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Thoracic endovascular aortic repair with surgeon modified fenestration of celiac truncus in elective and emergency settings

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ABSTRACT

The surgeon-modified fenestrated stent graft seems to be a fast, reliable, and economic technique, necessitating no extra sophisticated instruments or additional costs. The surgeon-modified fenestrated stent graft technique is an assistive endovascular revascularization technique for the celiac truncus in elective and emergent manners. Herein, a ruptured thoracic aortic aneurysm and a Crawford type V descending aortic aneurysm treated with surgeon-modified fenestrated stent graft were presented. It is desirable to achieve successful results with a homemade device. This procedure stays as a feasible assistive technique for thoracic endovascular aortic repair.

Keywords: Aortic aneurysm, endovascular treatment, surgeon modified fenestrated stent-graft.

Thoracic endovascular aortic repair (TEVAR) is a fast-growing procedure for treating thoracic aortic diseases and has significantly reduced morbidity and death rates for thoracic aortic aneurysms and dissections compared to open surgery. Consequently, it is now the first treatment option due to its less intrusive nature.

The scope of TEVAR was initially limited to the descending thoracic aorta, but with the introduction of assistive TEVAR techniques, such as chimney grafts, periscope grafts, *in situ* fenestrations, surgeon-modified fenestrated stent grafts (SMFSGs), and hybrid procedures, the scope has broadened.[1-3] Visceral branch involvement is encountered in 4 to 14% of instances, and covering of the celiac truncus may be required for adequate TEVAR landing zones. The current guideline suggests open or endovascular revascularization in the event of high risk of celiac truncus region ischemia.[4-6]

The SMFSG seems to be a fast, reliable, and economic technique, necessitating no extra sophisticated instruments or additional costs. Herein, we would like to share the feasibility of the SMFSG technique as an assistive endovascular revascularization technique for the celiac truncus in elective and emergent settings in two different aortic pathologies, a Crawford type 1 ruptured thoracic aortic aneurysm and an elective but symptomatic Crawford type 5 thoracic aortic aneurysm.

SURGICAL TECHNIQUE

Case 1- A 58-year-old Caucasian male patient with uncontrolled hypertension and chronic obstructive pulmonary disease presented to our emergency department with chest pain. After the computed tomography (CT), a ruptured thoracic

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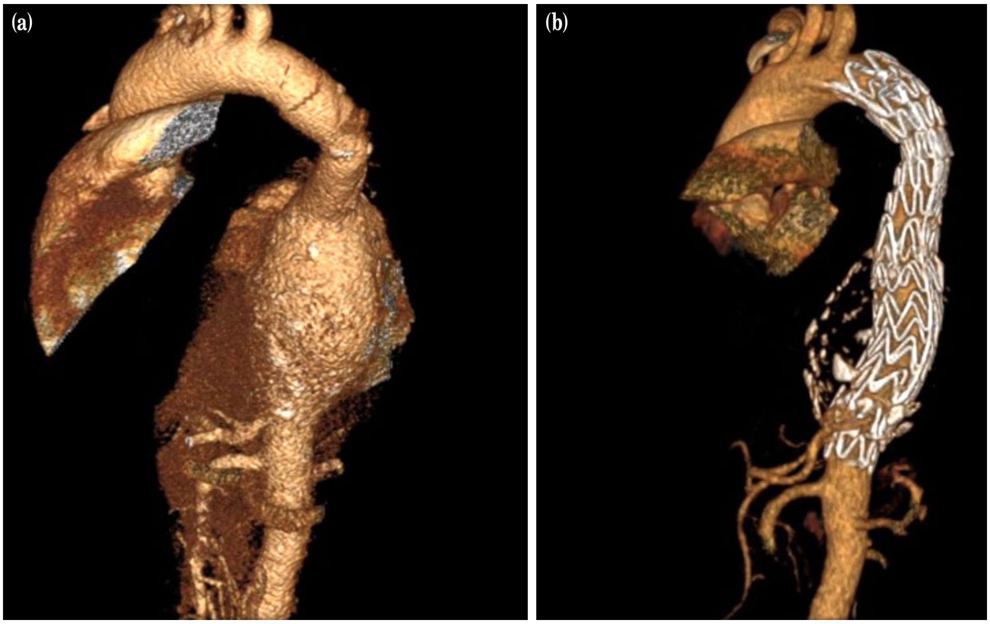

Figure 1. (a) Preoperative computed tomography scan demonstrating the ruptured thoracic aortic aneurysm. **(b)** Postoperative computed tomography scan displaying the SMFSG.
SMFSG: Surgeon-modified fenestrated stent grafts.

aortic aneurysm (80 mm maximum diameter) was diagnosed (Figure 1a). As an emergency, the patient was taken directly into the angiography operating room, and a TEVAR graft (30×30×200 mm) was initially deployed under general anesthesia from the distal part of the left subclavian artery to treat the ruptured part of the aortic aneurysm. After the first endograft, there was a type 1b endoleak from the distal part, mainly due to the distal improper landing zone. The territory of the celiac truncus was the healthy aortic section. Beyond the celiac truncus, there was a 1.76 cm distance to the superior mesenteric artery (SMA), and this aortic region was suitable. Although intentional coverage was also a treatment of choice in such an emergent case, we decided to preserve the celiac truncus with a back-table fenestration (Figure 1b). To preserve the celiac flow, we unsheathed the endograft (30×26×120 mm), performed the back-table fenestration, and then resheathed the endograft (Figure 2).

Figure 2. An image of the fenestrated graft.

Case 2- A 69-year-old Caucasian male patient with abdominal pain was consulted by the emergency department. The patient was in the American Society of Anesthesiologists (ASA) III status, and the associated comorbidities were chronic obstructive pulmonary disease, hypertension, and hyperlipidemia. After the CT angiography, the patient was diagnosed with a Crawford type 5 descending aortic aneurysm with a diameter of 7 cm (Figure 3). In elective manners, the endograft was unsheathed after the general anesthesia and the femoral exposure. A tapered 34×28×160 mm thoracic stent graft was selected for the procedure. The fenestration was performed on the back table (Figure 4), and then the graft was resheathed. The distance between the Celiac truncus and the SMA was 3.48 cm (Figures 5a and b).

Three-dimensional vascular imaging (RadiAnt Dicom viewer version 2021.2 (64 bit) was used to plan the procedure and size the devices. Over the aortic axis, the diameter of the visceral aortic branches, the distance between them, and the clock position of each branch were measured. For both cases, an oversizing of around 10 to 20% was envisaged. In

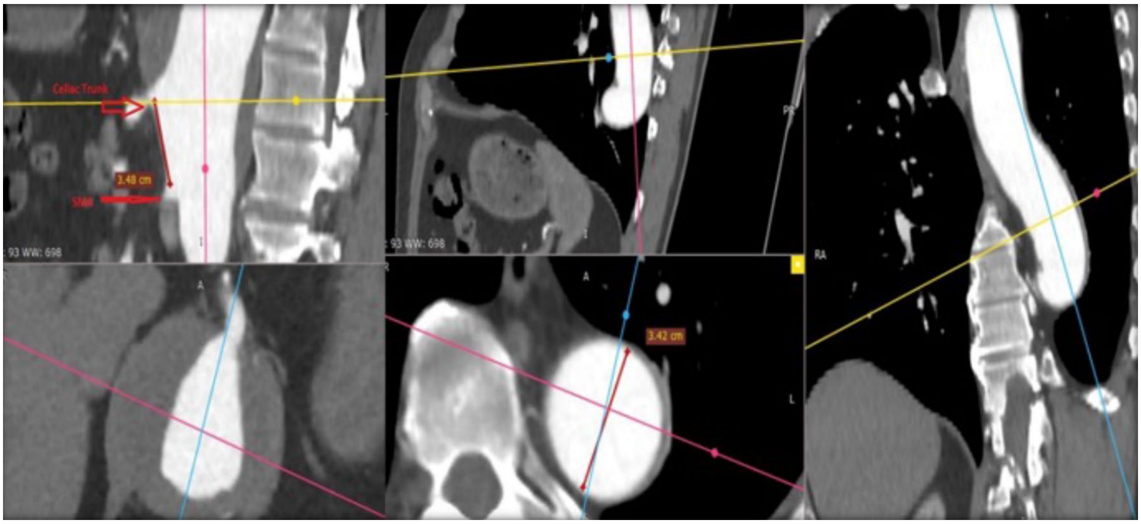

Figure 3. Preoperative computed tomography scan demonstrating the Crawford type 5 descending aortic aneurysm.

Figure 4. An image of the fenestrated graft.

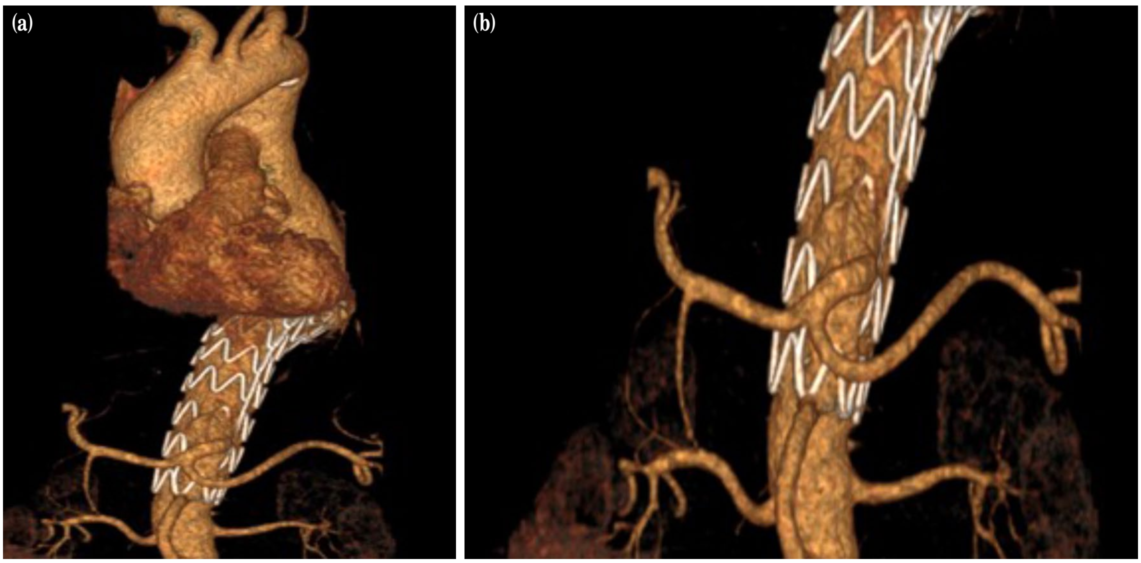

Figure 5. (a) Postoperative computed tomography scan of the SMFSG. **(b)** Postoperative computed tomography scan of the SMFSG.
SMFSG: Surgeon-modified fenestrated stent grafts.

the hybrid operating room, the treatment was carried out under general anesthesia. The right femoral artery was surgically exposed, and access to the left femoral artery was gained using percutaneous means. A pigtail catheter was inserted and parked between the T12 - L1 vertebrae for direct viewing of the celiac truncus and the SMA in the anteroposterior position after heparin administration. The stent graft was entirely unsheathed on the surgical back table in a sterile manner after the femoral access routes were prepared. An 11-sized scalpel was used to fenestrate the endograft covering material. It took around 10 to 20 min to complete the unsheathing, fenestration, and resheathing procedures. Marker 8 should be on the larger curvature and is observed as a line while introducing the endograft. The endograft's malpositioning was confirmed by the ability to read the marker 8 or 0 during fluoroscopy. The deployment was carried out after ensuring that the fenestration was directed toward the aortic target vessel. The mean arterial blood pressure was reduced to 70-80 mmHg throughout the deployment to improve accuracy. Markers were enough for positioning during the procedure. No radiopaque marker sewing was needed. The complete angiography for both patients revealed aneurysm sac coverage, celiac truncus patency, and no endoleak. After a month, computed tomography revealed no migration, no endoleak, and the celiac truncus was still intact.

DISCUSSION

An endovascular operation requires a secure proximal landing zone. Most surgeons believe that depending on the mesenteric collaterals, the celiac truncus can be selectively covered; nonetheless, revascularization is typically preferable to prevent ischemic problems.[4] In addition, a selective SMA angiography is required to show collateral circulation and SMA patency.

In physically fit patients, hybrid treatments are also a viable option. Endovascular methods that are not conventional have been recorded. Perigraft endoleaks are a danger with the chimney approach of attaching parallel grafts to the aortic stent graft.[1-3,7] Another alternative is a fenestrated or branching endograft, which has the drawbacks of a long wait period and a high cost, restricting its utilization.[7,8] For a correct design of the fenestrations, the SMFSG requires experience and a learning curve. The surgeon must be familiar with the endograft utilized to perform the surgery. On either side of the proximal side of the Ankura™ TAA Stent Graft, two differently shaped radiopaque markers (8 and 0) simplify placement. There is a connecting bar just distal to the radiopaque marker 8 on the greater aortic curvature, and the bar avoids shortening, which is also crucial for orientation.

Despite the increasing experience, a margin of error in placing fenestrations always exists, and the mismatch possibility may lead to complications. Aortic three-dimensional printing has been widely described in medicine for simulation, training, and surgical planning.[9] The SMFSG needs correct preoperative measurements and good patient selection to assure orientation.

Anatomical restrictions must be acknowledged, as the SMA CT distance should be more than 10 mm to guarantee endograft integrity and a healthy proximal landing zone. Owing to its small body and early splitting, CT stenting has its own set of problems. However, stenting should be done if the blood flow on completing angiography is weak, delayed, or if there is an endoleak. When there is sufficient collateral flow and a patent SMA, CT coverage may be the therapy of choice. The endograft integrity, the fabric durability concerns, and the absence of bench testing are the main limitations waiting for answers.

In conclusion, the SMFSG stays a feasible assistive technique for TEVAR in endovascularly maintaining the blood flow of CT. The SMFSG is a fast, economic, and reliable treatment modality.

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