

False lumen occlusion in chronic type B aortic dissection using the candy-plug technique

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Abstract:

Endovascular repair has become the treatment of choice for type B aortic dissections (mainly acute, and in specific indication in chronic too). However, the persistent false lumen patency represents the Achilles heel of this method. Herein we describe the successful use of the candy-plug technique in a patient with residual chronic type B aortic dissection after thoracic endovascular repair and a false lumen aneurysm of an increasing diameter due to persistent false lumen backflow. A custom-made candy-plug device was used to seal the false lumen. Computed tomography angiography one month after the procedure revealed complete thrombosis of the false lumen.

INTRODUCTION

According to the latest European Society for Vascular Surgery (ESVS) guidelines on the management of descending thoracic aorta diseases, in patients with chronic aortic dissection, an aortic diameter greater than 60 mm should be considered as an indication for treatment in patients at reasonable surgical risk (Class IIa, Level of evidence C).¹ Endovascular repair should be considered in such patients, provided that the anatomy is suitable for endografting and that the centre is dedicated (Class IIa, Level of evidence C).¹ The efficacy of the procedure is determined by the ability of the endograft to induce false lumen thrombosis, with persistent false lumen patency representing the Achilles heel of the method. Patency of the false lumen despite endovascular repair has been unequivocally recognized as a predictor of both false lumen expansion as well as expansion of the visceral segment of the aorta during follow-up.^{2,3}

Recently, several techniques have been introduced for the induction of complete false lumen thrombosis after thoracic endovascular aneurysm repair (TEVAR) including the Candy-plug, the Knickerbocker, vascular and iliac plugs, coils and liquid embolization.^{4,5} Herein we describe the successful use of the candy-plug technique in a patient with residual chronic aortic dissection after TEVAR and thoracic false lumen aneurysm of an increasing diameter due to false lumen backflow.

CASE REPORT

A 55-year-old male with history of a chronic type B aortic dissection presented to the outpatient clinic of our Department. The dissection had occurred 8 years before and was being treated conservatively. A few days before his appointment, the patient had been submitted to a computed tomography angiography (CTA) which verified the presence of the type B aortic dissection with the entry tear located 7.5 cm below the left subclavian artery (Figure 1A). All splanchnic branches of the aorta originated from the true lumen as well as both internal iliac arteries. The true lumen was completely compressed in both external iliac arteries and both legs were supplied from the false lumen. The diameter of the descending thoracic aorta (DTA) at the widest point was 75 mm, the diameter of the abdominal aorta 3 cm, the right common iliac artery (CIA) 5 cm, the left CIA 4.4 cm and the left external iliac artery 4 cm (Figures 1A and B).

The patient had history of hypertension, dyslipidemia, hypothyroidism and benign prostatic hyperplasia. He did not report any thoracic or abdominal pain over the past 8 years.

A staged therapeutic approach with TEVAR followed by open repair of the iliac aneurysms was hindered by the chronic, complete occlusion of the true lumen at the level of both external iliac arteries, so a reverse staged procedure was planned. The patient was submitted to open surgical reconstruction of the infrarenal aorta and two iliac arteries with an aorto-bi-iliac Dacron graft with an end-to-end proximal anastomosis below the renal arteries and two end-to-end distal anastomoses at the internal iliac arteries. Two jump-grafts were then placed between the limbs of the bifurcated graft and the common femoral arteries. Two months later, the patient underwent endovascular repair of the dissecting aneurysm of the thoracic aorta with the implantation of a 20 cm in length and 34 mm in diameter Bolton RelayNBS Plus endograft (Bolton Medical, FL, USA).

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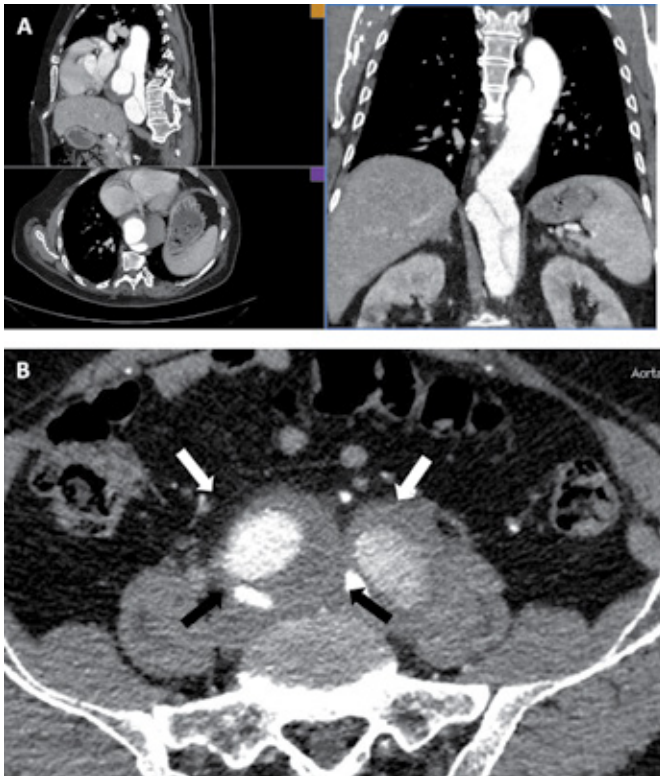


Figure 1. (A) CTA showing a type B aortic dissection with the entry tear located 7.5 cm below the left subclavian artery. The diameter of the descending thoracic aorta at the widest point was 75 mm. (B) at the level of the common iliac arteries there were two narrow true lumens supplying the internal iliac arteries (black arrows) and two dilated false lumens supplying the external iliac arteries (white arrows). The diameter of the right CIA was 5 cm and of the left 4.4 cm.

One month after this procedure, a CTA revealed thrombosis of the thoracic aneurysm but with some retrograde flow in the false lumen next to the last stent of the endograft (Figure 2).

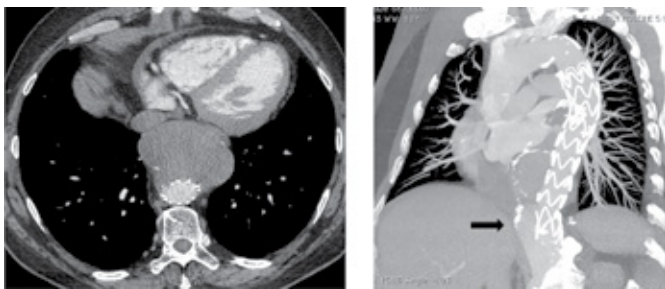


Figure 2. Post-TEVAR CTA showing thrombosis of the thoracic aneurysm but with some retrograde flow in the false lumen next to the last stent of the endograft (arrow).

Follow-up CTA 1 year later revealed a type Ib endoleak within the aneurysm, the diameter of which had gone up to 9.7 cm (Figure 3). The diameter of the false lumen at the level of the supraceliac aorta was 3.8 x 2 cm. Occlusion of the false lumen with the candy-plug technique was decided. A custom-made, double-tapered endograft (candy-plug) with a 42 mm proximal and distal diameter, a 16 mm diameter at the narrow part and a 105 mm length was prepared by Bolton Medical, FL, USA. The procedure was performed in the

operating room with the use of a Philips BV Endura mobile C-arm. Under general anesthesia, the jump-grafts from the aorto-bi-iliac graft limbs to the femoral arteries were exposed just above the femoral anastomoses. The false lumen was cannulated through the right ilio-femoral jump-graft and the true lumen through the left ilio-femoral jump-graft (Figure 4A). The celiac artery was catheterized with a Cobra catheter and the level of its orifice was marked on the screen of the C-arm (Figure 4B). A 36 x 100 mm Bolton RelayNBS Plus endograft was implanted in the true lumen from within the previous endograft down to the orifice of the celiac artery and the candy-plug was implanted in the false lumen at the same level. A 22-mm Amplatzer Vascular Plug II (St. Jude Medical, St. Paul, MN, USA) was then deployed in the waist of the candy-plug (Figure 4C and D). Completion angiography showed absence of retrograde flow to the false lumen and unrestricted patency of the celiac trunk (Figure 4E).

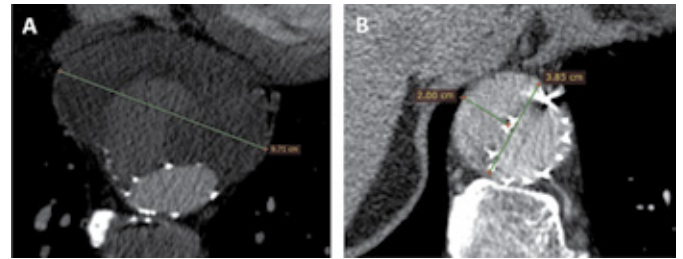


Figure 3. (A) CTA 1 year post-TEVAR revealing a type 1b endoleak and a thoracic aneurysm of 9.7 cm in diameter. (B) The diameter of the false lumen at the level of the supraceliac aorta was 3.8 x 2 cm.

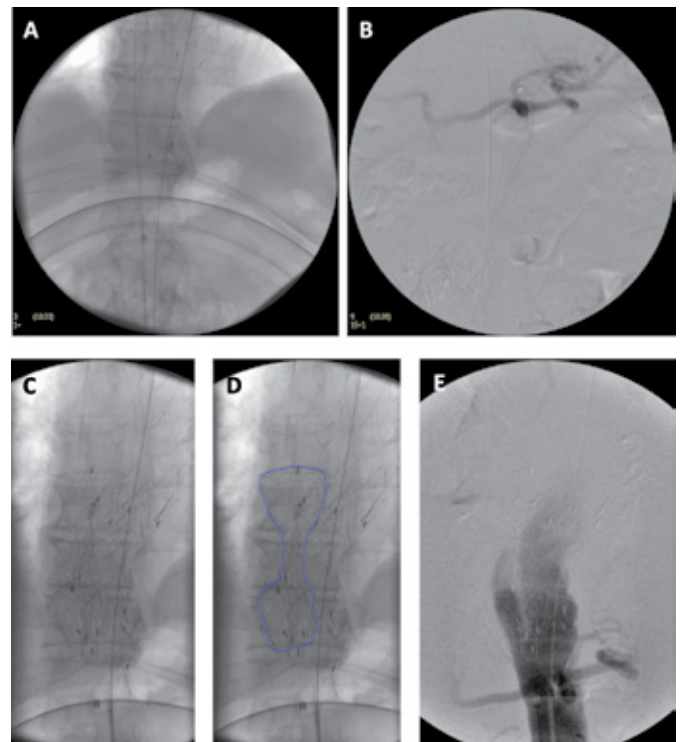


Figure 4. (A) Cannulation of the false and the true lumen and (B) catheterization of the celiac artery. (C, D) Implantation of a standard thoracic endograft in the true lumen and a candy-plug in the false lumen above the level of the celiac trunk. (E) Completion angiography showing absence of retrograde flow to the false lumen.

The patient was discharged on the fifth postoperative day. CTA at 1 month showed no endoleaks and complete thrombosis of the false lumen and the dissecting thoracic aneurysm above the candy-plug device (Figure 5).

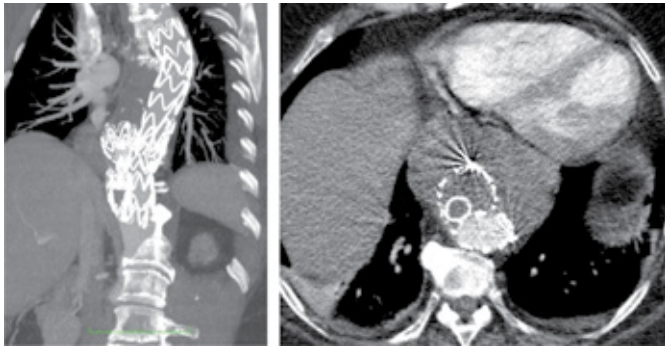


Figure 5. CTA 1 month post-TEVAR showing no endoleaks and complete thrombosis of the dissecting thoracic aneurysm above the candy-plug device.

DISCUSSION

The candy-plug technique was described for the first time in 2013 by Kölbel et al who modified a 42 mm Cook Zenith TX2 thoracic endograft (Cook Medical, Bloomington, IN, USA) to a large diameter vascular plug by partial unloading the stent-graft and adding a diameter-reducing suture between the third and fourth Gianturco Z-stents to restrict the opening of the stent-graft at this point to about 10 mm.⁶ The customized stent-graft was implanted in the false lumen of a chronic type B aortic dissection and its waist was occluded with an Amplatzer vascular plug. Completion angiography as well as CTA at 1 week and 3 months verified the complete thrombosis of the false lumen. Ogawa et al described the applicability of the candy-plug technique to another type of stent-graft, the Ex-

cluder aortic extender (W.L. Gore & Associates, Flagstaff, AZ, USA), which offers the advantage of an easier modification since it does not have to be unloaded from a delivery sheath.⁷

Another interesting modification of the candy-plug technique was described by Marone et al, who used two commercially available stent grafts released side by side in the false lumen: a 32 to 12 mm converter aortouniliac stent-graft and a 13 to 24 mm bell bottom iliac extender stent-graft in order to obtain an adequate oversizing sufficient to allow false lumen occlusion.⁸ Both stent-grafts were occluded using two Zenith and two Amplatzer vascular plugs.

Nowadays, the candy-plug endograft is available as a custom-made device with a maximum diameter of 50 mm and a mid-section of 16 or 18 mm, whereas the latest development has been the production of a candy-plug endograft, the central portion of which closes itself as soon as the dilator tip is removed.⁹ This new design obviates the additional placement of a plug to occlude the mid-section of the endograft.

Rohlffs et al have published a series of 18 consecutive patients in whom the Candy-Plug technique was applied.¹⁰ Technical success was 100%. Complete distal false lumen occlusion was present on postoperative CTA in 15 patients, while 3 had minor contrast enhancement in the distal false lumen. Over a mean 9-month follow-up, 1 patient died due to rupture. Follow-up >6 months was available in 10 patients: 7 patients showed aortic remodeling, while aneurysm size was stable in 3 patients.

A subsequent study by the same group reported on a consecutive series of 14 patients who were treated with the self-sealing Candy-Plug generation II (CP II) device (Cook Medical, Bloomington, IN, USA).¹¹ Immediate complete false lumen occlusion was achieved in 12 patients; the other 2 required reintervention. One patient died due to retrograde type A aortic dissection that was not related to CP II placement. Over a mean 8-month follow-up (range 3-12), 9 patients had CTA; 8 patients had evidence of aortic remodeling, while 1 aneurysm sac was stable.

| Author | Year | No of patients | Candy-Plug Device | Vascular Plug | Follow-up |
|------------------------|------|----------------|---|---------------------------------------|--|
| Kolbel ⁶ | 2013 | 1 | Cook Zenith TX2 | Amplatzer | 3 months: complete thrombosis of the false lumen |
| Ogawa ⁷ | 2016 | 1 | Gore Excluder | Amplatzer | 14 months: decreased maximum diameter, greater expansion of the true lumen, and volume reduction of the thrombosed false lumen |
| Marone ⁸ | 2017 | 1 | Cook Zenith converter + bell-bottom iliac extension | Cook Zenith vascular plug + Amplatzer | 18 days: complete thrombosis of the false lumen |
| Kotani ¹² | 2017 | 1 | Gore Excluder | Amplatzer | 1 year: complete thrombosis of the false lumen |
| Rohlffs ¹⁰ | 2017 | 18 | Cook Zenith TX2 | Amplatzer | Mean follow-up of 14.7 months: 1 patient died due to rupture, 7 patients showed aortic remodeling, while aneurysm size was stable in 3 patients. |
| Branzan ¹³ | 2018 | 1 | Medtronic Valiant Captivia | Fractured tip of the delivery system | 6 months: complete thrombosis of the false lumen and shrinkage of the aneurysm |
| | | 2 | Cook Candy-Plug II | - | |
| Lin ¹⁴ | 2018 | 1 | Gore Excluder | Amplatzer | Postoperative CTA: complete thrombosis of the false lumen |
| Wu ¹⁵ | 2018 | 1 | Medtronic Valiant Captivia | Amplatzer | 6 months: complete thrombosis of the false lumen |
| Furukawa ¹⁶ | 2018 | 1 | Cook Zenith TX2 | Amplatzer | 1 year: complete thrombosis of the false lumen |
| Yap ¹⁷ | 2019 | 1 | Zenith Alpha | Amplatzer | 2.5 years: no endoleak, the thrombosed false lumen in the thoracic aorta was reduced in size |
| Morisaki ¹⁸ | 2019 | 1 | Gore Excluder | Amplatzer | 3 months: shrinkage of the thrombosed false lumen |
| Hasegawa ¹⁹ | 2019 | 1 | Cook Zenith TX2 | Coils | 1 month: complete thrombosis of the false lumen |
| Eleshra ¹¹ | 2019 | 14 | Cook Candy-Plug II | - | Mean follow-up of 8 months: 9 patients had CTA; 8 patients had evidence of aortic remodeling, while 1 aneurysm sac was stable. |

Table. Summary of studies reporting on the use of the Candy-Plug technique

A literature search reveals that until the 6th of October 2019 there had been 45 reported cases of the application of the Candy-Plug technique to achieve false lumen thrombosis (Table). Our report adds another case of a successful treatment of a residual chronic type B aortic dissection after TEVAR using the candy-plug technique. Implantation of the candy-plug was uneventful and short-term outcome was excellent, though long-term results are still awaited.

In conclusion, the candy-plug technique appears to be a safe and effective endovascular method to achieve thoracic false lumen occlusion in chronic aortic dissection. However, long-term results are needed before a robust conclusion is reached.

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