Periscope graft to extend distal landing zone in ruptured thoracoabdominal aneurysms with short distal necks

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PERISCOPE GRAFT TO EXTEND DISTAL LANDING ZONE IN RUPTURED THORACOABDOMINAL ANEURYSMS WITH SHORT DISTAL NECKS

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Abstract

Endovascular aneurysm repair of ruptured thoracoabdominal aortic aneurysms may be compromised or even impossible due to short proximal and/or distal necks or landing zones, respectively. Supra-aortic branches may limit the proximal, visceral or renal arteries the distal anchorage of endografts. While solutions have been proposed to overcome the problem of a short proximal neck, no technique has been described that solves the problem of a short distal neck. We present the “periscope technique” which allows extension of the distal landing zone and complete endovascular treatment of ruptured thoracoabdominal aneurysms with short distal necks using devices already stocked in most centers performing EVAR procedures.

keywords: ruptured; aneurysm; aortic; thoracoabdominal; EVAR; TEVAR; stentgraft; periscope; short neck; technique
Branched and fenestrated stentgrafts have been developed to deal with aneurysms extending to or involving aortic main branches. Unfortunately, these devices have to be customized to the patient’s specific anatomy, which is a time consuming procedure. For ruptured or urgent aneurysm treatment, so called “chimney” grafts have been successfully used to treat thoracic or abdominal aortic aneurysms with short proximal necks. We have developed a technique similar to the chimney technique, but where the graft is reversed and blood flow to the branched artery is retrograde; hence the term the “periscope” graft an analogy to an optical periscope. We report here about our initial experience in two patients presenting with contained thoracoabdominal aneurysm rupture that were successfully treated with such periscope grafts.

**THE PERISCOPE TECHNIQUE**

A percutaneous 8F-Arrow sheath (Arrow International Inc., Reading, PA, USA) is inserted and a 5F-Chuang visceral reverse curve catheter (Cook, Inc., Bloomington, IN, USA) is used to cannulate the target artery or arteries in a retrograde fashion. Over a Rosen wire (Cook, Inc., Bloomington, IN, USA), the bare and/or covered stent is inserted into the target artery. In a parallel fashion, the same procedure is carried out for any other target artery. All bare and/or covered stents remain non-deployed (figure 1A). The (contralateral) arterial access and the common EVAR procedure have been recently described elsewhere. Once the aneurysm exclusion is completed (figure 1B), the stents or stentgrafts to the aortic branch(es) are deployed, so that they are positioned between the stent graft and aortic wall and running caudally and beyond the distal end of the aortic stentgraft (figure 1C). If the length of branch stents or stentgrafts is insufficient, additional stents are used. Finally, the periscope stents or stentgrafts as well as the aortic stentgraft are fully expanded with balloon catheters inflated simultaneously as in the kissing balloon technique.
Patient Experience: To date, two patients have been treated using this periscope technique to resolve a problem with an insufficient distal landing zone due to a short distal neck.

In the first patient, a 58 year old man, thoracoabdominal CT angiography (CTA) revealed an acute ruptured syphilitic thoracoabdominal aneurysm (TAAA) Crawford type III with a maximal diameter of 18.5 cm (figure 2A). The celiac trunk, superior mesenteric artery (SMA), and left renal artery (RA) were occluded. The right pelvic kidney was regularly perfused through an aberrant right RA. The only arterial supply for all abdominal organs was an elongated inferior mesenteric artery (IMA) with mid-grade stenosis at the origin. Since the patient was hemodynamically unstable, the procedure was performed under local anaesthesia with analgosedation. The IMA remained patent after deployment of one Viabahn stentgraft (W. L. Gore and Associates Inc., Flagstaff, AZ, USA), and the right RA flow was preserved with a Palmaz Blue® stent (Cordis Endovascular Warren, NJ, USA) and an additional Viabahn stentgraft. Five stentgrafts (4 TAG®, W. L. Gore and Associates Inc., Flagstaff, AZ, USA, 1 E-vita thoracic, Jotec Inc., Hechingen, Germany) were used for main graft aortic exclusion of the TAAA (figure 2B).

In the second patient, a 40 year old, mentally impaired and obese (BMI 32) man, CTA showed an acute rupture of a TAAA Crawford type I with a maximum diameter of 10.4 cm (figure 3A-B). The SMA and RAs were not involved. Extension of the distal landing zone was obtained by a self-expanding Wallstent ® Endoprosthesis (Boston Scientific, Natick, MA) in the celiac trunk and a Viabahn® stentgraft (W.L. Gore and Associates Inc., Flagstaff, AZ, USA) in the SMA. The ruptured TAAA was excluded with two stentgrafts (1 Valiant Thoracic®, Medtronic Vascular, Santa Rosa, CA, USA, and 1 E-vita thoracic, Jotec Inc., Hechingen, Germany). The procedure was performed under local anaesthesia with analgosedation. Two months later, the aneurysm was completely sealed and shrunk from 78.9 mm to 73.4 mm (figure 3C).
DISCUSSION

Different authors have described similar techniques to extend the proximal landing zone. Greenberg first reported a technique to extend the proximal landing zone across the renal arteries with preservation of renal blood flow. He created a longer neck by deploying a self-expanding stent into the renal artery with a longer segment “running parallel to the aortic wall” between the aortic wall and stentgraft. Later, Larzon described “the top fenestrating technique” in a series of 24 patients, where the covered renal arteries, left common carotid artery or the left subclavian artery have been reopened by preplaced stents. Larzon and Hiramoto reported similar techniques of branch stenting to preserve blood flow to the supraaortic trunks. Finally, Malina proposed the term “chimney graft” when covered stent devices were employed in a similar fashion.

Up to now, there is to our knowledge no report of such a technique applied to extend the distal landing zone. We have used our periscope technique in a similar way to those described to extend the proximal landing zone as a way of allowing endovascular treatment to patients with ruptured TAAAs having inadequate distal landing zones. This has enabled us to treat highly unstable patients in whom open surgery was not expected to be successful.

The main difference of such branch stent and/or stentgrafts used in the distal neck position is that blood flow to the branched artery is retrograde. Our limited experience, with the periscope technique is so far promising, as it allowed maintenance of blood flow to the branched vessels, without interfering with aneurysm sealing.

There are of course some issues with the periscope technique. Which kind of stent or stent-graft should be used? We believe that covered stents are superior to bare stents, as bare stents do allow blood flow through the struts and therefore may be more prone to produce type Ib endoleaks, as we have experienced. Regarding covered stents, we prefer Viabahn stentgrafts
as they are highly flexible and available in different sizes and lengths. Another issue is that of aneurysm sealing. In our limited experience, sealing was not achieved immediately after aortic stentgraft deployment, but required several days. There are several possible explanations for this. Firstly, the space in-between the branch grafts and aortic stent graft does not occlude immediately, allowing some residual blood flow (i.e. type Ib endoleak) inside the aneurysm. This was confirmed with on-table angiography. Secondly, coagulation in patients presenting with aortic rupture is often profoundly altered, delaying in-sac thrombosis. Finally, infolding of the aortic stentgraft induced by the branch grafts might occur. Nevertheless, in our two cases our damage control periscope procedure stopped blood loss outside the aorta. Moreover, CT scan revealed complete sac thrombosis within a few days and aneurysm shrinkage two months later. Another issue is that the grafts within the branches could compress the aortic stentgraft or that the aortic stentgraft could compress the grafts to the target branches. This could result in a blood flow reduction to the branches and/or the distal extremities. We experienced such a situation in our first patient. Since the pressure gradient from the narrowed distal part of the aortic stentgraft graft was not significant, we accepted it. However, we recommend consideration of performing additional stenting in the branch grafts and of performing an axillofemoral bypass to increase blood flow to the branches and lower extremities. We also recommend performing selective pressure measurements in the distal aortic and branch lumens to exclude important flow restriction.

CONCLUSION

Our experience in two patients with ruptured thoracoabdominal aortic aneurysms extending to or involving the renal and visceral arteries showed that the periscope technique was successful and effective in extending the distal aortic landing zone while maintaining blood flow to the aortic branches. Moreover, complete aneurysm exclusion and shrinking was achieved in both cases. This technique can be performed with devices in stock in most institutions doing
EVAR and could be useful in the treatment of some patients with thoracoabdominal aneurysm rupture particularly when open surgery is deemed to be of high risk.
Reference List


Figures

Figure 1. The periscope technique. 1A, the stentgrafts to the target aortic branches and the aortic endograft are positioned but still not deployed. 1B, the aortic endograft is deployed first. 1C, all stentgrafts are deployed and balloon dilated, allowing retrograde flow to the target arteries (red arrows); the branch stentgrafts run coaxially between the aortic endograft and the aortic wall (small picture).

Figure 2. 2A, ruptured thoracoabdominal aortic aneurysm (case 1, sagital view). the inferior mesenteric artery (IMA) was responsible for the perfusion of all visceral organs. The right aberrant renal artery (RRA) supplied the single right pelvic kidney. 2B, postoperative 2D reconstruction after complete endovascular exclusion of the ruptured TAAA. The two periscope grafts to the right pelvic kidney (arrowhead) and inferior mesenteric artery (arrow) are patent.

Figure 3. 3A, ruptured thoracoabdominal aortic aneurysm (case 2, 3D reconstruction). 3B, rupture site, maximal aortic diameter 78.9 mm. 3C, two months after the emergent repair, the aneurysm is completely excluded and the maximal aortic diameter diminished to 73.4 mm.
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