Central cannulation (aortic and pulmonary artery) and sequential clamping from distal to proximal in the surgical management of chronic type B dissection utilizing hypothermic circulatory arrest

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Clinical vignette

A 66-year-old gentleman presents with extent II thoracoabdominal aortic aneurysm (TAAA) secondary to chronic dissection with a maximal diameter of 6 cm. Partial thrombosis of false lumen in thoracic and abdominal aorta was present. Intimal tear was detected at the origin of the left subclavian artery and the dissection extended down to the aortic bifurcation. The left femoral artery, ascending aorta and pulmonary artery (PA) were healthy. Left ventricular function was good.

Surgical techniques

After standard anesthetic preparation for left thoracotomy, monitoring measures were set up including right radial arterial and femoral arterial lines for proximal and distal pressures, central venous pressure monitoring line, Near Infrared Spectrometry (NIRS) (INVOS, Covidien, USA) for cerebral oxygen saturation monitoring, a spinal drain for CSF pressure and motor evoked potential (Medtronic NIM-ECLIPSE system, Minneapolis, USA) monitoring for intraoperative and postoperative spinal monitoring.

Left thoracolaparotomy was performed via the 5th intercostal space. The 5th rib was resected posteriorly and the costal margin was divided anteriorly to facilitate exposure. A retroperitoneal approach was used to expose the abdominal aorta down to bifurcation. Left femoral artery was exposed for cannulation and pericardium was opened to expose the PA and ascending aorta. The patient was heparinized and cardiopulmonary bypass (CPB) established with a left femoral artery cannula [18 French (F)] and PA venous return cannula (32 F). After establishing CPB, the ascending aorta was cannulated with 20-F cannula and arterial flow was switched to this cannula. Patient core body temperature was then brought to 22 ℃ by systemic cooling. A left ventricular (LV) apical vent was inserted to prevent LV dilatation. During cooling, the infrarenal aorta was cross-clamped and distal aorta just above the bifurcation was fashioned and fenestrated by excising dissection membrane. It was anastomosed to a 26 mm Vascutek graft (Gelsoft™ Plus Vascutek, a Terumo Company, UK) using continuous 3.0 prolene. Reinforcement was performed with interrupted teflon pledgeted 3.0 Prolene sutures posteriorly, from inside. Perfusion of lower limbs was re-adopted through the femoral cannula.

At target temperature, hypothermic circulatory arrest (HCA) was established. The proximal descending aorta (DTA) was opened and thrombus from false lumen was evacuated. Left common carotid artery and innominate arteries were cannulated with 13 F retrograde cardioplegia cannulae (DLP® Silicone RCSP Cannulae, Medtronic-USA) and selective antegrade cerebral perfusion started. Abdominal aorta arteriotomy was performed down to the infra-renal segment and both true and false lumens were opened along the length. Thrombus from the false lumen was evacuated. Coeliac artery, superior mesenteric artery (SMA) and both renal arteries were identified, cannulated with 13 F and 10 F cannulae (Medtronic, USA) and perfused with cold blood at 22 ℃. A 28 mm Vascutek graft (Vascutek® Vascular Grafts, UK) was anastomosed to proximal DTA at the origin of LSA using continuous 3.0

Prolene suture in reversed elephant trunk fashion. It was reinforced with interrupted Teflon pledgeted 3.0 Prolene sutures tied posteriorly. Upper body circulation was re-established through the ascending aortic cannula, and the proximal DTA graft was cross-clamped to check hemostasis.

A 12 mm Hemashield graft (MAQUET Cardiovascular, Rastatt, Germany) was used to reimplant a large lumbar artery and lower thoracic intercostal arteries in a side-to-side manner, using continuous 4.0 Prolene. This graft was then perfused with cold blood. The right renal artery, coeliac artery, SMA and finally left renal artery were anastomosed to corresponding branches of Vascutek Multibranch Thoracoabdominal Coselli graft using continuous 5.0 Prolene. The thoraco-abdominal multibranch graft was then anastomosed distally to the infra-renal aortic graft and proximally to the distal DTA graft, using continuous 3.0 Prolene.

After de-airing, the aortic cross-clamp was removed. Proximal and distal ends of the intercostal artery conduit graft were anastomosed onto lower descending graft and infra-renal graft using continuous 4.0 Prolene with partial occlusion clamps.

The LV apical vent was removed and cannulation site repaired. Arterial perfusion was switched to the femoral artery cannula. The ascending aortic cannula was removed and the cannulation site repaired with Teflon pledgeted 3.0 Prolene. PA venous cannula was removed and the cannulation site was repaired. Patient was weaned off CPB on adrenaline infusion. Femoral venous and arterial cannulae were removed and cannulation sites sutured. Multiple back-bleeding intercostal arteries from true and false lumens of aorta were sutured. Final hemostasis was achieved by packing and transfusion with two adult doses of platelets, 4 F frozen plasma and two cryoprecipitate.

Comments

Despite significant advances in perioperative critical care, anesthetic and surgical techniques, the repair of TAAA remains associated with a high morbidity and mortality (1). The era of “clamp and sew” has become historical along with its high mortality and morbidity, in particular paraplegia. Instead, circulatory adjuncts are favored in the modern practice of thoracoabdominal aneurysm repair. The ideal method of cannulation and perfusion in surgical management of chronic dissecting aneurysm of the thoracoabdominal aorta remains debatable. Although this is mainly dependent on the pathology involved and the extent of the aneurysm, it is difficult to isolate a single best method of cannulation to establish circulatory support and safe aneurysmal resection and repair.

Left heart bypass (LHB) is an accepted method for providing decompression of the proximal aorta in conjunction with distal perfusion of the abdominal viscera, spinal cord, and lower extremities (2). This potentially mitigates complications associated with distal ischemia such as generalized metabolic acidemia acute tubular necrosis or overt renal failure, and paraplegia.

The main advantages of LHB are low mortality and paraplegia incidence and a reduction in heparinization that may alleviate bleeding from the left lung. If necessary, extra pumps and heat exchangers could be added to the circuit, thus providing coeliac, SMA and renal perfusion at a variable temperature. However, LHB does not enable full control of cardiopulmonary function in the case of cardiac dysrhythmias and arrest (3). It is ineffective for patients with aneurysms involving the distal arch and who require HCA, and the control of temperature is suboptimal. Additionally, the blood from the surgical field requires management with cell-saver, which in turn can lead to the depletion of clotting factors and platelets.

In patients with dissecting aneurysm that do not have a suitable proximal aortic clamping zone, CPB and DHCA are the standard circulatory options. The use of DHCA in TAAA repair has its merits and limitations (4). Although this method is simple and an effective intervention to provide substantial protection against paraplegia and organ dysfunction, it is associated with an increased risk of coagulopathy and pulmonary complications due to the prolonged CPB time. Hence, a multitude of selected protection methods need to be employed to effectively improve outcomes.

It is a common practice to utilize femoral artery and vein (peripheral) cannulation for establishing CPB during TAAA surgery. However, in chronic type B dissection, the risk of malperfusion is significantly high due to partial thrombosis of the false lumen and varying origins of visceral and supra-aortic branches (5).

In our experience, we advocate the use of central cannulation due to its simplistic use and ease of applicability. This technique has the advantage of being performed without disrupting the aneurysmal wall and its associated pathology including chronic dissection, intramural hematoma and thrombus within the aortic wall. Technically, this intervention allows access to the supra-aortic vessels for cerebral protection, and proximal and distal aortic pressure control, avoiding pressure overload and its adverse effects. In particular, this method is effective during repair of chronic dissection in thoracoabdominal aortic repair. The atheromatous or chronically dissected segment can potentially cause retrograde cerebral embolism and malperfusion. To avoid this potential complication, the circulation can be supported initially by antegrade perfusion from a central approach utilizing the PA and ascending aorta. The benefit of this approach is the prevention of prolonged DHCA, allowing adequate perfusion to all vital organs. On the other hand, central cannulation can be limited in patients with a deep chest and reduced accessibility to the ascending aorta, and in patients with prior cardiac and ascending aortic surgery.

In summary, CPB with central cannulation provides a safe alternative means of circulatory support during TAAA repair in chronic dissection.

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References

1. Wong DR, Parenti JL, Green SY, et al. Open repair of thoracoabdominal aortic aneurysm in the modern surgical era: contemporary outcomes in 509 patients. J Am Coll Surg 2011;212:569-79; discussion 579-81.
2. Coselli JS. The use of left heart bypass in the repair of thoracoabdominal aortic aneurysms: current techniques and results. Semin Thorac Cardiovasc Surg 2003;15:326-32.
3. Ballard JL, Duensing RA. Extracorporeal techniques in thoracoabdominal aortic surgery. Semin Vasc Surg 2000;13:331-9.
4. Yoo JS, Kim JB, Joo Y, et al. Deep hypothermic circulatory arrest versus non-deep hypothermic beating heart strategy in descending thoracic or thoracoabdominal aortic surgery. Eur J Cardiothorac Surg 2014. [Epub ahead of print].
5. Veron S, Neri E, Buklas D, et al. Cannulation of the extrathoracic left common carotid artery for thoracic aorta operations through left posterolateral thoracotomy. Ann Vasc Surg 2004;18:677-84.