Internal mammary artery conduit: an additional surgical procedure in difficult coarctation of the aorta

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SUMMARY Between October 1986 and February 1987 two young men with coarctation of the aorta and a hypoplastic isthmus were treated by a combined resection and isthmusplasty with implantation of the left internal mammary artery to the distal aorta. An appreciable drop in the systolic gradient was seen in both patients after the mammary artery anastomosis and haemodynamic variables across the repair continued to improve postoperatively. Digital transvenous subtraction angiography five months after operation showed a satisfactory mammary artery conduit across the repaired coarctation.

The choice of operation for aortic coarctation is influenced by the patient's age, anatomical abnormality, and the surgeon's experience.^{1,2} Several different techniques have been described: resection and end to end anastomosis, subclavian flap aortoplasty, patch aortoplasty with prosthetic or biological grafts, Vosschulte's aortoplasty, and prosthetic tubular conduit between the ascending and descending parts of the aorta.³⁻⁵ Severe hypoplasia of the isthmus in the adult patient may limit the extent of resection because in an attempt to maintain the collaterals to the spinal cord every effort is made to limit the number of intercostal vessels ligated or divided. A wider anastomosis may be achieved by isthmusplasty, but in severe cases of hypoplasia this alone may not reduce the systolic gradient to an acceptable value.

In these circumstances implantation of the left internal mammary artery to the distal aorta is a simple but effective additional procedure to achieve better flows beyond the repair.

Case reports

PATIENT 1

A 27 year old symptom free man was found to have a coarctation of the aorta at a routine medical examination.

Blood pressure recordings showed a systolic gradient of 90 mm Hg (170/110 in the arm and 80/40 in the leg). A tight coarctation with hypoplastic aorta was confirmed at aortography. At operation, through a left thoracotomy, the coarctation was excised and repair effected by isthmusplasty. The systolic gradient fell from 90 mm Hg to 30 mm Hg. The left internal mammary artery was therefore dissected off the chest wall and the distal end was anastomosed to the distal aorta with 5 O Prolene sutures over a side clamp on the aorta. The internal diameter of the internal mammary artery was 10 mm and the final gradient across the repair was 9 mm Hg.

Paradoxical hypertension developed immediately after operation; this responded to β blockade. His recovery was otherwise uneventful and the arm to leg systolic gradient had disappeared on subsequent examination eight days after operation. His condition was entirely satisfactory at an outpatient review four months later. Patency of the internal mammary artery was confirmed by digital transvenous subtraction angiography five months after the repair (figure).

PATIENT 2

A 28 year old symptom free man was found to have coarctation of the aorta at a routine medical check up. His aortogram showed a coarctation of a long segment and hypoplasia of the isthmus, with a systolic pressure gradient of 65 mm Hg across the coarctation. At operation, through a left thoracotomy, the repair was effected by resection of the coarctation and isthmusplasty, and the systolic pressure gradient fell to 41 mm Hg. The left internal mammary artery, which had an internal diameter of 6 mm, was

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Figure Transvenous digital subtraction angiogram showing the internal mammary artery conduit across the site of the repaired coarctation.

dissected off the chest wall and implanted on to the distal aorta with 5 O Prolene sutures by means of a side clamp on the aorta. Subsequent recordings showed a systolic gradient of 20 mm Hg. This patient developed paradoxical hypertension, which responded to β blockers. The arm to leg systolic gradient was < 10 mm Hg before his discharge nine days after operation.

Discussion

The object of any corrective operation for aortic coarctation is a zero gradient across the repair. There are no absolute guidelines, but most surgeons regard a systolic gradient of < 20 mm Hg in an adult or 10 mm Hg in a child as acceptable.⁶⁻⁸ In a series of cases of recurrent coarctation, Sweeny *et al* considered an arm to leg systolic gradient of ≥ 30 mm Hg as an indication for reoperation.⁹

Ischaemic injury to the spinal cord is a known complication of operation for coarctation, and this is more common in reoperations.^{2,10} Even though no definite correlation has been established between the extent of spinal cord ischaemia and the number of intercostal arteries divided, most surgeons believe that every effort should be made to achieve an adequate anastomosis with division of as few intercostal vessels as possible. Other factors that influence damage of the spinal cord include the anatomical abnormalities of the anterior spinal artery and the duration of aortic cross clamping.

A relatively small aorta and the proximity of large

collaterals are common characteristics of the hypoplastic isthmus. Resection of the abnormal tissue of coarctation may be justified in an attempt to prevent recurrence. Isthmusplasty will increase the effective diameter of the anastomosis. In severe hypoplasia, however, the final gradient may still remain high because the size of the anastomosis is limited. The systolic gradients after isthmusplasty in our two patients were 30 and 40 mm Hg respectively. The large left internal mammary artery was therefore dissected off the chest wall and implanted to the distal aorta in both patients; this reduced the systolic gradient to 9 mm Hg and 20 mm Hg respectively, indicating better flows beyond the site of repair.

Use of the internal mammary artery as a free patch graft has been described.^{11,12} The technique we have described has the advantages of a relatively easy anastomosis over a side clamp and of a very large and convenient collateral being used as a conduit. We must emphasise, however, that this technique is unsuitable for young patients with coarctation because their internal mammary arteries are small. The fragility of the intercostal vessels in aortic coarctation is well known. We noticed that even though these vessels had aneurysmal dilatation at their origin from the aorta, they were of remarkably good quality where they communicated with the internal mammary artery. These communications were divided between Ligaclips and then each end was reinforced with 6 O Prolene sutures for added safety. We found that vessel wall hypertrophy of the dilated mammary artery made it safe to anastomose to the aorta. We were quite satisfied with the condition of the mammary artery as visualised on the digital transvenous subtraction angiogram (figure). Caution should, however, be exercised if this patient has a left lung resection in later years because of the position of the mammary artery in relation to the left hilum.

We recommend the implantation of the left internal mammary artery to the distal aorta in adults with coarctation and a hypoplastic isthmus if the systolic gradient remains ≥ 30 mm Hg after the repair. It is simple but effective and does not increase morbidity because the anastomosis can be constructed without cross clamping of the aorta.

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