Bespoke total aortic arch replacement with frozen elephant trunk: A novel but a practical strategy

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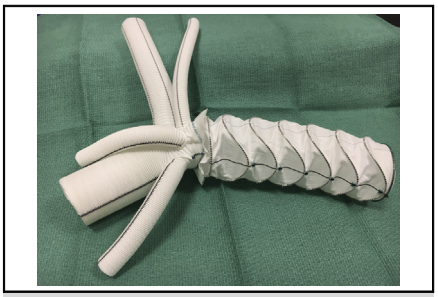

Custom-made frozen elephant truck (FET) graft.

CENTRAL MESSAGE

The frozen elephant trunk has made complex aortic surgery more accessible with excellent results. A bespoke graft specific to patient anatomy can deliver size-matched prosthesis.

The complexity in managing aortic arch diseases is very challenging and has evolved over time. There is emerging expert consensus for the use of stent grafts with concomitant stabilization of upstream and downstream aorta.[1] The advancement of endovascular technology has revolutionized aortic arch surgery over the last decade and has allowed further development of surgical hybrid techniques to repair aneurysms with various morphologies and in those patients presenting with acute aortic syndromes involving the arch.[2,3] One such technique is the "elephant trunk procedure," which led to the subsequent development of the frozen elephant trunk (FET) technique. The introduction of FET has enabled a single-stage operation for highly complex disease with excellent outcomes.[4]

At present, the available Vascutek Thoraflex prosthesis (Vascutek, Inchinnan) comes in fixed sizes (Figure 1, *A*). The branch configuration on the graft is innominate artery (size range 10-12 mm), left common carotid (size 8 mm), and left subclavian artery (size range 8-10 mm), respectively. However, these sizes restrict the surgeon in delivering an ideal prosthesis in an already restricted space (Figure 1, *B*).

To minimize the aforementioned problem, we designed our own size-matched prosthesis with the aid of Vascutek. This is the first custom-made Vascutek Thoraflex-Hybrid to be successfully implanted in the United Kingdom.

CASE DESCRIPTION

An elderly 76-year-old female patient was found to have an enlarged ascending aorta with mild-to-moderate aortic regurgitation on an echocardiogram. Her computed tomography (CT) scan showed a significantly dilated ascending aorta, proximal aortic arch, and proximal descending thoracic aorta (Figure 2, *A* and *B*).

We felt a specific custom-designed Thoraflex would aid in the reconstruction of the patient's aorta for the following reasons: (1) compact mediastinum; (2) short neck with crowded neck vessels; (3) low-lying dilated arch and greatly dilated ascending aorta with displacement of the origins of neck vessels on the arch; (4) large native innominate artery (20 mm)- premade graft has a maximum size of 12 mm; (5) short ascending aorta (the lie of the side branches has to be triangulated so as to get more length of the proximal portion for anastomosis); and (6) a large descending thoracic aorta requiring the larger size of the endostent portion of Thoraflex.

We created a computerized image of the proposed bespoke graft using patient's CT images to overcome the aforementioned reasons with her informed consent (The institutional review board approval was not applicable). The proposed bespoke graft design had a larger innominate artery and a triangulated branch configuration to acquire sufficient length to perform proximal portion for anastomosis (Figure 2, *B*). This was then manufactured by Vascutek (Figure 2, *C*) and was inserted into the patient successfully. Overall, the customized prosthesis provided

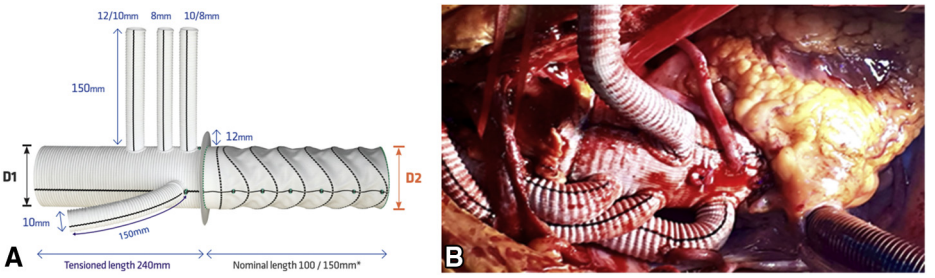

FIGURE 1. A, Current Vascutek Thoraflex orientation with branch configuration and sizes (image adapted from Vascutek). B, This image highlights the challenges of the branch configuration postinsertion of the Thoraflex.

a better match to patient's native vessels and was spatially better orientated (Figure 2, *D*). The patient was discharged after an uneventful recovery with a satisfactory postoperative CT (Figure 2, *E* and *F*).

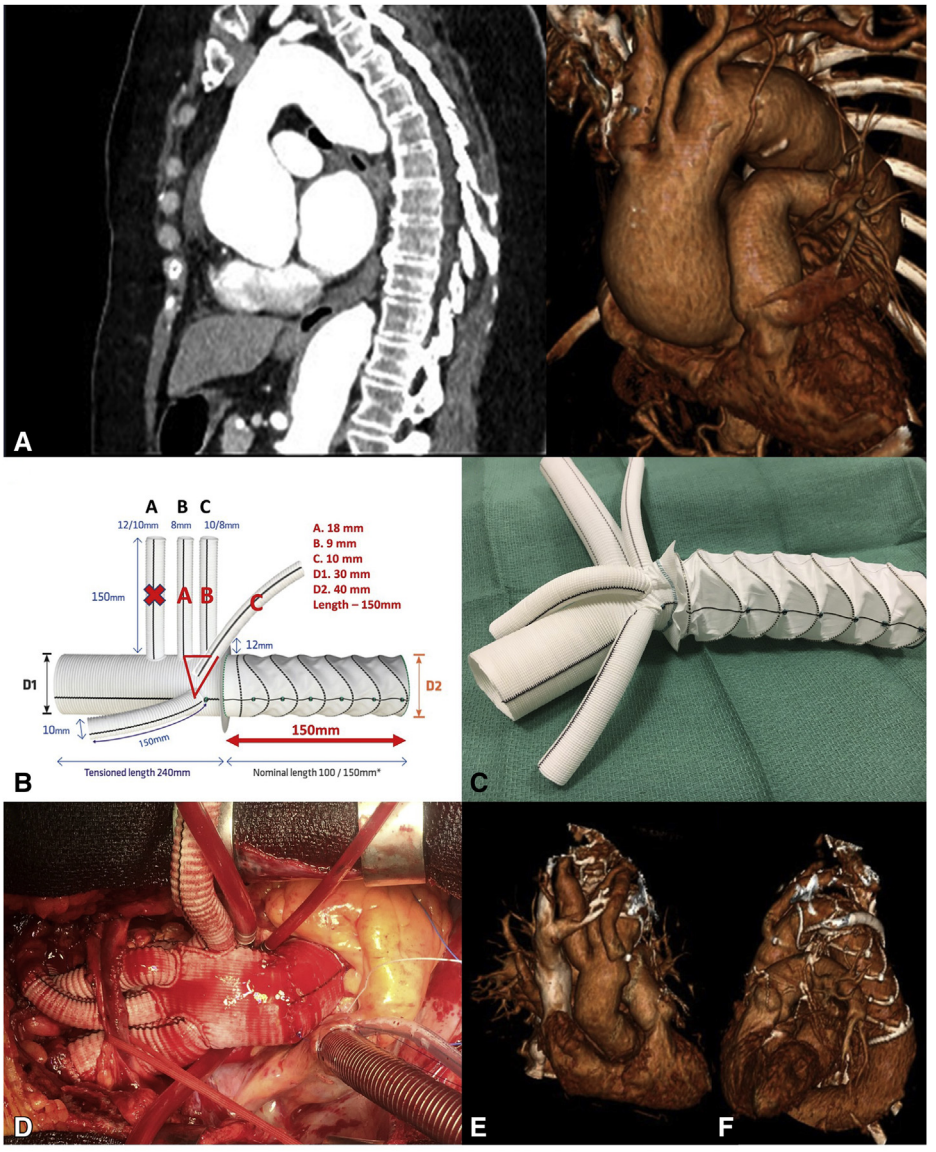

FIGURE 2. A, Contrast-enhanced computed tomography (CT) image and 3-dimensional reconstructed CT images: head and neck vessels are of various calibers. B, Bespoke Thoraflex with proposed computerized image of the bespoke graft. C, Manufactured bespoke graft. D, Intraoperative image showing the orientation of the graft after the completion of the frozen elephant truck. E and F, CT image of the aorta before discharge.

CONCLUSIONS

The FET technique using the Vascutek Thoraflex is an ideal solution to treat aortic arch aneurysm and dissections. A customized bespoke prosthesis will provide a better match to the patient's native vessels and provide a greater spatial arrangement as shown with our case. We believe a customized bespoke Thoraflex in the elective setting will provide greater clinical options and may improve outcomes. It is feasible only for elective cases, as design and production needs 4 to 6 weeks.

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