Masters of Cardiothoracic Surgery

Open repair of a thoracoabdominal aortic aneurysm using hypothermic cardiopulmonary bypass and circulatory arrest

Nicholas T. Kouchoukos

Division of Cardiovascular and Thoracic Surgery, Missouri Baptist Medical Center, BJC Healthcare, St. Louis, MO, USA

Correspondence to: Nicholas T. Kouchoukos, MD. Missouri Baptist Medical Center, 3023 N. Ballas Road, Suite 150 D, St. Louis, MO 63131, USA. Email: ntkouch@aol.com.

Submitted Jan 13, 2023. Accepted for publication May 19, 2023. Published online Jun 12, 2023.
doi: 10.21037/acs-2023-scp-07
View this article at: https://dx.doi.org/10.21037/acs-2023-scp-07

Clinical vignette

A 78-year-old female presented with recent onset of interscapular chest pain. She was a smoker and had previously undergone coronary artery stenting. Left ventricular function was normal. A computed tomography (CT) angiogram showed aneurysmal degeneration of the distal descending thoracic and the entire abdominal aorta. There were high-grade stenoses at the origins of the celiac, superior mesenteric, and both renal arteries. This was classified as a Crawford extent III thoracoabdominal aortic aneurysm.

Surgical technique

Preparation

After induction of anesthesia, intubation with a double-lumen endotracheal tube, and placement of appropriate monitoring devices including a spinal fluid drain, a standard thoracoabdominal incision is made through the bed of the resected fifth rib.

Exposition

The incision is extended obliquely across the divided costal margin to the midline of the abdomen, terminating below the umbilicus. The diaphragm is divided circumferentially. The left common femoral artery and vein are exposed through an oblique incision in the groin crease. Heparin is administered, a two-stage venous cannula is inserted into the femoral vein with the tip positioned in the superior vena cava, and the femoral artery is cannulated. Ultrasonic examination of the thoracic aorta shows evidence of only minimal atherosclerosis on the posterior wall, and the descending thoracic aorta proximal to the aneurysm is cannulated with a straight dispersion cannula. Cardiopulmonary bypass (CPB) is established using the aortic cannula, and cooling is initiated. A venting catheter is inserted into the left ventricle through a purse-string suture in the left superior pulmonary vein.

Operation

During cooling, the aorta is separated from the surrounding tissues to the level of the aortic bifurcation. The heart fibrillates. When the nasopharyngeal temperature reaches 12 ℃, circulatory arrest is established and the ventricular vent is turned off. The descending aorta is clamped distal to the aortic cannula, and the aorta is incised vertically. The incision is extended to just above the aortic bifurcation, and the aorta is divided at this level. The origins of the renal and visceral arteries are identified. No intercostal or lumbar arteries suitable for implantation are identified. A four-branched aortic graft is cut to the appropriate length and positioned so that the three contiguous branches lie opposite the origins of the right renal, superior mesenteric and celiac arteries. The fourth branch, which is perpendicular to the other three, is ligated. The distal end of the aortic graft is sutured to the aorta with a continuous polypropylene suture reinforced with a strip of polytetrafluoroethylene felt, and sealed with BioGlue. Arterial flow is established to the lower body, and the aortic graft is clamped just proximal to the anastomosis. Flow is also established to the upper body. Two thirds of the total flow is directed to the lower body

and one third to the upper body. The temperature of the perfusate is maintained at 12–15 ℃.

Because of the severe stenosis present at the origins of the renal and visceral arteries, they are transected beyond the stenoses. The right renal artery is anastomosed end-to-end to the most distal branch of the graft with a continuous 5-0 polypropylene suture. The superior mesenteric and celiac arteries are attached in a similar manner. The distal aortic clamp is repositioned more proximally as each anastomosis is completed to minimize the ischemic times. A separate 8 mm collagen-impregnated graft is sewn end-to-end to the left renal artery with a 6-0 polypropylene suture. This graft is positioned beneath the aortic graft and sutured to the aortic graft on the left lateral aspect proximal to the aortic clamp, which is now located above the celiac artery graft. After evacuation of air from the renal artery graft, the aortic clamp is repositioned more proximally, and flow to the left renal artery is established. Rewarming is initiated at this time. The proximal aorta is divided and anastomosed to the graft with a continuous polypropylene suture reinforced with felt and BioGlue. The clamp on the aortic graft is released first to evacuate air, which is accomplished with multiple needle sticks into the graft. The clamp on the aorta is then removed to establish antegrade flow, and when rewarming is completed and hemostasis achieved, CPB is discontinued.

Completion

The duration of circulatory arrest was 23 minutes, the ischemic times to the kidneys and visceral arteries ranged from 44 to 90 minutes, and the duration of CPB was 170 minutes. The patient was extubated 16 hours postoperatively, and had normal cardiac, renal, hepatic, and central nervous system function. She required five units of red cells, four units of frozen plasma, and three units of platelets intraoperatively, and one unit of red cells postoperatively. She was discharged on the eighth postoperative day. A CT angiogram obtained three months postoperatively demonstrated patency of all four renal and visceral artery grafts.

Comments

Clinical results

In our experience with this technique in 285 patients, 74% of whom had Crawford extent II or III aneurysmal disease, the 30-day mortality was 7.4% (1). Stroke and permanent spinal cord injury occurred in 4.2% and 5.3% of patients respectively. Permanent dialysis was required in 3.9% of the patients discharged from the hospital. Early mortality for elective procedures was 5.6% compared with 32% for emergency procedures. Spinal cord ischemic injury was also lower for elective versus emergency procedures (4.5% *vs.* 15.8%).

Advantages

We believe the technique described offers several advantages over other techniques. It requires only minimal peri-aortic dissection and manipulation of the aorta, which reduces the risk for atheromatous embolization. It eliminates the need for sequential aortic clamping, another risk factor for atheromatous embolization. It provides access to the aortic arch, a bloodless operative field, and allows shed blood to be returned into the perfusion circuit. Monitoring of evoked potentials or separate perfusion of the renal and visceral arteries is not required. The rates of permanent paraplegia and permanent renal failure with this technique are among the lowest reported in the literature (1). Based upon our experience and that of others (2), routine use of this technique for management of extensive aortic disease requiring lateral exposure is justified, and remains our technique of choice.

Acknowledgments

Funding: None.

Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

References

1. Kouchoukos NT, Kulik A, Haynes M, et al. Early outcomes after thoracoabdominal aortic aneurysm repair with hypothermic circulatory arrest. Ann Thorac Surg 2019;108:1338-44.
2. Fehrenbacher JW, Siderys H, Terry C, et al. Early and late results of descending and thoracoabdominal aortic aneurysm open repair with deep hypothermia and circulatory arrest. J Thorac Cardiovasc Surg 2010;140:S154-S60.

Cite this article as: Kouchoukos NT. Open repair of a thoracoabdominal aortic aneurysm using hypothermic cardiopulmonary bypass and circulatory arrest. Ann Cardiothorac Surg 2023;12(5):506-508. doi: 10.21037/acs-2023-scp-07

