Balloon guidance for superior mesenteric artery scallop alignment during Cook Zenith Fenestrated AAA Endovascular Graft deployment

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ABSTRACT
To achieve seal, aortic endografts may require coverage of the aorta adjacent to or involving critical branch vessels. One technique for maintaining branch vessel patency at the leading edge of an endograft is use of a scallop. However, it may be difficult to ensure proper scallop alignment both before and after endograft deployment. We describe a technique for improving superior mesenteric artery scallop alignment of the Cook Zenith Fenestrated AAA Endovascular Graft (Cook Medical, Bloomington, Ind) using scallop precannulation and ostial superior mesenteric artery balloon inflation during both diameter expansion and top cap release. (J Vasc Surg Cases and Innovative Techniques 2020;6:405-8.)

Keywords: Aortic aneurysm, abdominal; Superior mesenteric artery; Fenestrated endograft; Mesenteric ischemia; Angioplasty

Superior mesenteric artery (SMA) scallop misalignment is a potential complication of Cook Zenith Fenestrated AAA Endovascular Graft (ZFEN; Cook Medical, Bloomington, Ind) deployment, with potentially devastating consequences if it is unrecognized. Proper alignment can be difficult to ascertain before graft deployment as the scallop is partially constrained by the device's top cap, and primary focus is placed on the renal fenestrations. Even after deployment, partial misalignment can be difficult to identify. We describe a technique to potentially improve alignment of the ZFEN's SMA scallop with the SMA ostium and to decrease likelihood of need for SMA stenting. In this technique, the scallop and SMA are cannulated after device unsheathing. A balloon is inflated across the scallop and vessel ostium during both diameter expansion and top cap advancement.

Consent for publication was obtained from the patients.

CASE REPORTS
Case 1. An 88-year-old man with a 7.0-cm juxtarenal abdominal aortic aneurysm presented for elective treatment. Anatomy was notable for left renal artery stenosis and right renal artery occlusion. He underwent left renal artery stenting, followed 2 months later by implantation of a Cook ZFEN graft (proximal piece: ZFEN-P-2-32-124-R) with a 10-×12-mm-deep SMA scallop and a single left renal fenestration. Contralateral 14F groin access was established. After endograft unsheathing, the left renal fenestration and prestenosed artery were wired. Next, the SMA scallop and SMA were wired with a Rosen wire (Fig 1, A). A 6F barebacked 8-mm×2-cm noncompliant angioplasty balloon was positioned across the scallop and SMA ostium. Over the left renal wire, a 6.5F deflectable sheath and balloon-expandable stent graft were positioned. The SMA balloon was inflated to facilitate proper scallop orientation (Fig 1, B). Diameter reduction was released and the top cap was advanced, releasing the uncovered struts. The SMA balloon was deflated and removed. The procedure was completed according to the Cook ZFEN instructions for use (IFU).

Case 2. A 78-year-old man with a 5.9-cm juxtarenal abdominal aortic aneurysm presented for elective endovascular treatment with a Cook ZFEN graft (proximal piece: ZFEN-P-2-32-124-R) with a 10-×12-mm-deep SMA scallop and bilateral renal fenestrations. Contralateral 18F groin access was established. After endograft unsheathing, each renal artery was wired through respective fenestrations (Fig 2, A). A 6.5F, 55-cm-long defectable sheath was used to cannulate the SMA scallop and SMA. An 8-mm×4-cm-long shaft noncompliant angioplasty balloon was positioned over a Rosen wire across the scallop and SMA ostium (Fig 2, B); 7F sheaths and balloon-expandable stent grafts were advanced into each renal artery. Given access constraints, the SMA sheath was withdrawn over the balloon shaft to permit insertion of the second renal sheath. The SMA balloon was inflated to facilitate proper scallop orientation. Diameter reduction was released and the top cap was advanced, releasing the uncovered struts. The SMA balloon was deflated and removed. The procedure was completed according to the Cook ZFEN IFU. Imaging at 1 month demonstrated excellent alignment of scallop with SMA (Fig 3).
DISCUSSION

Proper alignment of the Cook ZFEN’s scallop or large fenestration to the SMA ostium is difficult to confirm intraoperatively. Lateral angiography optimally visualizes the SMA origin but cannot ensure that device rotation is optimal. Anteroposterior angiography provides the best view of the scallop or fenestration but conversely provides suboptimal visualization of the SMA origin. Scallop positioning is further hindered because of partial constraint by the top cap, adding an element of unpredictable expansion on top cap advancement. After deployment, partial ostial encroachment can be difficult to identify angiographically as contrast material may still fill the SMA lumen. Similarly, intravascular ultrasound may be inadequate to characterize the fabric edge’s relationship to the vessel ostium.

Scallops on the U.S.-available ZFEN platform are only 10 mm wide, and this width may be reduced in vivo if complete graft expansion is constrained by the aortic neck. Researchers have noted a significant risk of ZFEN scallop misalignment, including one study that found some degree of shuttering in 50% of unstented SMA scallops. In response, some have recommended either selective or routine SMA stenting. At the Cleveland Clinic, 26 of 213 SMA scallops were stented. Whereas those without stents experienced no increased risk of SMA occlusion, those with stents had a higher rate of reintervention, suggesting that SMA stenting in this setting is not risk free.

We theorize that a balloon sized to the SMA lumen, inflated across the scallop, helps actively refine graft rotation and then acts as a space-occupying strut around which the scallop expands during diameter expansion and top cap release. Because scallops are usually in the appropriate vicinity, the balloon acts in a refining capacity; if the inflated balloon appears kinked or torqued between the scallop and SMA ostium, rotational graft adjustments may be necessary. Once the graft’s uncovered struts have been deployed, scallop positioning is fixed, and the balloon is removed, followed by top cap recapture. In our experience, the sequence of events from release of diameter reduction to advancement of the top cap proceeds rapidly, with balloon inflation lasting no longer than 30 seconds.

Fig 1. A, Before release of diameter reduction. The left renal fenestration and prestented artery have been wired. The superior mesenteric artery (SMA) scallop and SMA have been cannulated with a deflectable sheath and soft catheter. B, A barebacked 8-mm × 2-cm noncompliant angioplasty balloon is inflated over a Rosen wire across the SMA scallop and SMA ostium during release of diameter reduction and top cap advancement. A biliary stent is also visible.
This technique is technically straightforward and unlikely to have a significant impact on operative time, fluoroscopy dose, contrast material use, or procedural cost. The risk of transient SMA balloon inflation is unclear and likely to be patient specific, affected by factors such as ostial diameter, calcification, and intimal fragility. The potential for benefit must be weighed against risk of SMA rupture, dissection, or distal embolization. In cases in which elevated concern is present, a slightly undersized balloon may be a safer choice while still helping decrease the chances of clinically significant scallop shuttering.

This technique may necessitate larger diameter access. Variations exist in ZFEN implantation techniques, with contralateral sheaths often ranging from 12F to 18F, depending on the type of renal access established before graft release. The addition of a barebacked 6F balloon increases required access diameter accordingly and must be factored into preoperative planning. Alternatively, long-shaft balloons or balloon-expandable stents delivered through relatively short (55-70 cm) sheaths create the ability for sheaths to be withdrawn over the balloon shafts, increasing functional space; with use of such techniques, required access diameter may be further minimized.
This technique cannot guarantee proper alignment and may fail if scallop misalignment is severe enough to introduce significant torque in the endograft between the levels of the SMA balloon and the renal sheaths. Correspondingly, use of this technique should not reduce the surgeon’s attentiveness, intraoperatively or postoperatively, to the lingering possibility of SMA scallop misalignment, and any subsequent symptoms of mesenteric ischemia should prompt interrogation and intervention. Despite these caveats, our anecdotal experience has been good; in six patients treated accordingly, none have required SMA stenting or demonstrated SMA malperfusion, and no renal branches have failed or required reintervention.

This technique is outside the IFU of the Cook ZFEN device and is not endorsed by Cook Medical, the graft manufacturer.

CONCLUSIONS

We describe a technique of balloon inflation across the SMA scallop and SMA ostium during critical steps of Cook Zenith fenestrated (ZFEN) endograft deployment, aimed at improving scallop alignment. Although the technique is not proven to be effective, the risk to benefit ratio of this additional step may be favorable if it can decrease likelihood of need for SMA stenting. More experience will be required to document efficacy.

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