Use of the frozen elephant trunk technique in complicated chronic dissection with porcelain aorta and visceral arteries originating from different lumens

Michal O. Zembala, Vadim Irimie and Paul P. Urbanski*

Abstract
A rare case of aortic arch aneurysm combined with chronic aortic dissection is reported. Because the visceral arteries originated from different, equivalently perfused lumens and the descending aorta was circumferentially calcified (porcelain aorta) limiting the possibilities of anastomosing, careful planning of the surgical strategy was of utmost importance. The complex surgery consisted of ascending and total arch replacement using the ‘frozen elephant trunk’ technique with Thoraflex™ Hybrid Prosthesis (Vascutek, Terumo, Inchinnan, Scotland); however, before insertion of the stent graft, an angioscopic resection of the dissection membrane in the proximal part of the descending aorta was carried out to ensure a complete expansion of the distal edge of the stent within the entire common lumen of the aorta and unimpaired distal flow in both lumens below the stent graft. The surgery and the postoperative course were uneventful.

Keywords: Chronic aortic dissection • Aortic arch surgery • Porcelain aorta • Endovascular aortic repair

INTRODUCTION
Surgical management of chronic aortic dissection using endovascular techniques is controversial, especially in extensive thoraco-abdominal dissections with visceral arteries originating from different lumens, because their basic aim is obliteration of the false lumen [1–3]. On the other hand, some pathologies, like a porcelain aorta extending throughout the entire descending aorta, can limit the possibilities of conventional surgery. In this complex pathology, a hybrid prosthesis was used for total aortic arch replacement and covering of the dilated segment of descending aorta, using the frozen elephant trunk (FET) technique after angioscopic resection of the dissection membrane.

CASE REPORT
A 70-year old male presenting with an aneurysm of the aortic arch combined with chronic dissection of the thoraco-abdominal aorta, in which both lumens were equally perfused and the visceral arteries originated from different lumens, was referred for surgery. In addition, the proximal portion of the descending aorta was atherosclerotiatically changed and dilated with a maximum diameter of 7.3 cm (Fig. 1). Because the concomitant circumferential calcification of the entire descending aorta (porcelain aorta) limited the possibilities to replace it conventionally, as is our preferred option [3], a hybrid procedure was chosen.

The patient was operated on using median sternotomy, and the innominate artery (IA) was used for arterial cannulation via an 8-mm side graft. Once tympanic temperature reached 28°C, the supra-aortic arteries were clamped and circulatory arrest of the lower body with unilateral cerebral perfusion (UCP) was commenced by reducing the arterial flow to ~1.5 l/min. The aortic arch was excised to the level between the origins of the left common carotid artery (LCA) and left sub-clavian artery (LSA) due to massively calcified aortic wall beyond this level. The LSA was ligated. Dissection membrane was then identified and resected under endoscopic guidance (10 mm variable viewing angle endoscope EndoCAMeleon, Carl Storz Endoscope, Germany) along its visible length. Endoscopic scissors and a grasper were used to resect the membrane 5 cm past the lowest point, allowing creation of a landing zone for a 150-mm-length and 40-mm-wide stent portion of the 32/40/150 Thoraflex™ Hybrid Prosthesis (Vascutek, Terumo, Inchinnan, Scotland). The prosthesis was then introduced and deployed within a newly created single aortic lumen. Distal anastomosis, facilitated by a sewing collar between the arch portion and the stent graft, was sewn to the aortic arch between the stump of the LSA and origin of the LCA. Next, distal perfusion was re-established via the second branch of the Y-shaped arterial line connected with one side branch of the quadrifurcated arch.
prosthesis (circulatory arrest time: 40 min). Because the predeter-
mined anatomical form of the arch portion did not fit with the
patient’s anatomo-pathological requirements, a non-anatomical
reimplantation of the LCA and IA was performed (Fig. 2), as
described elsewhere in detail [4]. The duration of UCP was 57 min.
Because the diameter of the unstented portion did not match
the diameter of the patient’s sinotubular junction, a second vascular
graft was used for the ascending aorta replacement (Fig. 2).
Finally, the ascending graft and arch graft were anastomosed, and
myocardial perfusion was re-established. During reperfusion and
rewarming, a left aorto-axillary bypass was carried out using the
last branch of quadrifurcated prosthesis and additional infraclavi-
cular incision.

The postoperative course was event-free and the computed
tomographic (CT) angiography performed before discharge showed
the FET with the well-anchored stent graft within the single lumen of
the descending aorta (Fig. 2).

**DISCUSSION**

Obliteration of the false lumen, which is actually a basic aim of endo-
vascular techniques, can be catastrophic in cases with visceral arteries
and/or spinal cord supplying arteries originating from a false lumen.
In such situations, open conventional surgery offers excellent results
with which evolving techniques have to be judged [3]. However, in
some complex pathologies, as reported here, conventional surgery is
associated with relevant limitations or is even unfeasible. A hybrid
procedure can be considered in such situations; however, because
the dissection membrane is thick and stiff, the stent graft cannot
expand completely and, due to existing flow through the distal
intimal tear, the increased pressure in the proximal blind-end of the
false lumen can accelerate the aneurysm growth. In such cases, an
endografting should ensure proper anchoring of the distal end of the
stent, resulting in complete thrombosis of the dilated false lumen
and, at the same time, securing intact distal perfusion of both lumens.
[3, 5]. Roselli et al. [5] proposed an open fenestration at the distal landing zone to achieve the aspects mentioned above, but due to porcelain aorta, their technique as well as conventional surgery, be it through a left or a clamshell thoracotomy would not be feasible. Nevertheless, the Roselli’s technique is connected with a weakening of the aortic wall at the site of the longitudinal incision, and this can result in additional complications [5].

The antegrade resection of the dissection membrane can be performed even in porcelain aorta, offering a very efficient feature for simultaneous repair of the aortic arch and descending aorta in chronic dissection with visceral arteries originating from different lumens. It ensures complete expansion of the stent within the entire single lumen of the aorta, resulting in total thrombosis of the aneurysm around the stent graft and sufficient perfusion of both lumens below its distal edge.

Conflict of interest: none declared.

REFERENCES


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Author: Martin Czerny
University Heart Center Freiburg-Bad Krozingen, Freiburg, Germany
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Rare clinical scenarios represent ideal grounds for introducing creative approaches to solve particular clinical challenges, as was the case here [1]. This patient had a combination of several underlying thoracic aortic pathologies such as ascending and proximal aortic arch true aneurysm formation, chronic post-dissection aneurysm formation distally as well as a porcelain aorta needing thoughtful adjustment of the surgical strategy. Finally, a visceral artery originating from different lumina had to be taken into consideration.

The frozen elephant trunk (FET) technique has broadened the armamentarium of surgeons to simplify the treatment of complex thoracic aortic pathology. The conceptual strategy to obtain the most complete primary repair possible and to provide concomitant circumstances that facilitate any future secondary intervention has proven to be effective. However, the exact definition of suitable indications for the technique is still evolving. In a recent position paper of the European Association for Cardio-Thoracic Surgery (EACTS), post-dissection aneurysm formation was addressed and the following considerations were put forward: 1) the location of the segment with the maximal diameter- the more proximal, the higher the likelihood of effectiveness and 2) the size of the true lumen is often very narrowed because of a remaining risk for pseudoacoarctation after FET implantation [2].

The authors considered all these aspects in their case planning and extended the concept by excising the chronic dissection membrane down to a level where aortic diameters were in the normal range and complete sealing by the stent graft portion of the FET prosthesis could be obtained. This was a very smart extension of a strategy that has been described in classical open membrane resection by others [3]. In order to overcome the issue of the porcelain aorta and the challenges associated with a secure suture line at the proximal descending level, the authors proximalized the descending anastomosis to the level of the mid-aortic arch. This modification has several advantages such as a closer proximity to the most distal point of the anastomosis in the surgical field as well as better tissue quality. This modification is enabled by the branched design of the Thoraflex prosthesis.

Finally, we should shortly reflect on the issue of visceral arteries originating from different lumina. To better understand the discussion of a vessel origin from true and false lumina, one has to look upon its underlying mechanisms. In the initial acute phase of the disease, all vessels do primarily originate from the true lumen and secondary tear of the intimal-medial cylinder creates visual false lumen offspring [4]. It is crucial to understand that the very location where the cylinder tore, the communication between both lumina is still present, and in most cases, will be large enough to maintain branch vessel perfusion even if the primary entry tear is closed by a stent graft and therefore false lumen thrombosis – at least at the thoracic level- is induced [5]. This is the reason why malperfusion after closure of the primary entry tear in patients, in whom visceral and renal arteries originate from different lumina, is a very rare event.

However, in patients with chronic post-dissection aneurysmal formation, the membrane may already be very stiff and the remodeling process may not be influenced to an extent where complete exclusion of the false lumen from pressurization can be achieved. Therefore, the excision of the dissection membrane to the level of a regular aortic diameter was a very smart solution.

In summary, this report is an important contribution to share the continuing development and improvement of surgical strategies in treating complex thoracic aortic pathology by fulfilling the key issues: 1) an understanding of the underlying pathology, 2) thoughtful individualized case planning and 3) excellent surgical quality to achieve the intended result.

Conflict of interest: none declared.

References


