

Fenestrated aortic endograft branching with Gore VBX poses failure risk from delayed-onset branch kinking

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ABSTRACT

The Gore VBX stent graft (Gore Medical, Flagstaff, Ariz) provides a new option for branching of fenestrated aortic endografts. However, its modular stent structure has raised concerns about potential kinking at the interspace between stent rings if lateralizing force exists between the fenestration and target vessel orifice. We present a case of near-occlusion of a VBX celiac branch due to narrowing of this interspace identified at postoperative month 3. Although the Gore VBX offers several potential advantages as a branch endoprosthesis, its design poses the risk of unpredictable, delayed-onset kinking and raises concern for its use as a fenestrated endograft branch. (*J Vasc Surg Cases and Innovative Techniques* 2019;5:18-21.)

Keywords: Fenestrated endograft; Stent; Branch

Fenestrated endovascular aortic repair permits exclusion of perivisceral aneurysms while maintaining perfusion to critical end organs by aligning fenestrations with visceral vasculature. Whereas fenestrations in select cases may be left unstented, branching of fenestrations with stent grafts into target vessels provides more reliable seal and helps maintain fenestrated endograft orientation. Introduction of the Gore VBX balloon-expandable stent graft (Gore Medical, Flagstaff, Ariz) has created a new option for use as a branch endoprosthesis. Several features of the VBX system are attractive, including a polytetrafluoroethylene coating to improve device deliverability and to prevent inadvertent stent graft dislodgment from the balloon mount; an expansive size matrix including short, large-diameter stents useful for select branching applications (eg, short celiac arteries, superior mesenteric arteries with early origins of replaced hepatic arteries, large renal arteries with early branching); and the ability to overdilate larger sizes to 16 mm without risk of fabric rupture. However, the modular nature of the VBX's stent structure has raised concerns about development of kinking between stent rings in response to persistent point application of a lateral force, like an

endograft fenestration may apply to a branch stent if it is imperfectly aligned with the target vessel. We present a case of near-occlusion of a VBX celiac branch due to delayed-onset kinking between stent rings identified at postoperative month 3. No kinking was present at time of fenestrated endograft implantation or at postoperative month 1. The patient provided written consent for the publication of this case report.

CASE REPORT

A 69-year-old man with an asymptomatic 6.5-cm extent IV thoracoabdominal aneurysm underwent staged hybrid repair involving three procedures during 5 months. Operative interventions included a left iliac endoconduit, right iliofemoral bypass graft, and four-fenestration branched endografting across the visceral plate using a physician-modified Cook TX2 device (Cook Medical, Bloomington, Ind), Atrium iCast stents (Atrium Medical, Merrimack, NH) were used to branch the superior mesenteric and bilateral renal arteries. The celiac artery measured 9 mm at its orifice and 7 mm distally. An 8- × 8-mm celiac fenestration was made in the endograft. Because of the short length and wide caliber of the celiac artery, celiac branching was performed using a Gore VBX 8- × 29-mm stent, flared proximally to 10 mm. Intraoperative imaging and computed tomography at postoperative day 1 and postoperative month 1 demonstrated no sign of branch problems (Fig 1, A and B). However, computed tomography imaging at postoperative month 3 demonstrated a dramatic change in celiac branch configuration, with near-occlusion between stent rings at the transition point between the fenestration and the celiac artery orifice (Fig 1, C). Centerline three-dimensional reconstruction was performed to identify craniocaudal migration, and measurements from the top of the endograft to the celiac orifice were minimally changed from postoperative day 1 (46.7 mm) to postoperative month 3 (47.1 mm). Similarly, measurements from the iliac bifurcation to the bottom of the right iliac limb were not significantly different (postoperative day 1, 99.1 mm; postoperative month 3, 101 mm). Mesenteric duplex ultrasound demonstrated elevated velocities

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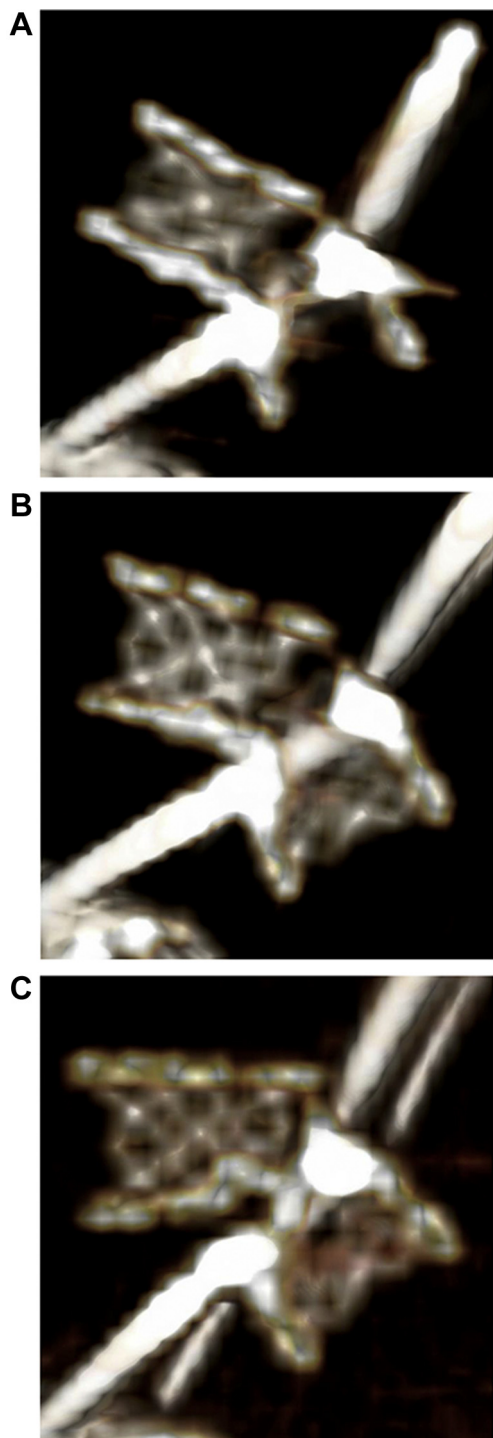


Fig 1. Three-dimensional reconstruction of the celiac fenestration and Gore VBX branch at postoperative day 1 (A), postoperative month 1 (B), and postoperative month 3 (C) with near-occlusion from kinking between stent rings.

within the celiac stent (peak systolic velocity, 278 cm/s; end-diastolic velocity, 87cm/s), consistent with high-grade stenosis.

To prevent subsequent occlusion of the stent, the patient was scheduled for prompt endovascular branch repair. Intraoperative imaging confirmed severe kinking of the celiac stent branch

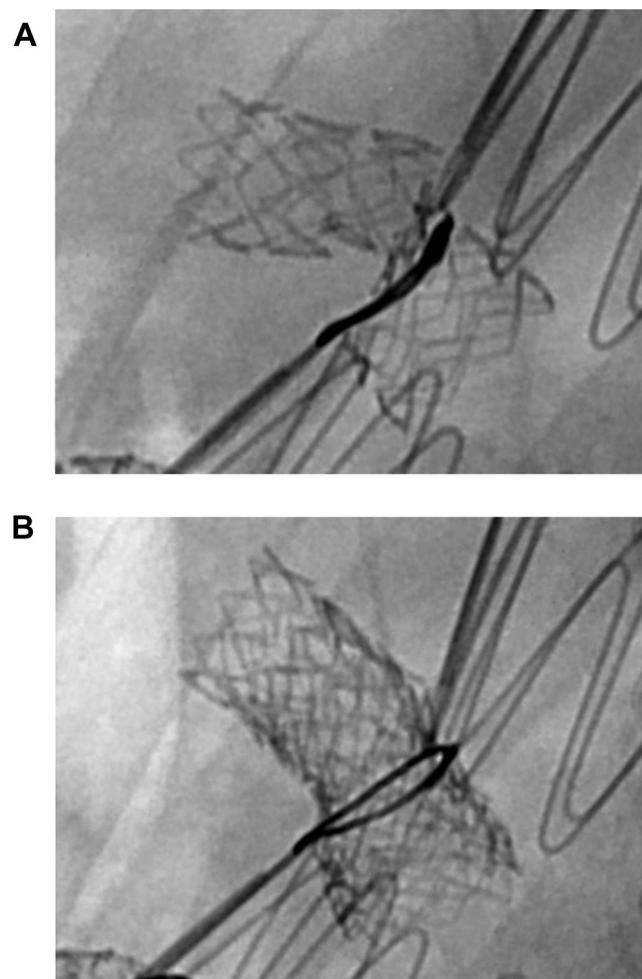


Fig 2. Intraoperative images of the celiac fenestration and Gore VBX branch before (A) and after (B) relining with two Atrium iCast stents.

at the interspace between two fully expanded stent rings (Fig 2, A). After wire access was established across the stenosis, the branch was relined using two Atrium iCast 7- × 22-mm stents, overdilated to 8 mm and flared proximally to 10 mm (Fig 2, B). Completion angiography and intravascular ultrasound confirmed wide branch patency without dissection of the arterial outflow. The patient tolerated the procedure well and was discharged home in <24 hours.

DISCUSSION

The Gore VBX stent is a balloon-expandable covered stent that offers a number of potential advantages over other stent grafts for use as a fenestrated endograft branch device, including an attractive size matrix, superior deliverability, and safe overdilation. A principal feature of its design, adding to deliverability and conformability, is the modular nature of its stent structure with areas of unreinforced graft material in the interspaces between stainless steel rings. To date, no clinical data either to support or to refute use of the Gore VBX as a fenestrated endograft branch device have been

published. However, theoretical concerns exist for the potential of kinking at the interface between fenestration and target vessel orifice, where imperfect alignment may contribute to chronic application of lateral force on the branch. This case demonstrates *in vivo* realization of this hypothetical risk.

At our center since 2012, we have performed 61 physician-modified endografts for treatment of thoracoabdominal aneurysmal disease; the majority of these (45 [74%]) have been four-vessel fenestrated grafts, with a total of 212 implanted branches. Of these, 206 (97%) branches have used Atrium iCasts, whereas 6 (3%) branches, all implanted within the past year, have used Gore VBX. In this case, a VBX was selected for celiac branching because of the native vessel's wide caliber and short length to bifurcation. Although the branch appeared unremarkable at time of operation and at postoperative month 1, chronic downward force from minor fenestration misalignment, either from time of implantation or subsequently arising from aortic endograft migration, likely resulted in a dramatic shift in VBX configuration by postoperative month 3. Kinking occurred in the interspace between stent rings, with stent rings on either side of the stenosis remaining fully expanded. Given this mode of stent graft behavior, we recommend caution with the use of the Gore VBX as a fenestrated aortic endograft branch until further preclinical data supporting its safety for this application become available.

In selecting branch devices, appropriate sizing to both diameter and length of the target vessel is critical to establish durable seal while also ensuring patency of crucial outflow branches. Long-standing stent graft technology, notably the Atrium iCast stent graft, has provided a satisfactory and durable solution to most fenestrated endograft branch needs. It is a balloon-expandable covered stent with an open-cell design. Unlike the VBX, its stainless steel struts are interconnected to prevent prolapse through the expanded stent. However, in certain cases, the matrix of available size and length combinations is suboptimal. Specifically, the absence of large-diameter, short-length stents may make it challenging to establish seal in wide and short celiac arteries, superior mesenteric arteries giving rise to replaced hepatic arteries, and large renal arteries with early branching into segmental arteries. Future development of stent graft technology should take these procedural needs into consideration.

Published rates of reintervention after fenestrated endovascular aneurysm repair range from 12.7% to 22%,¹⁻³ and the majority are performed to maintain or to re-establish branch patency.⁴ Branch patency is overall excellent, with primary patency of 96.6% to 98.2%^{1,3} and 5-year primary assisted patency of 95.8%.¹ Reinterventions are typically prompted by routine surveillance imaging findings and not by the patient's symptoms⁴; such was the case here. Uncovered stent branches exhibit higher rates

of problems than covered stent branches, mostly from in-stent stenosis⁵; however, no particular stent graft has been shown to be more effective or durable as a branch device than others. The failure modes of branches include stent kinking, stent fracture, device migration, material fatigue, thrombosis, and neointimal hyperplasia.^{6,7} A retrospective study of fenestrated aortic endografts reported that 34% of grafts experienced either proximal or distal migration, but there was no significant association between graft migration and kinking or component fractures.⁸ Thus, the type of kinking in this case is unique to grafts with a modular stent structure because of the unreinforced fabric interspace. Whereas the overall incidence of branch problems is low, the potential consequence of end-organ dysfunction may be devastating. This case, in which a branch problem developed between postoperative months 1 and 3, further highlights the importance of close surveillance of fenestrated branched endografts in the immediate and intermediate time periods after device implantation.

CONCLUSIONS

We present a clinical case in which use of the Gore VBX as a celiac branch for a fenestrated endograft led to subsequent near-occlusion. Development of late branch kinking was not predictable from early postoperative imaging. Furthermore, the modality of kinking, at a point of unstented fabric, is unique to this device and its modular stent structure. Although the VBX offers several potential advantages over other available stents for use as a branch endoprosthesis, the risk of unpredictable, delayed-onset kinking between stent rings should be a consideration when it is used in this application.

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