Editorial

# The elephant trunk procedure continues to evolve 40 years since its initial description

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Initially introduced by Borst and colleagues in 1983, a two-staged operation (conventional elephant trunk procedure via a median sternotomy followed by lateral thoracotomy) was the standard approach for the surgical repair of arch and distal aortic aneurysms (1). The landscape of complex aortic arch pathology treatment was subsequently impacted tremendously by the advent of the frozen elephant trunk (FET) technique (2-4). The procedure can be performed as a single stage operation through a median sternotomy, or even partial sternotomy, with varying degrees of lower hypothermic circulatory arrest (HCA). The recent paradigm shift of FET proximalization from zone 3 to zone 2 appears to be associated with a more favorable complication profile (5). Some groups are also describing proximal fixation within zone 0 and 1, which allows for an easier distal anastomosis, particularly when using the trifurcated stent grafts (6).

Within Europe, two hybrid prostheses are available on the market: E-Vita Open (Artivion, Kennesaw, GA, USA) and the Thoraflex hybrid device (Vascutek Terumo, Inchinnan, Scotland, UK). Elsewhere two other FETs are commercially available: the Cronus (MicroPort, Shanghai, China) and the J graft (Japan Lifeline, Tokyo, Japan). Device design consists of a proximal Dacron surgical graft and a distal reinforced covered stent graft designed to seal in the descending thoracic aorta (DTA), connected by a cuff to which the distal arch anastomosis is sutured. If further or subsequent endovascular reintervention is required, the stent-graft component may provide a landing zone for the distal extension. Furthermore, and particularly in the setting of acute aortic dissection, the FET technique has been associated with a reduction in residual patency of the false lumen whilst encouraging aortic wall remodeling (7).

Ho *et al.* are to be congratulated on their initial experience of the branched E-vita open NEO (8). Over a 12-month period involving 25 patients across two centres, zero mortality and stroke was achieved, and 8% spinal cord injury. Previous studies have reported rates of up to 10.2%, 7.7% and 6.5% for 30-day-mortality, stroke, or spinal cord injury, respectively (7). This reinforces a primary concern for the use of any hybrid stent graft prosthesis, which is spinal cord injury. In their experience, the cohort of patients at Gangnam Severance Hospital (GSH) had the length of the stent graft chosen such that the distal landing zone was located above T8–T10, while at Prince of Wales Hospital (PWH), the distal landing was planned superior to T8. Overall, 32% of patients had the extent of coverage at or distal to T8. Whilst only a small number, the two patients who suffered spinal cord injury were from the PWH. Furthermore, the mean length of stent graft was longer at GSH compared to PWH (137.7 *vs.* 128.7 mm), and across both sites most distal anastomotic sites were in zone 2. It is difficult then to determine the exact aetiology of the spinal cord injury, as this may be a result of a multifactorial process; lower body circulatory arrest time,

level of hypothermia achieved, atherosclerotic disease or the native aorta, embolization of debris, and adjunctive neuroprotective methods such as cerebrospinal fluid (CSF) pressure monitoring and lumbar drainage systems.

In a joint position paper on the management of thoracic aortic pathologies involving the aortic arch (9), the European Association for Cardio-thoracic Surgery (EACTS) and European Society for Vascular Surgery have recommended FET to be considered in patients with acute type A aortic dissection with a primary entry in the distal aortic arch or in the proximal half of the DTA to treat associated malperfusion syndrome or to avoid its postoperative development; in patients undergoing surgery for acute type A aortic dissection to prevent mid-term aneurysmal formation in the downstream aorta; in patients with complicated acute type B aortic dissection when endovascular interventions are contraindicated; and in patients with concomitant distal thoracic and thoraco-abdominal aortic disease that, in a later stage, will or is likely to require either surgical or endovascular treatment. Despite large institutional experience being gained across many centers (10), the aortic community continues to decipher the intricacies of this technique (11).

Ho *et al.*'s report on their experience with the branched E-vita open NEO, as published recently in the *Journal of Thoracic Disease* adds considerable weight to the current landscape of management of complex aortic arch pathology with a novel hybrid stent graft device. Long-term metrics regarding survival, quality of life improvement as well as cost-effectiveness remain overall scarce. Although the short-term results are reassuring, we look forward to longer term follow-up, which will further strengthen this ever-evolving area in cardiac and aortic surgery.

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