

# Management of closed injuries of the innominate artery

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**ABSTRACT** Two cases of closed traumatic rupture of the innominate artery are described. Both patients underwent surgical reconstruction, for which one patient was cooled to 15°C on cardiopulmonary bypass. In the management of these rare and severe injuries, which almost invariably need surgical repair, protection of the cerebral circulation is vital; cerebral blood flow and function should be monitored during the operation, for which cardiopulmonary bypass, hypothermia, or local shunting should be available. Failure to recognise the features of these injuries lead to a high death rate, and aortography should be performed whenever there is clinical or radiological suspicion.

Traumatic rupture of the innominate artery is a severe and frequently fatal condition. Fortunately it is rare, but in this age of rapid travel deceleration or direct chest injuries are becoming more common,<sup>1</sup> especially in young people. The management of innominate artery injuries is difficult as the cerebral circulation must be protected, and owing to the rarity of this condition any one surgeon's experience in dealing with it is bound to be limited. We therefore report two cases of traumatic rupture of the innominate artery that reflect different aspects of the management of this severe injury.

## Case 1

A 21-year-old man was admitted in 1968 after a road traffic accident with concussion and a compound fracture of the knee joint. Chest radiography showed mediastinal widening and aortography indicated widening and irregularity of the root of the innominate artery suggestive of rupture (fig 1). The aortic arch and great vessels were exposed by median sternotomy. There was extensive bruising at the root of the innominate and left common carotid vessels. Palpation indicated complete medial disruption with separation of the anterior aspect of the innominate artery and left common carotid artery, continuity being maintained by thin adventitia. To protect the brain during surgery profound hypothermia was used, the patient being cooled to

15°C on cardiopulmonary bypass with the use of a heat exchanger and oxygenator. At this temperature the circulation was arrested with the appropriate vessels clamped. The aorta was opened longitudinally just anterior to the mouths of the innominate and left common carotid arteries, the injuries were confirmed, and the vessels were cleaned and re-implanted through separate openings in the aortic arch. The period of circulatory arrest required for re-implantation was 43 minutes. Although the patient did well initially, he died suddenly of intrathoracic bleeding 12 days later. At necropsy no bleeding point was discovered. We thought that bleeding might have been associated with the use of anticoagulants to treat thrombosis of the left femoral vein.

## Case 2

A 13-year-old girl was admitted in 1980 following a road traffic accident in which she was a back-seat passenger. She sustained concussion and multiple facial lacerations, but on arrival at hospital was conscious and orientated and had no neurological deficit. She was, however, noted to have a harsh systolic murmur in the right subclavicular region that radiated into the neck, and the blood pressure in her right arm was lower than her left arm (80/40 compared with 140/70 mm Hg). Chest radiography showed only minimal widening of the mediastinum, but aortography showed rupture of the innominate artery both at the root and at its bifurcation (fig 2). A median sternotomy was performed and the

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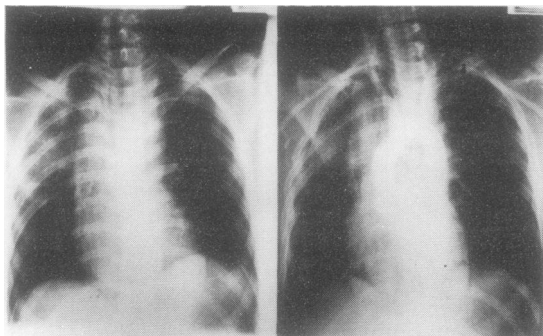


Fig 1 (a) Chest radiograph of case 1 showing a widened mediastinum.  
(b) Aortogram showing rupture of the root of the innominate artery.

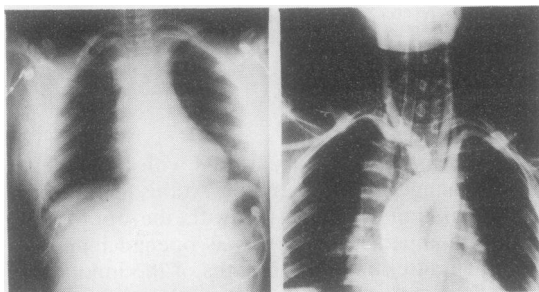


Fig 2 (a) Chest radiograph of case 2 showing slight widening of the mediastinum.  
(b) Aortogram showing rupture of the innominate artery at its root and at its bifurcation.

pericardium was found to contain about 100 ml of altered blood; there was a haematoma at the root of the innominate artery. Gentle palpation showed complete disruption of the media, the vessel at this point consisting only of a thin layer of adventitia. The innominate artery was cross-clamped just proximal to its bifurcation into right subclavian and right common carotid arteries, and the distal carotid stump pressure was measured. This was found to be 70 mm Hg systolic, and at this time the left radial pressure was a mean of 90 mm Hg. This indicated that adequate cerebral perfusion was being maintained by the left common carotid and left subclavian and vertebral vessels.

A 12-mm tailored woven Dacron graft was then anastomosed to the ascending aorta, a large Satinsky side-occluding clamp being used (fig 3). A further side clamp was then applied to the arch of the aorta at the origin of the innominate artery, care being taken not to occlude the left common carotid artery. The origin of the innominate artery was resected and the defect in the aorta closed with 3·0 prolene

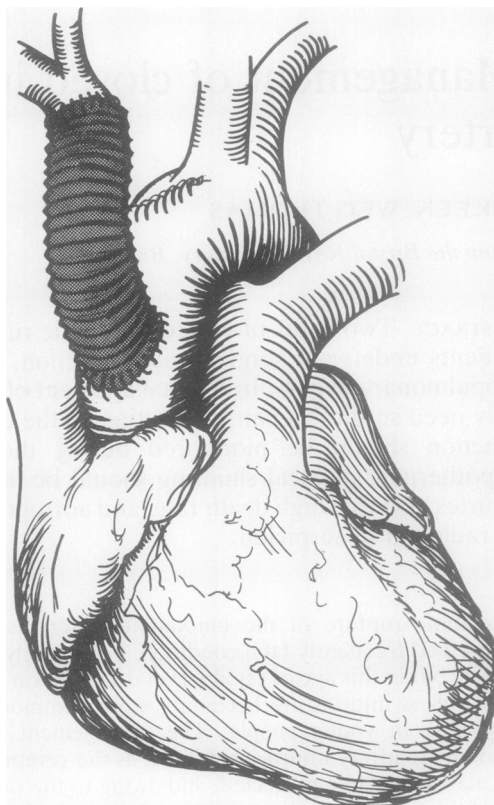


Fig 3 Case 2: diagrammatic representation of reconstruction of innominate artery.

buttressed with Teflon felt. The innominate artery was then resected up to its bifurcation and the distal end of the graft sutured in place. The patient made an excellent recovery, with no neurological or vascular deficit.

### Discussion

The management of innominate artery injuries is complicated, as during surgical repair some means of protecting the cerebral circulation may be necessary. Surgical repair is, however, indicated in most patients as there is the likelihood of complete and fatal rupture<sup>2</sup>—and experience has shown that most patients who initially survive aortic arch injuries will die of haemorrhage within the next 10 days if not treated.<sup>3</sup> Lesions of the aorta distal to the left subclavian artery can be repaired with the help of a local form of bypass,<sup>2-5</sup> but proximal lesions may require some method of protecting the brain.

When both the innominate and the left common carotid arteries are damaged full cardiopulmonary

bypass with coronary artery perfusion may be used, with or without profound hypothermia of 15°C.<sup>67</sup> This allows localised or total circulatory arrest, as used in patient 1; but others have repaired a solitary ruptured innominate artery under moderate hypothermia.<sup>8</sup>

Localised intraluminal shunts may be used from the aorta up to the common carotid and this has been found to maintain cerebral blood flow satisfactorily while the innominate injury is repaired.<sup>9</sup> Cerebral blood flow and function may be monitored during the operation by electroencephalography<sup>610</sup> and measurement of carotid stump pressures.<sup>1011</sup> When mean stump pressures exceed 25 mm Hg the perfusion of the brain is usually adequate<sup>1213</sup>—this can be confirmed by intraoperative electroencephalography. In case 2 stump pressures indicated that cerebral perfusion was satisfactory and the graft was therefore inserted without the need for either hypothermia and circulatory arrest or a local bypass shunt technique.

Placing the suture line of the repaired artery or graft on normal aortic wall is vital. This usually requires resiting the vessel or Dacron graft on the aorta, as was done in both our cases.

The high death rate associated with these injuries is due to a lack of awareness of, or failure to recognise, the clinical and radiological features of the condition, and in any case where there is any clinical or radiological suspicion of damage to the aortic arch or its great vessels an aortogram should be performed.<sup>4</sup> This has the advantage not only of delineating any suspected arterial lesion but also of showing any concomitant arterial injuries, which occur in 20% of patients with such injuries.<sup>14</sup> When arteriography confirms an injury to the innominate artery surgery should be recommended, with cardiopulmonary bypass, hypothermia, or local

shunting freely available should they be necessary. Intraoperative monitoring will allow confirmation that the method chosen is producing satisfactory cerebral perfusion throughout the procedure.

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