HYBRID SURGERY FOR THORACO-ABDOMINAL AORTIC ANEURYSMS: IS THIS REALLY A LESS AGGRESSIVE AND LASTING SOLUTION?

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Abstract

Thoraco-abdominal aortic aneurysm (TAAA) repair remains a formidable challenge to vascular surgeons with the open repair associated with a high morbidity and mortality despite advances in surgical technique and peri-operative care. Hybrid repairs, combining traditional open surgical and newer endovascular techniques are considered to be less invasive and have been successfully used for those not fit for an open operation. They may represent a viable treatment alternative to open surgery for this high-risk population. However, endovascular techniques and technology are constantly improving and evolving and we have yet to realize the full impact of fenestrated stents and branched grafts will have on TAAA repair. In the absence of an elegant wholly endovascular approach, hybrid surgery will remain a robust and adaptable method of treating this complex and life-threatening disease process.

Introduction

Thoraco-abdominal aortic aneurysms (TAAA) are defined by the involvement of the origins of the coeliac, superior mesenteric and renal arteries. Crawford's classification is universally accepted [1] (Fig. 13.1), although Safi subsequently added a fifth class of TAAA in his version of the classification system (Fig. 13.2) [2].

The open repair of TAAA has a high mortality and morbidity when treated by open techniques [3, 4]. These risks have persisted despite advances in operative technique (including left heart bypass, spinal cord protection, hypothermic cardiopulmonary arrest and selective visceral perfusion) and higher standards of peri-operative care.

In 1991, Parodi used the first endovascular stent-graft (EVSG) in an infra-renal abdominal aortic aneurysm [5]. As a direct evolutionary step, by 1994, endovascular techniques had developed such that Dake was able to use an EVSG for descending thoracic aortic aneurysms [6]. This use of EVSG for TAAA limited to the thoracic segment showed significant early promise. However their use for more extensive TAAA was necessarily limited by the presence of the visceral and renal arteries in the chest and abdomen.

Hybrid repairs of TAAA refer to procedures combining both open surgical and endovascular techniques (either staged or within the context of one operative procedure). By re-vascularising vital aortic side branches first, it is then possible to achieve total endovascular aneurysm exclusion. When the visceral and renal vessels are involved in the TAAA and require retrograde re-vascularisation, we refer to this operation as the visceral hybrid repair.

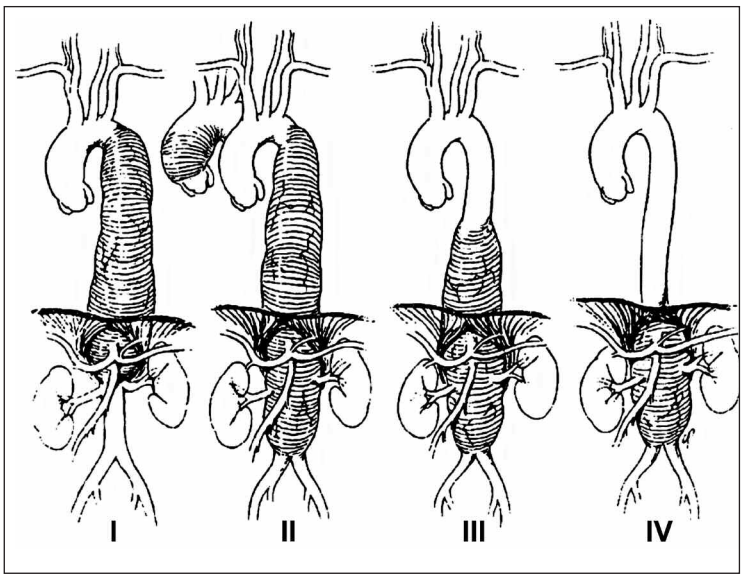

Fig. 13.1. – Crawford's classification system of thoraco-abdominal aortic aneurysms.

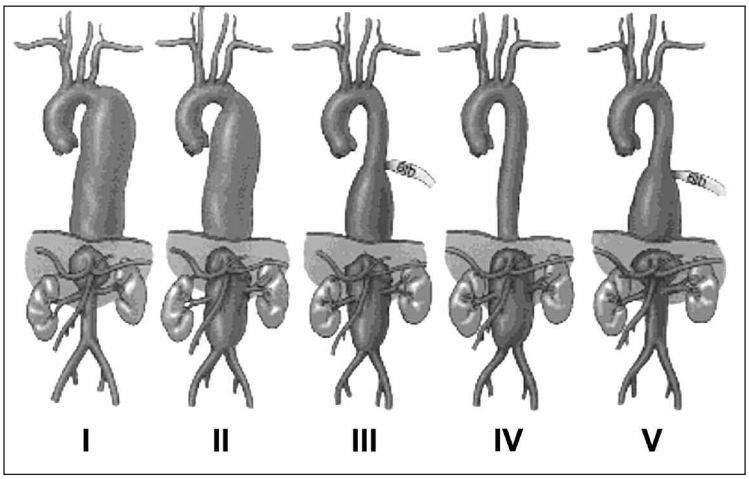

Fig. 13.2. – Safi's classification system of thoraco-abdominal aortic aneurysms.

Experiences of hybrid repairs of TAAA

Hybrid repairs of TAAA begin with an open abdominal procedure to first re-vascularise the visceral and or renal vessels depending on their relationship to the TAAA. This is followed by aortic endovascular stent-grafting (either as part of the same procedure or intentionally delayed). These repairs are particularly attractive and thought of as less invasive as they avoid the need for a thoracotomy, supra-coeliac aortic cross clamp, left or full heart bypass as well as the extensive tissue dissection all associated with an open repair.

In 1999, Quinones-Baldrich et al were the first to report a combined endovascular and open surgical approach for a type IV TAAA [7]. Previous abdominal aortic surgery and concomitant visceral artery aneurysms precluded an open repair. Retrograde visceral bypass-

es from a limb of a pre-existing bifurcated aortic tube graft were performed followed by TAAA stent-grafting.

Following this report, several centres around the world have published individual cases/small series (<5) of hybrid approaches to TAAA [7-24]. The results of these cases are encouraging considering the complicated nature of the TAAA disease process as well as the patients' co-morbidities. Of the 30 patients in this combined series, spinal cord ischaemia appeared to be rare or went unreported. Other post-operative complications were greatly reduced and intensive care stay was less than that of open TAAA surgery. Of note, no standard operative technique was employed and there was much variation in the EVSG used.

Resch *et al.* have reported their series of 13 staged hybrid repair of TAAA [25]. They all underwent retrograde visceral bypasses (11 ilio-visceral and 2 infrarenal aortic – visceral) as a first procedure prior to completion with EVSG. They report a 30-day mortality of 23% (3/13) for all patients. Their mean follow-up in the 10 surviving patients was 23 months (1-45) during which time a further 2 deaths were related to the hybrid repair. 2 Patients unfortunately suffered paraplegia and 2 further patients had transient parapetic events.

Most recently, Zhou *et al.* [26] published their series of 31 high-risk patients undergoing hybrid approaches to TAAA. Although there were a variety of hybrid approaches used for these TAAA, 18 of these patients had aneurysms involving the visceral vessels: Crawford type I (3), III (8) and IV (7). They reported 15 patients required iliac to coeliac artery bypasses, 15 required iliac to SMA bypasses and 10 required iliac to renal artery bypass grafting. There was no incidence of stroke or paraplegia reported in their series.

St Mary's visceral hybrid repair

Technique

The patient is placed in a supine position under general and epidural anaesthesia, with routine cerebrospinal fluid drainage. We routinely use cell salvage techniques (with rapid infusers available) and invasive monitoring with arterial and central venous lines, urethral catheterisation, and transoesophageal echocardiography.

A mid-line laparotomy allows for adequate exposure of the abdominal aorta, the origin of each renal artery, the coeliac axis, and the superior mesenteric artery (SMA). The inflow site for visceral bypass grafting is determined by previous abdominal aortic surgery and distal extent of aneurysmal disease. Where a previous infra-renal repair has been undertaken the bypass grafts are anastomosed in an end-to-side fashion to the existing graft. Where an infra-renal repair is possible, this is completed first and bypass grafts are subsequently sutured as before. If the infra renal aorta is normal an arteriotomy is performed and the bypass grafts anastomosed in an end-to-side fashion to the native aorta. If the aneurysmal disease extends to the bifurcation, one external iliac artery provides the inflow sites.

Most often two inverted (14 by 7 mm or 16 by 8 mm) Dacron® grafts function as the conduits. The renal arteries are sequentially anastomosed in an end-to-side fashion. The two remaining graft limbs are routed along the base of the small bowel mesentery to the coeliac axis and SMA in an end-to-side fashion. If Doppler signals are satisfactory in the

Fig. 13.3. – Type III TAAA.

Fig. 13.4. – Type III TAAA repaired with visceral hybrid procedure.

bypass grafts (with the origins of the native vessel clamped) they are subsequently suture-ligated to prevent retrograde flow into the aneurysm sac (termed Type II endoleak).

Following successful visceral and renal bypass a suitable access site is chosen for endovascular stent deployment: usually a dedicated conduit attached to the common iliac artery or the abdominal aorta. An angiogram catheter is introduced on the contra-lateral side and the stents are deployed in a sequential fashion from the left subclavian artery through the thoracic aorta to the landing zone. Completion angiography after adjunctive procedures (extension cuff, giant Palmaz stent, balloon moulding) then confirms exclusion of the aneurysm.

Our unit prefers this technique for Crawford Type I, II, and III TAAA, while an open approach with medial visceral rotation is used for Crawford Type IV aneurysms (Figs. 13.3, 13.4).

Results from the Regional Vascular Unit, St Mary's Hospital

Our unit's results were recently published by Black *et al.* [27], but up-to-date results are summarised below:

- n = 54 patients;
  - age: median 76, range 26-81;
  - sex: male 28, female 26;
  - mean ASA Grade: 3;
  - 36 elective, 13 urgent, 5 emergency;

– Crawford Type I (5), type II (25), type III (19), type IV (1) and complex (4);
- the median ischaemic time is 15 minutes (range 13 – 27min) for each anastomosis;
- 9.3% paraplegia (5/54) within 30 days;
- elective 30-day mortality of 16.7% (6/36).

Advantages

The Authors perceive several advantages of this approach over standard, open techniques:

- no thoracotomy:
  – potentially fewer pulmonary complications;
  – fewer cardiac arrhythmias;
  – less pain;
- reduced hypothermia with subsequent reduction in:
  – coagulopathy;
  – cardiovascular instability;
- reduced rate of spinal cord ischaemia;
- reduced duration of mesenteric and visceral ischaemia with reduction in:
  – acidosis and associated problems;
  – gut bacteria translocation/sepsis;
  – renal failure/use of renal replacement therapy;
- less blood loss/reduced transfusion requirement;
- reduced hospital stay:
  – ITU;
  – absolute;
- more patients can be treated where co-morbidity previously excluded them.

Conclusions

The future of hybrid repairs

The visceral hybrid repair of TAAA may be a bridging measure until branched EVSG technology matures to the point of established use.

Endovascular repair of juxtarenal and suprarenal abdominal aortic aneurysms with preservation of visceral perfusion by fenestrated [28, 29] or branched [30] EVSG has been shown to be feasible, and, using similar technology, several authors have described total endovascular repair of complex thoracic aortic disease [31, 32]. Until recently Chuter et al were the only authors to report total endovascular repair of a TAAA with preservation of all four visceral vessels in a single patient [33]. Anderson *et al.* reported a series of 4 patients treated in this way: 12 of 13 target vessels were revascularised, with no endoleaks. 3 of the patients required further procedures to correct bleeding from access vessels, and one patient died from multi-organ dysfunction syndrome after such a procedure. CT at 12 months confirmed antegrade perfusion in all 10 target vessels [34].

Further improvement of, and access to, such devices, and correct patient selection (in light of the EVAR 2 trial results) [35] will see a reduction in the numbers of visceral hybrid procedures being performed for TAAA. In the meantime, and in cases unsuitable

for fenestrated/branched EVSG, the visceral hybrid repair remains a robust and an adaptable method of treating this complex and life-threatening disease process.

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