Anesthetic Management of Vascular Emergencies

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VASCULAR emergencies include ruptured aortic aneurysm, acute aortic dissection, and traumatic aortic transection. The most common emergency is ruptured aortic aneurysm, with the majority of cases involving the abdominal aorta. Patients with true ruptured thoracic aneurysm rarely survive to make it to the hospital.

ANESTHETIC MANAGEMENT OF A RUPTURED AORTIC ANEURYSM

Despite the increasing number of elective abdominal aneurysmectomies, rupture of abdominal aortic aneurysms still occurs. In 1950, Estes reported that when no surgical resection was performed, ruptured aneurysms accounted for 63.3% of the deaths occurring at 5 years from the time of diagnosis of the aneurysm. In another report, in cases in which the aneurysm was not resected, 35% of all deaths at 5 years were due to ruptured aneurysm.

In another series of 52 patients who did not undergo aneurysm resection, Darling et al reported that 43% of deaths at 1 year were due to rupture. Although aneurysms over 10 cm in diameter tend to rupture six times more frequently than smaller aneurysms (<4 cm in diameter), the size of the aneurysm should not be the major factor in selection of patients for surgery.

The incidence of ruptured aneurysms in different surgical series varies, depending on how aggressive the surgeons are and their policy of aneurysm resection. It is reported that 4% to 37% of ruptured aneurysms are atherosclerotic. Aortic rupture may also occur at the point of origin of dissection of the aorta, which is the site of the mural tear. Another rare type of ruptured aneurysm is a mycotic aneurysm.

Patient Presentation

Some patients have a history of aortic aneurysms, while others may present for the first time with a ruptured aneurysm. Severe back pain is a common symptom, as are abdominal tenderness and abdominal distension. Although hypotension and shock are extremely common, some patients may exhibit normal blood pressure. The absence of hypotension is misleading, and is a common reason for the failure to diagnose a ruptured aneurysm. Abdominal aneurysms may rupture retroperitoneally; in this situation, the patient may not demonstrate symptoms of shock because of temporary tamponade of the bleeding site. This occurs in 75% of patients with ruptured aneurysms. Rupture into the peritoneal cavity usually is accompanied by severe hypotension and exsanguination occurs rapidly. Reports have shown that this occurs in approximately 25% of patients with ruptured abdominal aneurysms.

Rupture may also occur into other organs or sites, and when the rupture occurs into the inferior vena cava, it may produce an arteriovenous fistula.

The diagnostic triad of a pulsatile abdominal mass, back pain, and shock may not be present in all patients with ruptured aneurysms. reported that this triad exists in less than 50% of such patients. If the diagnosis is in doubt and the patient's hemodynamic status is stable, other tests and an emergency computed tomography scan should be performed. If the patient is hemodynamically unstable and the diagnosis of a ruptured aneurysm is suspected after clinical evaluation, surgery should be performed immediately. Other tests are then considered a waste of valuable time during which deterioration of vital signs may occur.

Anesthetic Management

Once the diagnosis of a ruptured aneurysm is suspected, the patient should be transported to the operating room immediately. An attempt at
resuscitation using volume replacement and vasopressors can only waste valuable time, since bleeding will continue as long as there is an opening in the aortic wall. In addition, even in the best circumstances, these measures may lead to a temporary increase in blood pressure and further aggravation of the bleeding.

In some situations, the anesthesiologist is alerted early enough to have the usual set-up ready. In other situations, the patient is rolled into the operating room suddenly and there is little or no time to prepare. Oxygen should be given as soon as the patient arrives in the operating room and is transferred to the operating table. Induction of anesthesia is usually accomplished with a narcotic and a rapid-acting muscle relaxant, such as succinylcholine, because these emergency surgical procedures involve patients with full stomachs. The dose of narcotic to be used for induction depends on the patient's blood pressure and state of consciousness. In patients with nonrecordable blood pressure, priority is given to the surgeon and a muscle relaxant only is given at this time. After control of the airway has been accomplished by the anesthesiologist, the surgeon should begin operating to achieve control of the aorta proximal to the rupture. Preparation of the incision site is usually performed during induction of anesthesia. An automated blood pressure cuff should be used first, and no time should be spent on inserting arterial lines, especially in patients with a nonpalpable pulse. After the aorta proximal to the rupture has been cross-clamped and the bleeding controlled, the blood pressure improves and palpation of the radial pulse is possible. An arterial catheter (20 g) should be inserted at this time for monitoring blood pressure, measuring blood gases, and, most important, assessing the acid-base status of the patient.

The patient usually arrives in the operating room with one or two venous catheters inserted for volume replacement. While one anesthesiologist is placing the endotracheal tube, another should start a central venous line. Depending on the expertise of the anesthesiologist, a decision should be made whether to insert the catheter into the subclavian or the internal jugular vein. The subclavian route is easier to perform during induction of anesthesia because this approach does not interfere with the neck and can be performed during intubation. After the blood pressure improves, more anesthetic agent should be administered. In addition, at this time insertion of a pulmonary artery catheter is important to assess the hemodynamics and prevent hypotension on aortic unclamping. A blood sample should be sent to the blood bank as soon as possible for type- and cross-match of blood; however, the use of an autologous transfusion device is highly recommended, especially if no blood is available. In addition, the patient usually requires the administration of sodium bicarbonate to treat the metabolic acidosis that results from shock and poor perfusion.

Urine output may be decreased or absent due to renal hypoperfusion accompanying the shock state. Adequate volume replacement should be assured by measuring the pulmonary capillary wedge pressure and cardiac output. These patients are usually hemodiluted with a hemoglobin count as low as 5 g. A small amount of diuretic should be given to make the transfusion of red blood cells possible without overloading the circulation. Coagulopathy is not uncommon; most often, it is dilutional. A coagulation profile consisting of prothrombin time, partial thromboplastin time, platelet count, fibrinogen level, and Sonoclot (Sienco, Inc, Morrison, CO) or thromboelastogram should be performed to assess the coagulation status and to properly treat the defect.

Hypothermia should be prevented by using blood warmers and especially by warming the room temperature in the operating room.

Results of Treatment

The operative mortality of patients with ruptured abdominal aneurysms in the studies cited varied from 23% to 75% due to difficulty in obtaining rapid control of bleeding.® Lawrie et al® reported a perioperative mortality rate of 14.8%. In their experience, the major determinant of survival was the ability to withstand hypotension, which is influenced mainly by age and the magnitude of blood loss. These investigators reported no deaths in patients younger than 60 years, and that 40% of their patients older than 80 years died. The most common cause of death in the elderly group was myocardial infarction.
Lawrie et al's group explained their improved results in cases of ruptured aneurysms as largely the result of recognition of the need for immediate operation, even in hemodynamically stable patients. Improvements in anesthesia, progress in autologous transfusion, component therapy, prosthetic grafts, and postoperative care also played a part in the improvement of the survival rate.

**ACUTE AORTIC DISSECTION**

Aortic dissection starts from a tear in the intima through which blood finds its way to the media, splitting the layers of the media. This forms a false lumen through which blood flows and compresses the true lumen.

DeBakey classified aortic dissection into three types. Type I involves the entire aorta, from the ascending aorta to the aortic bifurcation, type II is confined to the ascending aorta, and type III involves the descending aorta (type IIIa) and/or extends to involve the abdominal aorta also (type IIIb) (Fig 1). Aortic dissection occurs in approximately 2,000 patients annually. It is considered acute if the onset of dissection is less than 2 weeks in duration. Patients with acute proximal (types I and II) aortic dissection will undergo immediate surgery for repair of the
proximal aorta that is involved in the dissection process. On the other hand, patients with acute dissection involving the distal aorta (distal to the left subclavian artery) will be initially treated medically by controlling the blood pressure and preventing hypertension.

ANESTHETIC CONSIDERATION FOR ACUTE AORTIC DISSECTION

The majority of patients with acute aortic dissection present with a full stomach, and rapid sequence induction following preoxygenation should be performed. β-Adrenergic blockers, sodium nitroprusside, and nicardipine hydrochloride (Cardene, Wyeth Laboratory, Philadelphia, PA) are used to control hypertension. Some patients will have aortic regurgitation in addition to aortic dissection. These patients require special attention in managing the hemodynamics to prevent an increase in the afterload.

The procedure for repair of the proximal aortic dissection requires cardiopulmonary bypass if the ascending aorta is the only segment involved (type II). However, if the aortic arch is involved, profound hypothermia and cerebral circulatory arrest with retrograde cerebral perfusion is required (Fig 2).

These patients require a large-bore intravenous access and a pulmonary artery catheter for hemodynamic monitoring.

TRAUMATIC INJURIES OF THE AORTA

Traumatic injury of the aorta can result from either penetrating injuries (such as stabbing and missiles) or blunt trauma as occurs in motor vehicle accidents. This type of trauma may result in simple aortic contusion, intimal tear, formation of intramural hematoma or false aneurysm, or rupture of the aorta. Blunt trauma is a rare cause of aortic dissection, which usually occurs at the aortic isthmus. At this point, the aorta is tethered by the ligamentum arteriosum. This type of injury usually occurs in motor vehicle accidents due to a blow to the chest by the steering wheel. During rapid deceleration, the aorta will be pulled at the site that is fixed (the isthmus), resulting in a tear in the aortic media and adventitia and possibly the intima. Depending on the severity of the injury, a complete aortic transection may occur. However, the patient is sometimes stable and may be asymptomatic, only to develop problems in a few days or weeks (Fig 3).

MANAGEMENT OF TRAUMATIC AORTIC INJURY

Traumatic rupture of the aorta should be suspected in patients who suffer a severe deceleration or acceleration injury or in any patient who had blunt trauma to the chest. These patients may have sustained serious injuries of other organs and are considered to have a full stomach. Pe-
Fig 3. The aortic arch and descending thoracic aorta in a 19-year-old man who was involved in a motor vehicle accident 12 days before death. (A) The aorta is attached to the left pulmonary artery through the ligamentum arteriosum. (B) The blunt trauma occurred during a motor vehicle accident. (C) A tear through the aortic media allowing blood to extravasate into the adventitia. (D) The descending thoracic aorta with extravasation of blood into the entire descending aorta. (E) The descending thoracic aorta ruptured through the adventitia into the left pleural space, resulting in left hemothorax. (Reproduced with permission from Roberts WC: Aortic dissection: Anatomy, consequences and causes. Am Heart J 101:195-214, 1981)

Peripheral pulses may be absent due to dissection or simply due to shock, depending on the nature of the injury. Chest pain (76%) and dyspnea (36%) are among the most important symptoms in patients with aortic traumatic injury.

If there are no other associated injuries, the blood pressure may be normal or high. Hypertension is controlled with nitroprusside or beta blockers. Chest x-ray films may be abnormal. Widening of the mediastinum, narrowing of the left bronchus, and left pleural effusion may be present. In this situation, arteriography is indicated. Computed tomography and echocardiography may also be helpful. Transesophageal echocardiography while the patient is awake may lead to gagging, hypertension, and rupture of the aorta unless the patient is deeply sedated. Other associated chest injuries may include fractured ribs, sternum, or clavicle; flail chest; and hemothorax.

In addition to diagnosing aortic tear, peritoneal lavage for evidence of internal organ injury, especially the spleen, should be performed in trauma patients. A negative peritoneal lavage with evidence of shock and bloody pleural effusion is very suggestive of traumatic aortic rupture in patients with a history of motor vehicle accident. This situation requires emergency thoracotomy.

ANESTHETIC CONSIDERATION

The same precautions and management as that used for ruptured abdominal aorta aneurysm
apply in consideration of anesthetic. In addition, one-lung ventilation is very helpful in this situation. Depending on the status of the patient and the skill of the anesthesiologist, a rapid sequence induction with agents that do not compromise the hemodynamics, such as etomidate and succinylcholine, are chosen for intubation. A single-lumen endotracheal tube can be inserted first, and a nasogastric tube for evacuation of the stomach is then placed. The endotracheal tube can be replaced with a double-lumen endotracheal tube if the patient is stable; otherwise, a univent tube is used from the beginning of the procedure. The other alternative is to insert the double-lumen endotracheal tube after muscle relaxation is accomplished with succinylcholine.

A large-bore (12-g) double-lumen catheter should be inserted centrally, preferably in the right internal jugular vein. This will be connected to a rapid infusor system, such as the RIS (Haemonetics, Baintree, MA) for rapid transfusion and for warming the blood. One-lung ventilation is very helpful to the surgeon, and should be performed if the patient is stable. Using left atrial-femoral artery bypass with the centrifugal pump is superior to simple aortic cross-clamping alone. This technique can be used if the patient is stable. The incidence of paraplegia due to spinal cord ischemia is higher in these patients than in patients with atherosclerotic aortic aneurysms because in trauma patients there is no time to develop collateral circulation.

The use of extracorporeal circulation requires systemic heparinization of the patient, which may be disastrous in patients with multorgan trauma. For this reason, the centrifugal Bio-Medicus pump (Metronics, Minitonka, MN) is preferred. Renal function will depend on the hemodynamic status of the patient and the duration of shock. Mannitol (25 g) is given before aortic cross-clamping. The kidneys should be perfused if the Bio-Medicus pump with the left heart bypass is used.

Coagulopathy should be treated with component therapy guided by a coagulation profile, which includes prothrombin time, partial thromboplastin time, fibrinogen, platelet count, and thromboelastogram or Sonoclot. To prevent paraplegia, cerebrospinal fluid drainage can be used if the patient is stable.

The overall mortality rate in these patients is as high as 89% of total admissions, and only approximately 11% of the deaths were directly related to the thoracic aortic injury in the Duke experience. In another series, 20% of deaths from motor vehicle accidents were attributed to traumatic aortic rupture.

In summary, management of vascular emergency procedures requires attention to the airway (full stomach), blood volume replacement, and treatment of the complication of massive transfusion. Prevention of organ ischemia, especially the kidneys and spinal cord, in cases of ruptured thoracic aneurysm is an important aspect of management.

REFERENCES


