

# Right size matters! The ideal size of hybrid prosthesis in frozen elephant trunk

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[journals.sagepub.com/home/aan](https://journals.sagepub.com/home/aan)**Mohammed Idhrees<sup>1</sup> , Mohamad Bashir<sup>2</sup> and Heinz Jakob<sup>3</sup>**

## Abstract

There is abundant of literature emerging to support the use of the frozen elephant trunk prosthesis, but there is still a lack of clear consensus on the sizing of the hybrid prosthesis. There is a general consensus that the stent should not be oversized in acute aortic dissection and chronic aortic dissection. Some surgeons consider that only the true lumen has to be measured while others argue that the entire diameter of the aorta has to be measured, and a few measure the aorta intraoperatively. In regards to thoracic aortic aneurysm, most surgeons oversize the stent-graft by 10% to 20%. A small device may not provide adequate sealing, whereas a larger device may cause new entry points distally. Hence, an appropriate device has to be selected for the optimal outcome.

## Keywords

Aneurysm, dissecting, aortic aneurysm, thoracic, blood vessel prosthesis implantation, stents

## Introduction

Championships are won not because of the players but because of the organization that hosted and nurtured them. This saying generated continued debate centered on who gets the credit and scoops of the event. Despite the best team and managers, history has proven multiple times that championships are lost in one wrong decisive moment. Protagonists say that surgeons need to trust their instincts and work their skills and abilities toward this application. However, this approach is fraught with failure equally to the surgeon and patient outcome. We live by the book of outcome-reporting and avoidance of negative feelings around unacceptable mortality or morbidity risks for treating various pathologies with use of the frozen elephant trunk (FET). The use of an FET is a championship that is won for the patient and only the patient. The keys to this outcome are understanding the pathology of the disease and using the appropriate device in terms of diameter and length.

## Size matters!

Although there is a mass of literature arguing in favor of the FET, there are no general recommendations regarding the choice of diameter and length of the stent-graft

to be used in different pathologies. The stent-graft of the hybrid prosthesis is deemed to seal the reentry in the descending thoracic aorta, expand the true lumen, and limit residual patency of the false lumen. The choice of a smaller diameter of the stent is similar in effect to the classic elephant trunk with little sealing effect, whereas a stent of larger diameter may not expand and can cause a crumpling effect in the stent. Further, it is has been shown to injure the intima, causing a distal stent-graft-induced new entry that leads to endoleaks.<sup>1</sup> A shorter stent-graft may not adequately cover the entry tear, and an over-enthusiastic longer stent may cause paraplegia. This is reflected in the results, with some centers having an excellent false lumen thrombosis rate as high as 90%

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in acute aortic dissection (AAD) and 78% in chronic aortic dissection (CAD),<sup>2</sup> while a few others have low rates of false lumen thrombosis of 42% to 70%.<sup>3</sup> This is obviously reflected in the rate of freedom from reintervention, the former having 73% at 8 years,<sup>2</sup> and the latter having a 33% reintervention rate within 12 months.<sup>3</sup>

### Preoperative assessment

Detailed examination of the aortic anatomy from a preoperative computed tomography angiogram is essential. The extent of aortic dissection, the size of the aneurysm, the exact location of all the entry tears, measurement of the true and false lumens at different levels, determine the landing zones.<sup>4</sup>

### Deciding the diameter of the stent-graft

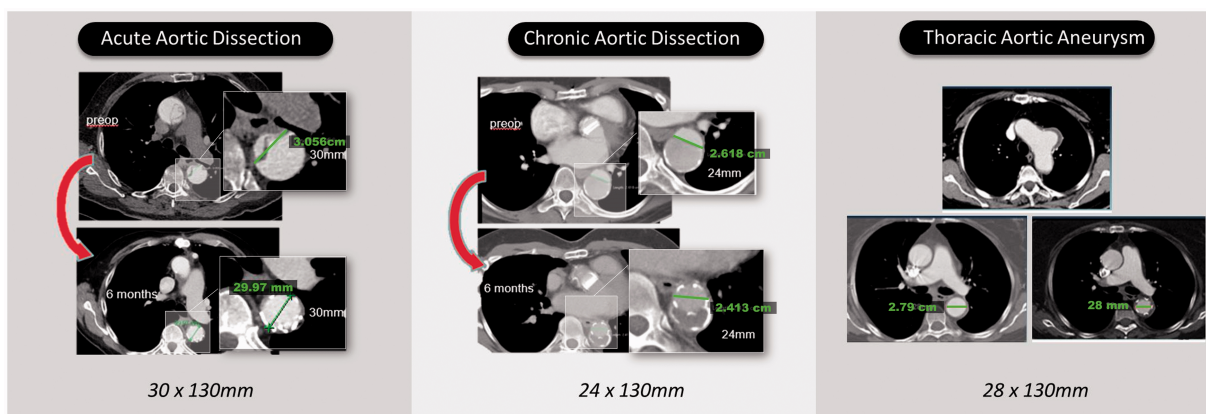
#### Acute aortic dissection

There is a general consensus among surgeons that the stent-graft should not be oversized in AAD. The change in geometry of the descending aorta after aortic dissection was studied by Rylski and colleagues<sup>5</sup> who concluded that the pre-dissection aortic diameter most closely resembles the post-dissection maximum diameter of the true lumen.<sup>5</sup> This group further suggested 3 possible solutions to calculate the size of the stent-graft in these patients: measure the maximum diameter of the post-dissection true lumen diameter, subtract 3 mm from the total aortic diameter in zone 2 of the aortic arch, add 8 mm to the true lumen diameter in the first quartile of the dissected aorta. The maximal true lumen diameter is used for sizing by the Essen, Hannover, and Bologna groups of surgeons (Figure 1).<sup>2,6,7</sup> A few other surgeons use the total

diameter of the aorta for sizing the stent-graft.<sup>8</sup> A group of surgeons in Japan believe that the diameter of the total aorta before aortic dissection should be used as the correct diameter of the stent-graft for AAD; but unfortunately, this cannot be assessed in all patients. They compared the intraoperative diameter and the diameter in the computed tomography angiogram and showed an approximate 8% increase in diameter. Hence, they recommended that the size of the stent graft should be at least 90% of the total aortic diameter in the descending aorta.<sup>9</sup>

#### Chronic aortic dissection

In CAD, the dissection flap is more rigid and fibrosed, with less mobility than in AAD. The Bologna surgeons size the diameter of the stent-graft based on the maximum diameter of the true lumen.<sup>6,7</sup> The Essen team avoid oversizing or prefer one-size less in CAD (Figure 1).<sup>2</sup> Few surgeons avoid oversizing of the graft and use the smallest possible graft (24 mm, 26 mm, or at most 28 mm).<sup>3</sup> However, the Hannover group measure the entire diameter of the aorta at the level of the landing zone and implant the largest possible graft.<sup>7</sup> It is worth noting that the Hannover group use FET grafts more aggressively when a type Ib endoleak is anticipated, especially in TAA and CAD. The average distal diameter is > 40 mm, especially when second-stage TEVAR is required.<sup>10</sup> The surgeon has to be cautious while performing the proximal anastomosis to a small true lumen using a large size graft. This may create a “coarctation” like phenomena if the large stent graft is crumbled and anastomosed to a small true lumen.



**Figure 1.** The Essen technique to measure the stent-graft: in patients with acute and chronic aortic dissection, the maximal diameter of the true lumen is measured, and the corresponding stent-graft is used. Postoperative image of a well-expanded stent graft. In patients with a thoracic aortic aneurysm, the stent-graft is oversized by up to 10% of the aorta at the landing zone.

### Thoracic aortic aneurysm

Most surgeons agree on oversizing the stent-graft in aneurysm patients. A 10%–20% oversizing of the stent at the level of the distal landing zone is used, except for patients with connective tissue disease.<sup>6,10,11</sup> The Essen group tend to oversize by only up to 10% of the aortic aneurysm (Figure 1).<sup>2</sup>

### The length of the stent-graft

Surgeons have to balance between a shorter device with the risk of causing endoleak and reintervention and a longer device with the risk of paraplegia. Most centers agree on a shorter device and accept the risk of reintervention. At present, the Hannover group use 100-mm grafts for AAD and CAD.<sup>12</sup> The Bologna group prefer 100 mm for AAD.<sup>6</sup> The surgeons in Essen use a 130-mm graft and fix it in zone 2, which allows the stent to reach Th5-7 level.<sup>2</sup> A group in Japan implant the stent-graft above the level of Th7. They use transesophageal imaging of the descending aorta to ensure that the distal portion of the stent is 3-cm above the aortic valve.<sup>9</sup> The team in Cleveland choose a device to accommodate the aortic curvature and a stent-graft of no more than 150 mm.<sup>8</sup> An angioscope (using a flexible video scope) is a useful tool to evaluate the downstream aorta for additional reentry tears and control the position of the stent-graft. This will aid in the decision on using additional TEVAR to cover the reentry tears.<sup>13</sup>

### Discussion

This leaves us with a set of unanswered questions. When the true lumen is collapsed in AAD to a slit-like shape, how would you measure it in that situation? If the true lumen in CAD is small and the total diameter of the aorta is 3-times larger, should we still size the graft to the true lumen? Given the higher incidence of paraplegia with longer stent-grafts, when is the ideal time to extend with TEVAR if needed? Of course, size and length do represent important cornerstones in achieving the projected short- and long-term results in excluding the pathology and avoiding later reinterventions within the stented portion of the descending aorta. However, the overall results also depend on other parameters that include: circulatory arrest (adequate cooling of the core temperature with the shortest possible circulatory arrest time); cerebral perfusion: use of bilateral antegrade cerebral perfusion (a few surgeons in Japan and Essen advocate perfusion of all three supraaortic arch vessels to promote collateral circulation to the spinal cord during circulatory arrest),<sup>14,15</sup> and deairing of the lower body (thorough deairing prior before restarting the peripheral

circulation will avoid air bubbles entering the spinal cord arteries).

These manoeuvres help to avoid the risk of paraplegia in an otherwise beneficial scenario. There is a need for further studies to assess the exact method of sizing the hybrid prosthesis. Preoperative 3-dimensional remodelling and virtual implantation of the stent-graft to accommodate the curvature of the aorta will aid in choosing the perfect length. Nevertheless, the contributions from aortic surgeons across the globe should be aimed at introducing a valuable stimulus to promote continued discussion to improve outcomes with a promising new treatment options for complex thoracic aortic pathologies. Innovation and avoidance of retrospective thinking should be allowed to dominate the scene. We are in the era of technological advancement positioned to help make the right choice for the patient and be guided clinically but scientifically driven.


### Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Dr. Heinz Jakob is a consultant to CryoLife/JOTEC, receives speaker's honoraria, and received royalties until December 2019.

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