Hybrid Repair of Thoracoabdominal Aneurysm: A Two-Stage Approach

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Despite higher standards of perioperative care and refinements in operative techniques, conventional open repair of thoracoabdominal aneurysms (TAAAs) is still associated with remarkable morbidity and mortality rates. Hybrid procedures as an option to traditional surgical procedures are still debated, especially in elderly patients with severe comorbidities. We report the experience of our institution using a hybrid technique in a subgroup of high-risk patients in an attempt to improve the results.

The gold standard for complex thoracoabdominal aortic aneurysms (TAAAs) is open surgical repair [1, 2]. Despite recent improvements in anesthesia and surgical techniques, this complex and demanding procedure is still associated with significant morbidity and mortality [3].

Hybrid approaches have been introduced to improve outcomes and extend indications to high-risk patients [4, 5]. We describe our hybrid technique, which was used in 7 male patients with extensive TAAAs who underwent aortic repair between July 2011 and December 2012. The mean age of the patients was 69.7 ± 10.1 years. The 7 patients were defined as high risk because of the presence of severe associated disease (chronic renal failure in 2 patients, chronic obstructive pulmonary disease in 3 patients, and a left ventricular ejection fraction < 30% in 1 patient) and old age (> 75 years).

Type B chronic dissection was present in 3 patients, 3 patients had type A residual chronic dissection, whereas chronic degenerative aneurysm was seen in only 1 patient. All patients had undergone previous aortic open procedures (100%).

Technique

In all cases a 2-stage approach was used. The first surgical stage was performed using general anesthesia with the patient in a supine position. A transperitoneal abdominal approach, similar to that used for conventional infrarenal abdominal aortic aneurysm (AAA) repair, was used, which allowed exposure of the abdominal aorta, the iliac arteries, and the origins of the renal arteries, the superior mesenteric artery (SMA), and the celiac trunk.

The isolation of the visceral arteries represents the first step of the procedure. The celiac trunk is isolated passing through the retroepiploic cavity after mobilization and twisting the left hepatic lobe to the right. Afterward, the left renal vein is carefully mobilized and the renal arteries are visualized and isolated. Finally, the SMA is isolated at the origin of the mesentery in the inferior aspect.

Once the exposure of the visceral vessels is completed, systemic heparin at a dose of 100 U/kg is administered. Replacement of the infrarenal aorta using a multibranched graft is performed. The Coselli thoracoabdominal graft (Vascutek/Terumo, Renfrewshire, Scotland) was used in 6 patients and the Lupiae branched arch graft (Vascutek/Terumo) was used in 1 patient. In 5 patients, a bilateral iliac aneurysm repair was performed, and in those cases a multibranched bifurcated graft was assembled intraoperatively.

Visceral rerouting usually starts from the left renal artery followed by the right renal artery, the SMA, and the celiac trunk. The limb for the celiac trunk is tunneled behind the pancreas. The anastomoses are usually performed in an end-to-end manner using a 6-0 polypropylene suture (Fig. 1). However, in 2 cases it was necessary to perform an end-to-side anastomosis with the celiac trunk and the SMA because the detachment of their origin from the aorta was difficult. Renal protection is achieved with infusion of Custodiol HTK solution (Essential Pharmaceuticals, Newtown, PA) after renal detachment (0.5 L for each kidney). All grafts were covered with the residual aortic wall and a pericardial patch to avoid any adhesion between the bowel and the prosthesis and constriction of the branches.

The second endovascular stage is performed with routine lumbar cerebrospinal fluid drainage and invasive cardiovascular monitoring. The vascular access was in all...
cases the femoral artery. The endovascular procedure was performed 2 to 4 weeks after the first procedure (mean time, 29 days).

A median of 1.43 stent grafts was deployed in each patient (1 in 4 patients and 2 in 3 patients). All patients underwent computed tomography at hospital discharge and at follow-up at 1, 6, and 12 months (Fig 2). Hospital survival was 100%. No patients experienced major neurologic events or bowel ischemia, and only 1 patient had postoperative renal insufficiency requiring hemodialysis (14.3%). At a median follow-up of 9.6 months, all grafts remained patent. No patients had type I endoleak, whereas in 2 patients (28.6%), type II endoleak was identified.

Comment

Open surgical repair of TAAAs is still associated with high mortality and morbidity, particularly in high-risk patients such as elderly patients or patients with significant comorbidities (cardiac, renal, or pulmonary). Conversely, endovascular treatment of extensive TAAAs (Crawford types II and III) is limited by the involvement of the visceral vessels.

Recently, a “hybrid” option became available, consisting of visceral aortic debranching with rerouting of the visceral arteries and aneurysm exclusion using straight thoracic endografts; this approach may have advantages in high-risk patients, and offers the potential to offer therapy to those ineligible for conventional open repair.

Heterogeneity of the morbidity and mortality rates among different studies raised debate about the benefits of hybrid procedures in TAAA treatment [4–7]. In a recent series, Quinones-Baldrich and colleagues [6] demonstrated that a combined endovascular and surgical approach to thoracoabdominal aortic pathologic processes can be performed with acceptable results in high-risk patients using either a 1- or 2-stage procedure. The 2-year cumulative survival was 76% and 80%, respectively, in patients with disease classified as III/IV according to the American Society of Anesthesiologist (ASA) classification. Different conclusions came from the recent meta-analysis of Mou-lakakis and colleagues [7], in which the hybrid repair of thoracoabdominal pathologic conditions in patients who were poor surgical candidates was still associated with significant morbidity and mortality. The proportional meta-analysis for overall spinal cord ischemia symptoms showed a pooled proportion of 7.5% (95% confidence interval, 5.0%–11.0%), whereas the meta-regression analysis showed that the pooled estimate for a primary technical success rate was associated, at a statistically significant level ($P = .02$), with the mean age.

These results are probably justified by the technically demanding operation and in particular by some unresolved issues such as type 1B endoleak, impaired patency of the graft with potential visceral or renal ischemia, and the onset of paraplegia caused by closure of all the intercostal and lumbar arteries.
Advantages of our technique include the following:

- The replacement of the infrarenal abdominal aorta allows a sure distal landing zone, which significantly reduces the risk of type 1B endoleak.
- The use of a multibranched prosthesis (such as the Coselli graft) taking origin from the infrarenal abdominal aorta seems to play a role in reducing the length of the prostheses used for the reimplantation of the visceral arteries. This should theoretically preserve long-term patency of the grafts themselves because it allows better physiological perfusion.
- There is a reduced risk of paraplegia after ligation of the lumbar arteries, probably because the implantation of the endovascular graft 1 month after the surgical procedure allows the development of collateral circulation for the spinal cord. Obviously, this can be achieved only when the second stage has not been anticipated for the potential rupture of the aneurysm in symptomatic patients. The mechanism of action is becoming understandable in terms of the collateral network concept for spinal cord perfusion and protection. Inputs into this network include not only the segmental vessels but also branches of the subclavian and hypogastric arteries [8]. The recognition that an important source of blood supply to the spinal cord comes from these arteries provides a physiological explanation for the surprising absence of spinal cord injury in this small series of patients, given the extensive nature of the repair and the complex disease. To reduce neurologic events, the routine use of spinal catheter drainage was adopted in all patients, and a mean blood pressure reading of 80 mm Hg during the perioperative period was maintained.
- Finally, the procedure can be performed through a transabdominal approach without thoracotomy, cardiopulmonary bypass, and hypothermia, leading to a shorter postoperative recovery period.

In conclusion, according to our small series, this 2-stage combined endovascular and surgical approach is a safe and effective alternative to open surgical repair of thoracoabdominal aortic aneurysm in high-risk and old patients. The preliminary results are extremely encouraging, even if long-term results are required.

References