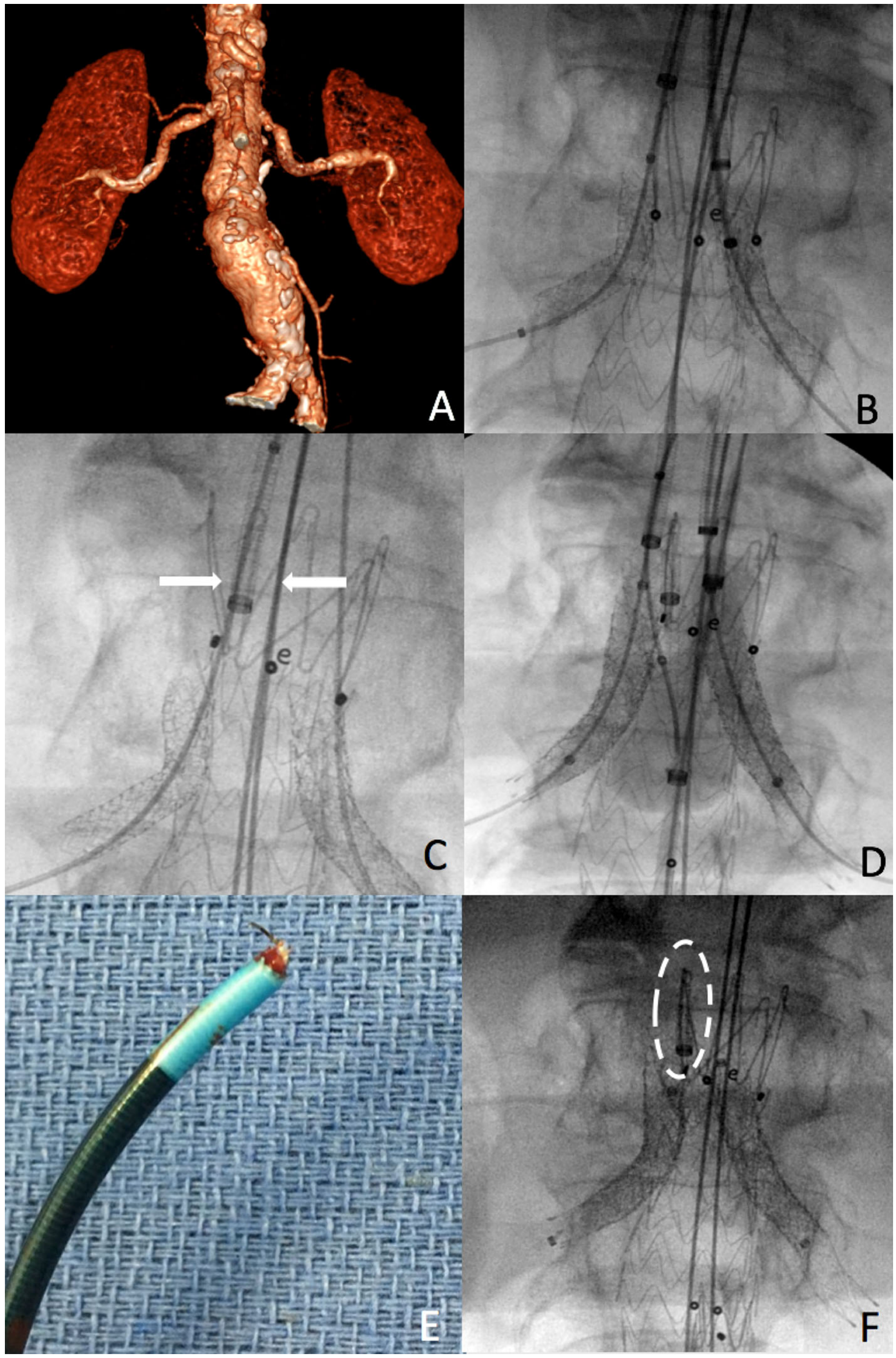

Fig. 1 **A** Preoperative CT scan showing a 57-mm diameter juxtarenal aortic aneurysm with anatomic suitability for Ch-EVAR procedure. **B** Fluoroscopic view depicting the original position of the stentgraft. **C** Fluoroscopic view of the blocked sheath (arrows) between two barbs and the main stentgraft body. Note that the main stentgraft has been displaced upward. **D** Illustration of the snapped piece of the sheath during simultaneous inflation of the stentgraft body and the renal stents. **E** Picture of the broken 7F sheath that has been removed. **F** Fluoroscopic view of the distal part of the sheath that remained blocked between the barbs and left in place

of 18 mm in length could be obtained in case of stentgraft sealing just below the superior mesenteric artery (SMA) level. An endovascular exclusion using a bifurcated stentgraft associated with chimney stentgrafts in both renal arteries was decided. The procedure was scheduled within the current instructions for use (IFUs) of the devices.

The patient was treated under general anesthesia. The right axillary artery was approached through surgical cutdown while bilateral percutaneous femoral accesses were performed. An 8-mm axillary prosthetic conduit was constructed. The conduit was punctured on two different sites, and two short 7F sheaths (Terumo Interventional Systems, Somerset, NJ, USA) were placed. After successful catheterization of the renal arteries using a 100-cm vertebral catheter (Merit medical, South Jordan, UT, USA) and a 0.035′ guidewire (Terumo Interventional Systems, Somerset, NJ, USA), a 0.035′ Rosen wire (Cook Medical, Bloomington, IN, USA) was positioned down to each distal renal artery. Two 70-cm 7 French sheaths (Cook Medical, Bloomington, IN, USA) were brought in the renal arteries. On each side, one 6 * 37 mm balloon expandable covered stent (BeGraft, Bentley, Hechingen, Germany) was positioned at the level of the renal artery. The sheaths were left in place, and the renal stents were initially not deployed. Through a right femoral access, the main stentgraft body (Endurant II 28-16-166, Medtronic, Santa Rosa, CA) was advanced over a Lunderquist wire (Cook Medical, Bloomington, IN, USA). The proximal part of the graft was positioned just below the SMA ostium, and the covering of the stentgraft started exactly below the level of the renal arteries. The stentgraft main body and its suprarenal stent were deployed. The renal sheaths were removed, and the covered renal stents were deployed in a way that the stents protruded the covered fabric of 2–3 mm, as previously described [4]. To prevent renal stents crossing at the level of the aortic stentgraft landing zone, a gentle pullback traction was applied while the balloons were inflated in the renal stents, as recommended [5].

After deploying the right renal stent, it appeared that the long sheath inserted through an arm access could not be retrieved out of the aorta. The blockage was at the distal part of the sheath. Using high-magnification images, it was discovered to be trapped behind the aortic stentgraft barbs (Fig. 1C). Trying to remove the sheath, the graft was displaced upward partially covering the SMA ostium.

A parallel catheterization of the right renal artery was performed through a third 7F sheath introduced in the axillary conduit. To prevent superior mesenteric artery thrombosis, a fourth 7F sheath was advanced to perform a chimney on the SMA and two 7 * 29 and 8 * 29 mm stents (Cordis Corporation, Johnson & Johnson Company, Miami, FL, USA) were deployed in the SMA. The balloons were left in place in the target vessels. It was felt that the repair was secured, since each of the three target vessels was stented with one balloon in place in each target vessel. To remove the blocked sheath, simultaneous ballooning of the three target vessels and the main stentgraft body (Coda balloon, Cook Medical, Bloomington, IN, USA) permitted to exert a strong pullback traction on the blocked sheath (Fig. 1D). This maneuver allowed its removal. Examining the removed sheath, it appeared that its two distal centimeters were missing (Fig. 1E). Fluoroscopy examination of the aortic repair demonstrated that this distal extremity was left between the barbs (Fig. 1F). Both anteroposterior and mediolateral views showed that it appeared fully stabilized between the aortic wall and the suprarenal stent. Decision was made to leave it in place. The renal covered stents were proximally extended with 7 * 37 mm balloon expandable covered stents (Bentley, Hechingen, Germany) due to the proximal stentgraft migration. It was also decided to reline the renal stents distally due to a slight kink on both sides (Absolute Pro, Abbott vascular, Santa Clara, CA).

The second part of the procedure comprised a standard aneurysm exclusion using an aorto-bi-iliac stentgraft preserving bilaterally the internal iliac arteries. Completion angiography confirmed the satisfactory aspect of the repair with target vessels patency but there was a type 2 endoleak through the lumbar arteries. Total operative time was 310 min. Fluoroscopy time was 49 min, and 115 ml of iodine contrast was used.

Postoperatively, the patient was kept in the vascular surgery department and was discharged on day 5 without any unanticipated or unexpected events. Discharge medications included a double oral antiplatelet therapy (daily aspirin 75 mg and clopidogrel 75 mg). At 12-month follow-up, the patient was healthy and all stents were patent on the CT scan. The aneurysm was excluded and remained stable in diameter. No event related to the part of the sheath that was left in place was noted (Fig. 2).

Discussion

While IFUs for Ch-EVAR were initially followed, this case highlights a very unusual intraoperative adverse event performing this technique. In the present case, the choice of a Ch-EVAR rather than fenestrated or branched stentgraft was made because of the downward renal arteries, anticipating the fact that catheterization through the arm would be quite straightforward. Besides, fenestrated or branched stentgrafts were not considered because the suprarenal aorta was not aneurysmal. These devices require a more extensive coverage of the descending thoracic aorta, thereby leading to a higher risk of spinal cord ischemia." Finally, chimney graft procedures are associated with satisfactory short- and mid-term outcomes and are nowadays a valuable option to treat pararenal aortic aneurysms [6, 7].

Different aortic and peripheral stentgrafts were initially used to perform Ch-EVAR[4], but recent FDA and CE approvals were obtained with the Endurant aortic stentgraft associated with the V12 (Maquet, Rastatt, Germany) or the BeGraft (Bentley InnoMed, Hechingen, Germany) covered stents for the renal arteries. These IFUs were followed in this case, aside from the secondary distal addition of nitinol stent to correct renal stent kinking with a subsequent risk of renal artery thrombosis. Of note, this correcting step to reline the inside of a covered chimney stent represents 7–25% of Ch-EVAR procedures [1, 5].

In this case, an axillary conduit was used through the right upper limb and allowed a third chimney on the SMA because of intraoperative upward aortic graft displacement. It is now our practice to use a conduit when more than one chimney is performed, to work comfortably, allow bail out

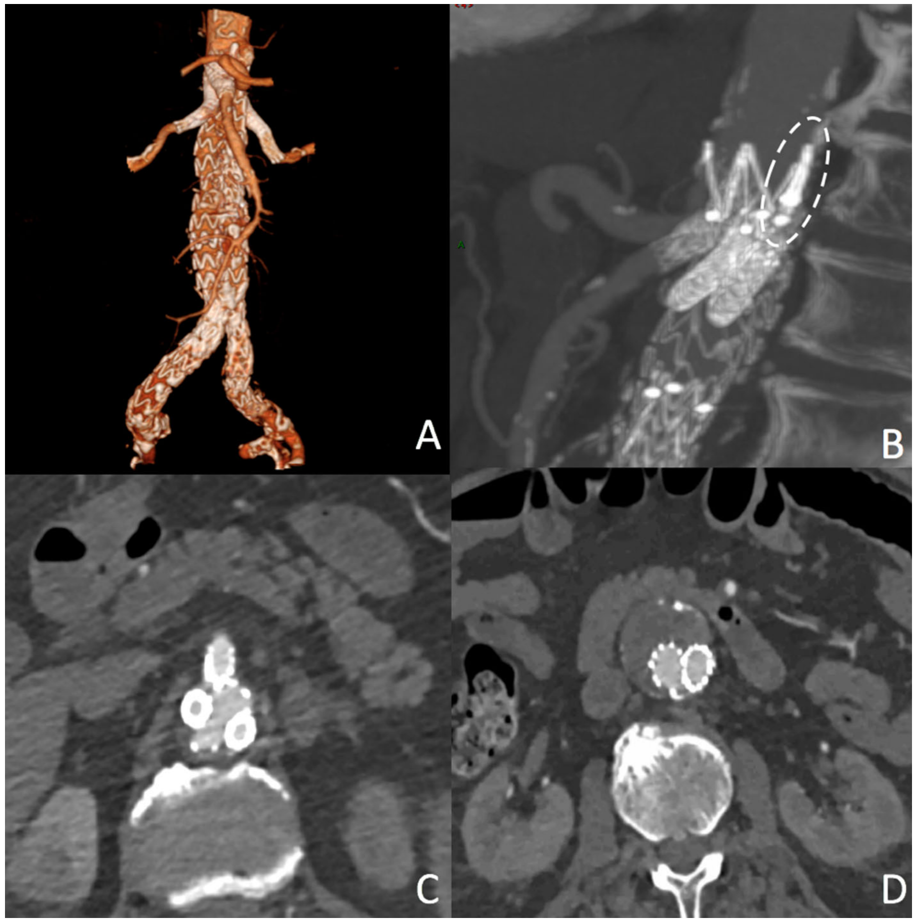

Fig. 2 **A** 3D reconstruction of the repair at 12 months CT scan. **B** Same CT scan. Sagittal maximum intensity point (MIP) view showing the absence of migration of the distal part of sheath blocked between the barbs (dotted circle). **C**, **D** Same CT scan. Axial cuts confirming the absence of endoleak, stents patency and the absence of event related to the distal part of the sheath left in place

supplementary chimney stent(s) and avoid multiple punctures of the native artery.

We here report a case of an intraoperative technical problem during a planned chimney graft procedure. Its cause relies in an insufficient retrieval of the long renal sheath before deploying the uncovered suprarenal stent of the main Endurant II device. This 15-mm-long suprarenal stent is made of five pairs of 2-mm-long downward hooks, and the sheath was blocked between the two hooks of one pair. From this case, we learn that sheath removal must be performed outside the active fixation zone of the uncovered proximal stent of the stentgraft. Leaving an appropriate distance between the balloon of the covered stent and the barbs of the suprarenal stent is also necessary to prevent balloon perforation by the hooks.

Even though pulling the sheath during simultaneous ballooning of the stentgraft was successful, other maneuvers could have been considered. First, we tried to move the sheath bringing a balloon back into the distal segment and inflate it into the distal sheath end, but the balloon used failed to advance probably because the barbs went through the sheath. Secondly, pulling the barb via a femoral access with a snare could have been considered but this option was at risk to destabilize the repair or kink the right renal stent.

The long-term outcomes of leaving the distal part of the sheath in place in the aorta are unknown. Emergent open conversion with the need of a supraceliac clamping was felt to be at high risk in this 83-year-old patient [8] for an uncertain benefit. We finally decided to leave the foreign body in place. The migration risk was anticipated to be low due to the fixation by the hooks. Long-term follow-up remains however necessary to ensure the absence of local thrombus development. At the last follow-up, the CT scan showed a satisfactory result with the incorporation of the distal part of the sheath in the repair (Fig. 2B).

Conclusion

Although IFUs for Ch-EVAR were initially followed, this case highlights a very unusual intraoperative adverse event. Physicians should be aware of such complication that must be prevented by removing the long sheaths above the level of the suprarenal stent before deployment.

Compliance with Ethical Standards

Conflict of interest Raphaël Coscas has been consultant for the following companies: Medtronic Inc, Bard Inc, Terumo Inc, Gore Inc, Spectranetics and Abbott Vascular Inc.

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