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CASE REPORT

Inferior Mesenteric Artery Side Branch for Selected Patients with Endovascular Aortic Aneurysm Repair

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Objective/Background: To report on our experience of the treatment of aortic aneurysms by custom-made, branched stent-grafts with an additional inferior mesenteric artery (IMA) side branch to preserve IMA perfusion in patients at risk for colon ischemia.

Methods: Three male patients (mean age 60 years) with a thoracoabdominal, pararenal, and infrarenal aortic aneurysm (AA), respectively, were treated by endovascular aneurysm exclusion using custom-made, branched stent-grafts with a side branch to the IMA for prevention of colon ischemia. Indications for selective IMA side branch perfusion were occlusions or high-grade stenosis of the visceral or hypogastric arteries.

Results: No colon ischemia and no neurological deficit were observed. All three IMA side branches were perfused and patent, as documented by computed tomography scan and duplex ultrasound postoperatively and after 12 months. Patency after 24 months was documented as 2/3.

Conclusion: Custom-made, branched stent-grafts are an endovascular option to preserve the IMA perfusion in selected, electively treated patients with an increased risk for insufficient colon perfusion due to stenosis or occlusions of visceral or hypogastric arteries.

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INTRODUCTION

Colon ischemia is a well-known, major complication of open and endovascular aortic aneurysm repair (EVAR). The incidence is described as 1—6% in elective cases.[1] Revascularization of the inferior mesenteric artery (IMA) is reserved for anatomical disorders such as superior mesenteric artery (SMA) and/or celiac trunk high-grade stenosis/occlusion or iliac/hypogastric artery occlusion. The IMA has an important collateral function for intestinal perfusion in these cases.

Donas et al. recently published the chimney technique as an endovascular tool to preserve IMA perfusion in patients with bilateral hypogastric artery occlusion.[2] In the associated commentary, Rancic stresses the importance of the correct patient selection and discusses the clinical relevance of an IMA revascularization because of the usually very functional collateral system.[3]

In the following case series, we report our experience on preservation of the IMA perfusion with custom-made, branched stent-grafts in selected patient with suspected compromised intestinal perfusion.

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CASE REPORT

At our hospital, an EVAR procedure with an additional custom-made side branch to the IMA (Cook Medical, Europe Ltd., Limerick, Ireland) was performed in three patients with thoracoabdominal, pararenal, and infrarenal aortic aneurysms (AA), respectively. The idea to create an additional side branch to the IMA was initially developed because of a patient with an occlusion of the celiac trunk, a large IMA, and the need for a multibranched stent-graft (Kasprzak PM, personal communication). In all three patients, a 6-mm, downward-directed branch was used with extension to the IMA using 6 mm Fluency Plus stent-grafts (C.R. Bard GmbH, Karlsruhe, Germany), endolined with self-expandable uncovered stent. Diameter of the IMA was at least 4 mm in all patients.

A transfemoral and transaxillary approach was used to have a stabilizing wire from the upper limb to the femoral access. An F12 sheath (45 cm) was applied by the axillary access for catheterism of the IMA gate by a vertebral angiographic catheter. After catheterism, the Fluency Plus stent-graft was delivered via a stiff wire (Rosen Wire Guide [Cook Medical] or Amplatz Super Stiff Guidewire (Boston Scientific, Marlborough, MA, USA)]. Time for completion of the side branch to the IMA was about 20—30 minutes with an additional 15—20 mL contrast. Follow-up was done after 6 and 12 months, and annually thereafter by computed tomography (CT) scan and duplex ultrasound.

The retrospective data evaluation complies with the principles outlined in the Declaration of Helsinki and subjects gave informed consent (ethics committee approval REC number 12-101-0121). Table 1 summarizes patients' characteristics and treatment concepts.

Patient 1 (aged 64 years) had a thoracoabdominal AA of 6.6 cm with an occlusion of the celiac trunk, a high-grade stenosis of the SMA, stenosis of both renal arteries, and a large IMA of 4 mm. Distal aortic diameter was too small for a bifurcated graft (Fig. 1A). To preserve two visceral arteries for intestinal perfusion, procedure was planned as a left-sided, monoiliac, fourfold branched stent-graft with side branches to the SMA, both renal arteries, and the IMA (Fig. 1B). The patient also received a right-sided iliac plug and an iliofemoral left-to-right crossover bypass (Fig. 1B). The patient died 60 months after the procedure (not as a result of an aneurysm-related cause) with open branches to both visceral and renal arteries.

Patient 2 (aged 57 years) had a pararenal AA of 8.5 cm with a high-grade stenosis of the right hypogastric artery, an occlusion of the left iliac and hypogastric artery, and a large IMA of 4.5 mm (Fig. 2A). The procedure was initially planned as a right-sided, monoiliac, fivefold branched stent-graft with branches to the celiac trunk, SMA, renal arteries, the IMA, and a right-sided iliac branch device. Because of the high-grade stenosis of the right hypogastric artery and difficult anatomy, catheterism of this hypogastric artery failed (as previously feared) and the ostium had to be covered by a stent-graft, resulting in occlusion of both hypogastric arteries (Fig. 2B). The patient additionally received a femorofemoral right-to-left crossover bypass (Fig. 2B). Follow-up could be continued until 24 months, demonstrating a patent IMA side branch. Afterwards, the patient was lost to follow-up and died 48 months after EVAR, most likely from heart failure or acute pulmonary embolization.

Patient 3 (aged 60 years) had a 4.9-cm, fast-growing, infrarenal AA, and suffered from bilateral buttock claudication due to bilateral hypogastric artery occlusion. The IMA (4.0 mm) showed collaterals to the left hypogastric and sacral arteries, and a large lumbar artery (4.0 mm) supplied blood flow to the pelvis and the spinal collateral network (Fig. 3A). An endovascular procedure was performed with a bi-iliac stent-graft and two additional branches to the IMA and the dominant lumbar artery (twofold branched stent-graft; Fig. 3B). Postoperatively and after 12 months, CT scan and ultrasound examination showed regular results with a patent IMA branch (Figs. 3B and 4). However, routine control after 24 months demonstrated an occlusion of the IMA stent-graft without any signs of stent-graft kinking (Fig. 3C). Collateral function via the patent lumbar branch remained unchanged after 24 months and after 64 months. So far, this patient has not been suffering from any clinical symptoms.

DISCUSSION

The incidence of colon ischemia in AA repair is described as 1—6%, and mortality is high (53% within 1 month) —

Table 1. Patients' characteristics and treatment concepts.

	Patient 1	Patient 2	Patient 3
Age (years)	64	57	60
Gender	Male	Male	Male
Comorbidities	Coronary artery disease	Coronary artery disease, severely impaired left ventricular function, peripheral artery disease	Coronary artery disease
Aneurysm morphology	Thoracoabdominal	Pararenal	Infrarenal
Aneurysm diameter (cm)	6.6	8.5	4.9
Additional anatomic features	Occlusion of celiac trunk, high-grade stenosis of SMA, stenosis of both renal arteries, distal aortic diameter to small for bifurcated graft, large IMA (4.0 mm)	High-grade stenosis of right hypogastric artery, occlusion of left iliac and hypogastric artery, large IMA (4.5 mm)	Bilateral hypogastric artery occlusion, large lumbar artery (4.0 mm) and IMA (4.0 mm) as collaterals
Device implanted	Monoiliac: Branches and extension for SMA, both renal arteries, IMA (**4-fold branched**)	Monoiliac: Branches and extension for celiac trunk, SMA, both renal arteries, IMA (**5-fold branched**)	Bi-iliac: Branches and extension for dominant lumbar artery and IMA (**2-fold branched**)
Fluency stent-graft	6 × 60 mm	6 × 80 mm	6 × 60 mm (lumbar artery and IMA)
Additional surgical procedures	Iliofemoral crossover bypass (left > right), right-sided iliac plug (16 mm)	Femorofemoral crossover bypass (right > left), implantation of right-sided iliac branch device failed	∅
Duration of spinal drainage (days)	3	3	∅
Spinal cord ischemia	∅	∅	∅
Postoperative colon ischemia	∅	∅	∅
IMA patency (months)	60	24	12

SMA: superior mesenteric artery, IMA: inferior mesenteric artery.

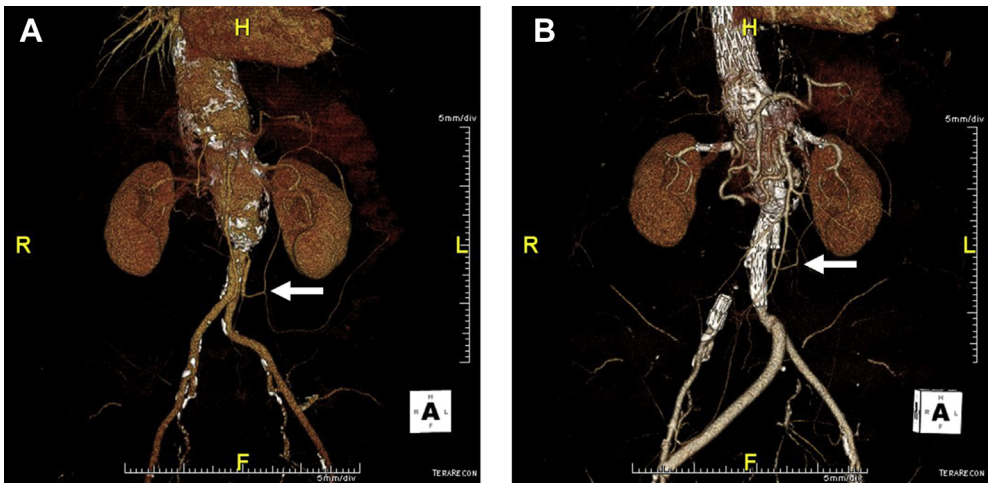

Figure 1. Patient 1 (fourfold branched stent-graft). (A) Preoperative computed tomography (CT) scan of a thoracoabdominal aortic aneurysm of 6.6 cm, occlusion of the celiac trunk, high-grade stenosis of the superior mesenteric artery (SMA), small distal aortic diameter, and poststenotic dilatation of a large inferior mesenteric artery (IMA). (B) Postoperative CT scan after treatment by a monoiliac, fourfold branched stent-graft (SMA, both renal arteries, IMA) with a right-sided iliac plug and a left-to-right iliofemoral crossover bypass. Arrows point towards the IMA.

without a relevant difference between EVAR and open repair (57% vs. 52%).[1] Embolization and inadequate mesenteric collateral circulation are described as major causes of ischemia.[4] Independent risk factors for colon ischemia were shown to be rupture, duration of the operation, and prior renal disease.[1] The role of the hypogastric arteries is discussed controversially.[4–7]

In our opinion, maintenance of IMA perfusion has to be taken into consideration if patients have an occlusion of the celiac trunk or the SMA, or if both hypogastric arteries are occluded. Diameter of the IMA should be at least 4 mm for successful IMA side branch perfusion. In our cases, the first patient had an occluded celiac trunk. EVAR of the second patient resulted in occlusion of both hypogastric arteries, and the third patient had bilateral hypogastric artery occlusion and suffered from buttock claudication. The IMA was a large vessel in all of the cases, as diagnosed by preoperative CT scan. The EVAR procedure was technically successful in all patients. No colon ischemia and no neurological deficit were observed, and all visceral artery side branches were perfused, including patent side branches to the IMA, as documented by CT scan and duplex ultrasound postoperatively and after 12 months. After 24 months, one of the three IMA side branches was occluded but without symptoms.

So far, there have been only two case reports on endovascular preservation of IMA perfusion to prevent colon ischemia. Using a snorkel technique, Igari et al. employed

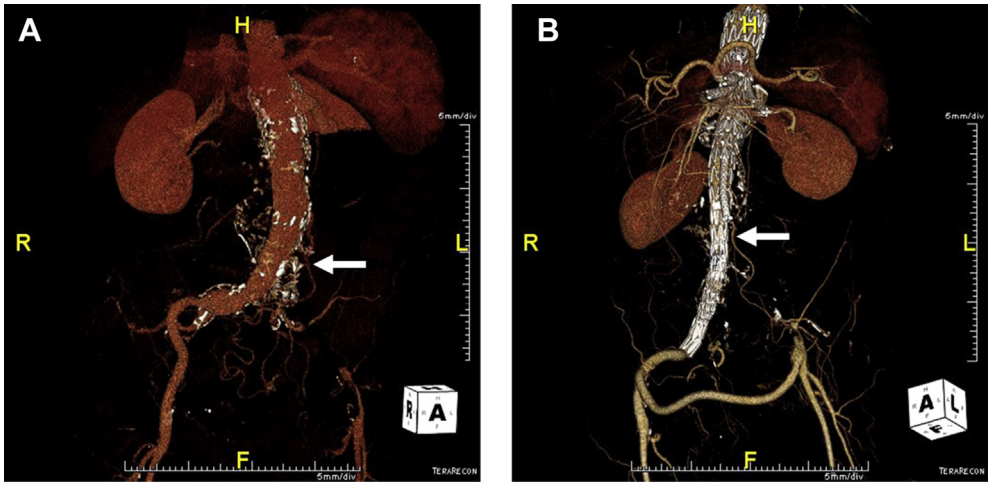

Figure 2. Patient 2 (fivefold branched stent-graft). (A) Preoperative computed tomography (CT) scan of a pararenal aortic aneurysm of 8.5 cm, high-grade stenosis of the right hypogastric artery, left iliac and hypogastric artery occlusion, and a large inferior mesenteric artery (IMA). (B) Postoperative CT scan after treatment by a monoiliac, fivefold branched stent-graft (celiac trunk, superior mesenteric artery, both renal arteries, IMA) with over-stenting of the right hypogastric artery and a right-to-left femorofemoral crossover bypass. Arrows point towards the IMA.

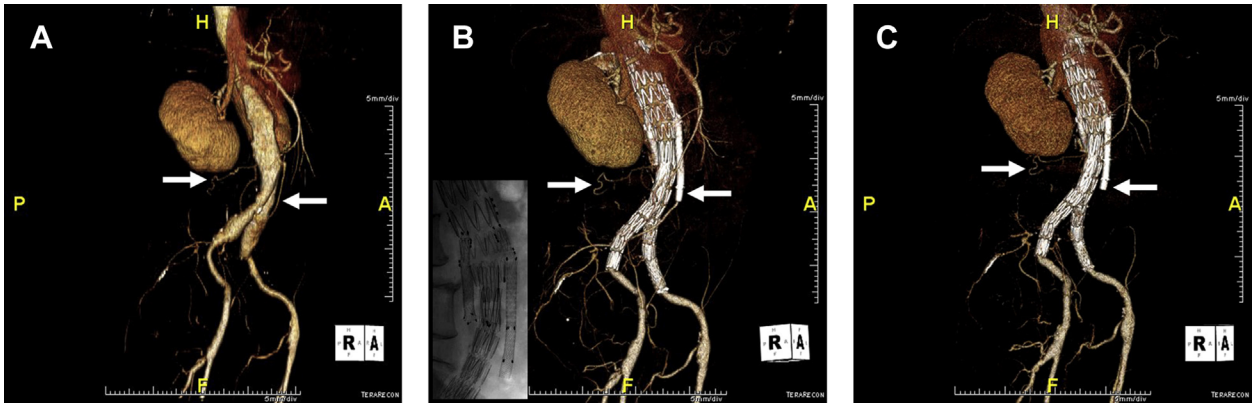

Figure 3. Patient 3 (twofold branched stent-graft). (A) Preoperative computed tomography (CT) scan of an infrarenal aortic aneurysm of 4.9 cm, occlusion of both hypogastric arteries, a dominant lumbar artery, and a large inferior mesenteric artery (IMA). (B) Postoperative CT scan after treatment with a bi-iliac, twofold branched stent-graft (dominant lumbar artery and IMA). Insertion shows radiograph of the two branches. (C) CT scan after 24 months with patent branch to the lumbar artery and an asymptomatic occlusion of the IMA branch but no signs of kinking of the IMA extension and sufficient intestinal collateralization. Arrows point towards the dominant lumbar artery and the IMA.

bare metal stents to preserve IMA circulation in two patients with bilateral common iliac artery aneurysms and the need for bilateral embolization of the internal iliac arteries.[7] Donas et al. treated two patients with symptomatic aortobi-iliac aneurysms with patent IMA and bilateral internal iliac artery occlusion with the chimney technique.[2] Both case series reported successful treatment without colon ischemia and a patent IMA postoperatively and after 12 months.[2,7]

To our knowledge, our patients are the first to be treated with an additional custom-made IMA side branch (first implantation March 2009) to preserve the IMA perfusion. Even if patency of the IMA side branch is limited during follow-up, this approach might offer time and chance for successful and sufficient collateralization of an otherwise probably compromised intestinal perfusion. To prevent stenosis of the side branch we use self-expandable stent-grafts and recommend endolining with self-expandable, uncovered stents. As shown in our series, treatment of a large lumbar artery with a custom-made side branch is another feasible option.

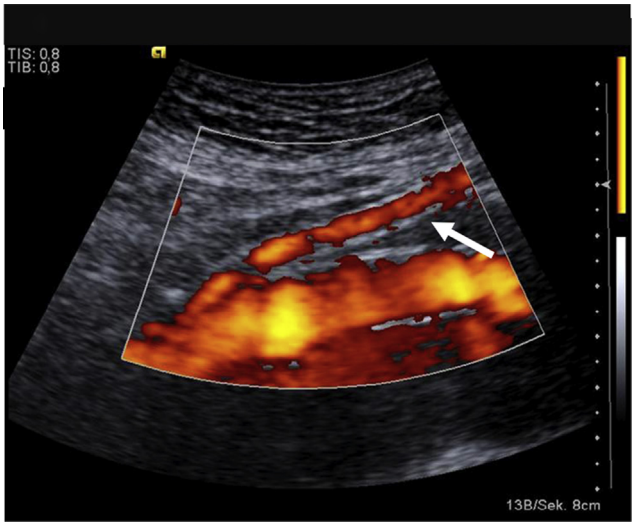

Figure 4. Postoperative, color-coded duplex sonography of patient 3. Power mode demonstrates patent, regular side branch to the IMA (white arrow) without kinking or stenosis.

Obviously, custom-made stent-grafts will require at least 6–8 weeks of fabrication, which means excluding patients with symptomatic or ruptured aneurysms from this procedure. In our opinion, the use of the chimney technique for IMA preservation is an option particularly in patients with urgent or emergency indication for treatment. There are no additional costs for the IMA branch if patients need a multibranched stent-graft. The chimney technique might be cheaper in patients with an infrarenal AA and the need for only one chimney graft. However, the risk of a type I endoleak through gutters has to be included. The risk increases from 7.0% to 15.6% by the use of two chimney grafts instead of one.[8] Owing to the supra-aortic approach, a risk of stroke has to be taken into consideration with both techniques.

Preservation of the IMA perfusion will undoubtedly remain a special procedure for highly selected patients. However, custom-made, branched stent-grafts with an IMA side branch can be another therapeutic option, besides the chimney or snorkel technique, for patients at risk of colon ischemia by EVAR.

CONCLUSION

Based on our experience, custom-made, branched stent-grafts are an endovascular option to preserve the IMA perfusion in selected and electively treated patients estimated as being at risk for insufficient intestinal perfusion due to stenosis or occlusions of visceral or hypogastric arteries.

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Gefäßmedizin, Berlin, Germany, 07.-11.09.2010: Janotta M, Pfister K, Schierling W, Apfelbeck H, Loibnegger A, Kasprzak PM. Endostentprothesen mit zusätzlichem Branch für die Arteria mesenterica inferior zur Vermeidung colorektaler Ischämien.

CONFLICT OF INTEREST

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