Perspective

Descending endograft for DeBakey type 1 aortic dissection: pro

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The surgical management of patients with DeBakey type 1 acute aortic dissection (DBT1-AAD) represents a major challenge for aortic surgeons. It has been demonstrated that the distal false lumen remains patent in about 70% to 80% of patients undergoing DBT1-AAD surgery and that a patent false lumen worsens the prognosis. In order to improve long term outcomes and reduce the frequency of late aneurysm formation and reoperation, a more aggressive primary operation involving total arch replacement (TAR) and concomitant antegrade stenting of the descending thoracic aorta (DTA) with a frozen elephant trunk (FET) has been introduced. Such extensive operations, however, remain controversial due to their increased technical complexity and perceived higher operative mortality and morbidity. This perspective article will overview the rationale behind, and the potential advantages and current evidence for, FET surgery in acute aortic dissection.

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Despite improvements in diagnostic techniques and refinements in management strategies, DeBakey type 1 acute aortic dissection (DBT1-AAD) continues to represent a great challenge for aortic surgeons. The optimal surgical management is still an open question and several issues remain under debate. Emergency surgery is the mainstay of therapy but hospital mortality still ranges from 15% to 30% (1-4). Given the high risk profile of patients with acute aortic dissection and the technical complexity of the necessary interventions, a conservative tear-oriented aortic replacement (more often a supra-coronary ascending/hemiarch replacement) with commissural resuspension and re-establishment of the dominant blood flow in the distal true lumen currently represents the most common surgical approach. However, it has been demonstrated that the distal false lumen remains patent in about 70% to 80% of patients undergoing surgery for DBT1-AAD dissection (5-8), and a wide and patent false lumen worsens the prognosis (6,9-16) by increasing the risk of late death, re-intervention and aneurysmal dilatation of the remaining dissected aorta (6,17-21). The regions with the highest risk of developing an aneurysm are the distal arch and proximal descending thoracic aorta (DTA) (17,22-24). In patients undergoing DBT1-AAD repair, freedom from aortic reoperation at 10 years ranges from 61% to 74% (10,20,25). To reduce the frequency of late aneurysm formation and reoperation, some surgeons have been motivated to perform more aggressive primary operations, all associated with strengths and weaknesses. Recently, total arch replacement (TAR) and concomitant antegrade stenting of the DTA with a frozen elephant trunk (FET) has emerged as an interesting form of treatment for patients with extensive DBT1-AAD, and its application has significantly increased over recent years (26). Different methods of how to perform this procedure have been described, but the common feature is that, under hypothermic circulatory arrest, the stent graft is delivered antegradely into the DTA through the open aorta and sutured into position while the transverse arch is replaced with a Dacron graft. Such extensive operations, however, remain controversial due to their increased technical complexity and perceived higher operative mortality and morbidity.

Arguments for DTA endograft during DeBakey type 1 acute aortic dissection repair (DBT1-AAD)

As opposed to more conservative interventions, the

rationales for TAR and concomitant antegrade stenting of the DTA, lies in its potential to more effectively treat patients with complex primary and re-entry intimal tears in the distal aortic arch and/or proximal DTA, optimize true lumen perfusion and minimize the effects of distal malperfusion and promote distal thoracic aortic remodelling and reduce late aortic events associated with a patent false lumen.

Distal arch tears and extensive arch disease

Complete resection of the primary intimal tear is mandatory for obtaining satisfactory early and long-term results in patients with acute aortic dissection (27-29). In patients with severe aortic arch compromise by the dissecting process, TAR seems to be more effective than a conservative approach in avoiding bleeding, anastomotic leak, progression of aneurysmal dilatation, aortic rupture, reoperation and brain injury (11,27,28). In this setting, the FET technique is a valuable adjunct to TAR in patients with complex primary and re-entry tears involving the distal arch and proximal DTA, distal arch and DTA rupture, an aneurysmal arch and proximal DTA, and a severely damaged aortic arch hampering safe distal aortic arch anastomosis. The FET construction may facilitate surgery by avoiding complex and unsafe distal anastomoses, performed at the level of the proximal DTA at high risk of rupture or bleeding due to the fragile dissected aortic wall. In fact, by taking advantage of the distal stent-graft with the FET technique, a distal anastomosis can be more easily carried out at a more proximal level (proximal to the left subclavian or left common carotid artery), still achieving valid exclusion of the distal arch tear (30). Furthermore, by avoiding persistent DTA false lumen perfusion, FET enhances haemostasis at the distal anastomotic site.

Distal malperfusion

It has been estimated that distal malperfusion syndromes occur in up to 30% of patients, and represent one of the strongest determinants of early death in TAAD patients (31-33). Stent-grafting the DTA may offer the potential to more rapidly reverse the malperfusion process by opening the compressed true lumen and covering additional entry tears located in the proximal DTA, which endure pressurization of the false lumen.

Recently, several groups reported encouraging results using this approach, and showed how FET techniques (which are often associated with secondary endovascular procedures to optimize final results) can result in superior outcomes for this high-risk group of malperfused patients when appropriately employed in hybrid operative rooms by a multidisciplinary team (34,35).

Distal aortic remodelling

In TAAD patients, limited aortic resections have been associated with poor distal aortic remodelling due to distal false lumen degeneration. Late distal aortic complications, including aneurysmal degeneration, rupture, malperfusion and the need for extensive re-interventions have been observed in up to 70% of patients undergoing TAAD repair (18,36). In acute dissection, antegrade stenting of DTA at initial surgery, by inducing both coverage of the secondary entry tears located in the proximal DTA and obliteration of the false lumen at the proximal DTA, is expected to mitigate DTA dilatation and, therefore improve long-term survival by reducing aortic-related deaths and the need for complex distal aortic re-interventions.

Progression of the aortic disease seems to be related to some anatomical variables that, in the acute or sub-acute phase, may portend poor long-term outcomes and that might support, in appropriate conditions, a prophylactic stenting of DTA. In particular, a DTA diameter at initial presentation >35 mm was found to be a risk factor for a patent false lumen postoperatively (24); an initial false lumen diameter ≥22 mm was associated with accelerated aortic dilatation and occurrence of adverse aortic events (37), and a large proximal intimal tear (>10 mm) emerged as risk factor for dissection related events and mortality (38). Moreover, Marfan syndrome or other connective tissue diseases are well-known risk factors for distal aortic re-intervention (3,38). The use of stent-grafts in Marfan patients is controversial mostly due to the young age of these patients, the limited long-term data available for the endovascular procedures and the increased risk of stent-related degeneration of the weakened Marfan aortic wall. The latter can lead to stent-graft migration and occurrence of proximal and distal endoleaks. However, using FET technique, stent migration and proximal endoleak seem to be prevented due to the suture of the stent graft to the proximal descending aorta (39).

TAR using FET technique in DBT1-AAD patients is a highly demanding and time consuming operation which mandates thorough experience with the surgical and endovascular forms of the therapy for aortic dissection and

optimal methods of organ protection. Therefore not all patients, and not all surgeons, are good candidates for the FET technique and this procedure should be performed by experienced aortic surgeons in patients who are deemed to have physical conditions sufficient to withstand such major interventions (26).

Current evidence

Recently, a systematic review and meta-analysis was performed to assess results of antegrade stenting of DTA during TAAD surgery (26). In-hospital mortality (10%) and stroke (4.8%) rates were extremely satisfactory while the risk of spinal cord injury (4.3%) appeared to be higher than that reported in more conservatively managed series. In this setting, lately, Katayama *et al*. showed that in patients undergoing FET, postoperative spinal cord injury may be prevented or minimized by avoiding deep insertion of the stent graft, keeping blood pressure elevated after the operation and using cerebrospinal fluid drainage (40). Nevertheless, the spinal cord injury remains the main Achilles heel of FET procedure.

To date, there has been limited long-term data published on aortic remodelling, re-interventions and survival after DTA stent-grafting in TAAD patients. One-year survival ranged from 79% to 100%, 5-year survival ranged from 68% to 96% and 1-year freedom from re-intervention from 72% to 100% (41-47). In the above mentioned meta-analysis, the pooled average of aortic remodelling, indicated by a partial or complete thrombosis of the persistent DTA false lumen, was 88.9% (26). Despite this imaging data comparing favourably with the imaging data reported for conservative management (20,48), a substantial survival benefit of the FET techniques has yet to be demonstrated, and more robust data is necessary to standardize new paradigms of treatment in patients with acute dissection.

Conclusions

Current evidence suggests the DTA endograft plays an increasingly important role in modern DBT1-AAD surgery. Patients with complex arch tears involving the distal arch and/or proximal DTA, and patients with distal malperfusion and compression of the true lumen at the DTA certainly represent an interesting subset for FET application. When used by experienced surgeons on selected patients, these techniques have been associated with satisfactory early outcomes, encouraging long-term radiological results and fewer re-intervention rates. Nevertheless, stronger evidence is still needed to assess long term clinical outcomes in this setting.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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