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CASE CONFERENCES

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Successful Open Repair of an Extensive Descending Thoracic Aortic Aneurysm in a Complex Patient

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THE OPEN REPAIR of an extensive descending thoracic aortic aneurysm (DTAA) frequently involves complex decision-making in a multidisciplinary fashion.[1–2] Given the risk of spinal cord ischemia in these procedures, a major focus in perioperative management is optimal protection of the spinal cord with possible strategies including deep hypothermic circulatory arrest, partial cardiopulmonary bypass, extensive neuromonitoring, and cerebrospinal fluid (CSF) drainage.[2–4] This case conference illustrates these principles to highlight the utility of a tailored approach to DTAA repair, taking into account specific patient characteristics. The ability of the anesthetic and surgical teams to integrate unusual patient features into a successful perioperative plan remains essential for the optimal outcome after open DTAA repair.

CASE PRESENTATION*

A 44-year-old male presented for open repair of a DTAA via left thoracotomy. Computed tomographic angiography of the aorta demonstrated a fusiform DTAA, measuring 5.8 cm at its largest diameter. This aneurysm originated immediately distal to the left subclavian artery and extended to the level of the aortic hiatus at the level of the diaphragm, thus covering the proximal (extent A), middle (extent B), and distal (extent C) thirds of the DTA (extent ABC).[5] Surgical management was recommended, given the maximal diameter >5.5 cm and a recent expansion rate of 10 mm per year (class I recommendation as per recent guidelines).[5] Given his minimal co-morbidities and young age, open surgical management was recommended, as per recent thoracic aortic guidelines.[5–6]

The patient's additional past history included hypertension, a traumatic right internal jugular vein injury, and a 2010 Heller myotomy for achalasia of the esophagus. The patient reported no dysphagia for liquids and solids. His physical examination was consistent with his history and otherwise was within normal limits. His laboratory studies were all within normal limits, except for an elevated partial thromboplastin time (PTT). Recent transthoracic echocardiography revealed normal biventricular function and no significant valvular disease. A myocardial stress test was negative for ischemia. His carotid ultrasound studies revealed no significant disease.

Review of his coagulation studies revealed a normal profile over time, except for an isolated chronically elevated PTT in the range of 36-41 seconds (normal range 20-34 seconds) with no clinical bleeding tendency or history of heparin exposure. There was no family history of a bleeding diathesis. There were no clinical features consistent with the antiphospholipid syndrome. Consultation with hematology confirmed no immediate contraindication to surgery and suggested elective investigation for an isolated mild clotting factor deficiency, if indicated, at a later time. Given that the patient was currently in the hospital with ongoing aortic pain despite strict blood pressure management, the decision was reached to proceed with definitive DTAA repair.

Even though the bleeding risk posed by the elevated PTT was trivial to mild, this risk was still very relevant for possible neuraxial procedures such as a lumbar spinal catheter for CSF drainage and an epidural catheter for perioperative analgesia. After a team discussion and review of the benefits and risks of CSF drainage, a joint decision was reached to proceed with DTAA repair without a lumbar spinal catheter or an epidural catheter, given that the risk for spinal cord ischemia was low in this case and alternative analgesic options were available. Furthermore, the team opted for aortic repair under deep hypothermic circulatory arrest to maximize spinal cord protection in this unusual setting.[7] Given this decision about perfusion management after team discussion, intraoperative monitoring with transesophageal echocardiography (TEE) was deemed essential to guide perfusion management, including adequate venting of the left ventricle from the left chest.[8] Because of his previous

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esophageal surgical procedure, the team also decided to minimize the risk of upper gastrointestinal injury by placing the TEE probe under endoscopic guidance.[9] The patient agreed to all components of the perioperative plan after full explanation. The patient also agreed to lumbar CSF drainage as a rescue procedure for spinal cord ischemia.

The intraoperative monitoring included standard American Society of Anesthesiologists monitors, a right radial artery catheter, and an oximetric pulmonary artery catheter. Comprehensive neuromonitoring included the full electroencephalogram to guide the level of hypothermia for circulatory arrest and somatosensory evoked potentials to monitor for spinal cord ischemia. After an uneventful induction of general anesthesia, the airway was secured with an adequately sized left double-lumen endotracheal tube to facilitate left lung collapse for optimal surgical exposure of the DTA via a left thoracotomy. The correct position of the endotracheal tube was confirmed and monitored intraoperatively with intermittent bronchoscopy. The pulmonary oximetric catheter was placed via the left internal jugular vein under real-time ultrasound guidance, given the history of a traumatic right internal jugular vein injury. The maintenance of anesthesia was with a balanced technique tailored to minimize anesthetic interference with neuromonitoring profiles. Subanesthetic doses of ketamine were added to augment perioperative analgesia. Upper gastrointestinal endoscopy under general endotracheal anesthesia confirmed adequate esophageal anatomy for safe placement of a TEE probe, which then was placed without incident. The TEE comprehensive examination confirmed the preoperative echocardiographic findings.

The patient then underwent left thoracotomy in the right lateral decubitus position. After the dissection was completed and adequate heparinization, the left femoral artery was cannulated successfully for cardiopulmonary bypass (CPB). Although the left femoral vein was cannulated easily, there was resistance to the advancement of a long venous catheter for CPB. The goal was to advance this venous cannula under TEE guidance into the body of the right atrium and then into the proximal superior vena cava for optimal venous drainage. The encountered resistance to passage of the femoral venous cannula might have been related to scar tissue from a previous inguinal hernia repair. The thoracotomy incision was extended to allow direct cannulation of the inferior vena cava from the left chest in a transpericardial fashion.[10–11] The correct position of the venous cannula tip was confirmed by TEE.

After uneventful initiation of cardiopulmonary bypass, the patient was cooled to electroencephalographic silence, which occurred at a nasopharyngeal temperature of 17.4 degrees Celsius.[12–13] A vent was placed via a left pulmonary vein for left ventricular decompression, and the heart was allowed to fibrillate during hypothermic CPB. The adequate venting of the left heart and the absence of clinically significant aortic regurgitation were monitored at frequent intervals by TEE during the procedure.

After administration of high-dose systemic steroids and initiation of deep hypothermic circulatory arrest, the descending aorta was divided just distal to the left subclavian artery and anastomosed to a vascular prosthetic graft. On completion of this proximal aortic anastomosis, it was tested for hemostatic integrity. Thereafter, the vascular graft was clamped and cannulated to allow upper body perfusion on hypothermic CPB at flows of 2 liters per minute while the distal aortic anastomosis was completed without lower body perfusion. The total time for deep hypothermic circulatory arrest was 19 minutes. Following completion of the distal aortic anastomosis, full CPB was reinstituted, and the patient gradually was rewarmed. The lower body ischemic time was 50 minutes, with a partial CPB time for upper body perfusion of 31 minutes. Separation from CPB was uneventful at a nasopharyngeal temperature of 35.7 degrees Celsius. The total time on CPB was 219 minutes.

Intraoperative spinal cord protection was optimal. The mean arterial pressure was maintained above 80 mmHg during CPB. The mean hematocrit was preserved above 26%. The only changes to the spinal cord tracings were related to systemic temperature management. Coagulopathy after protamine reversal of heparin rapidly was corrected with titrated transfusion of platelets and fresh frozen plasma. At the end of the case, the TEE probe was removed without any indications of gastrointestinal trauma. After surgical closure, the patient was returned to the supine position, and the double-lumen endotracheal tube was switched to a single-lumen endotracheal tube with an airway exchange catheter.[14]

In the intensive care unit, his sedation was weaned efficiently to facilitate early serial neurologic assessment. The spinal cord perfusion pressure was maximized with maintenance of the mean arterial pressure above 80 mmHg. Rescue CSF drainage with a lumbar spinal catheter was not required due to the freedom from spinal cord ischemia. He underwent uneventful tracheal extubation during the first postoperative day. Postoperative analgesia was maintained with patient-controlled intravenous narcotic analgesia. His stay in the intensive care unit was 2 days. His recovery thereafter was uncomplicated, except for the development of a left groin seroma which required a muscle flap by plastic surgery. His total hospital stay was 14 days. He was discharged home with a normal neurologic examination.

DISCUSSION

The Cardiac Surgical Perspective†

Spinal cord ischemia remains a devastating complication in DTAA procedures, whether open or not.[15,16] Although isolated open repair of a DTAA is associated with lower incidence of spinal cord compromise when compared with more extensive surgical repair of thoracoabdominal aortic aneurysms, perioperative strategies to optimize spinal cord protection remain essential, even more so in this young patient.

In this specific case, congenital mild coagulopathy determined the perioperative management of spinal cord perfusion to minimize the risk of spinal cord injury. Traditionally, DTAA repair can be managed with left-heart CPB in conjunction with lumbar CSF drainage.[17–18] This strategy maximizes spinal cord perfusion pressure by providing distal arterial perfusion and minimizes intrathecal pressure by providing spinal fluid drainage. This combination, therefore, achieves higher cord perfusion pressure, assuming that central venous pressure is not excessively elevated.[19–20] However, because placement of a lumbar spinal drain is associated with a significant risk of bleeding in the setting of coagulopathy, this traditional strategy of spinal cord protection was not straightforward in this particular patient.

Although the clinical utility of CSF drainage in DTAA repair has been well-documented, it always is important to balance its risks with its benefits when reaching a final decision about its role in a particular case.[21–23] Given the low risk of spinal cord ischemia in this clinical scenario and the increased risk for neuraxial hematoma, the patient was counseled accordingly. The patient agreed with the risk assessment and consented to rescue CSF drainage in the event of overt spinal cord ischemia in the perioperative period, after best efforts to correct concomitant coagulopathy.

Another technical concern was the close proximity of the distal extent of the DTAA to the diaphragm. The construction of the distal aortic anastomosis in the setting of left-heart CPB

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