Case report

Internal mammary artery to coronary artery bypass in paediatric cardiac surgery

Edward Brackenbury, Helena Gardiner, Kak Chan, Mark Hickey*

Department of Cardiothoracic Surgery, Glenfield Hospital, Groby Road, Leicester, LE3 9QP UK

Received 28 July 1998; revised version received 19 August 1998; accepted 1 September 1998

Abstract

The internal mammary artery is regarded as the optimal conduit for coronary artery bypass grafting in adults. Use of this conduit in paediatric surgery is rare and has been reported mainly in patients with Kawasaki’s disease. We report five patients who required internal mammary-coronary artery grafting due to adverse anatomical disposition of the coronary artery. In two cases an internal mammary graft was required during correction of transposition of the great arteries. The other cases involved correction of a left coronary artery arising anomalously from the pulmonary artery. Late angiography shows satisfactory growth and patency of the conduits.

Keywords: Internal mammary artery; Cardiac surgery

The internal mammary artery has been used to augment myocardial perfusion during surgery for congenital heart disease when coronary artery perfusion proves to be inadequate. The commonest indication for coronary artery bypass grafting in this group is for treatment of Kawasaki’s disease. Initial experience with reversed saphenous vein graft proved unsatisfactory and because of superior patency rates and growth potential, the internal mammary artery has become the conduit of choice. We have successfully used this technique during five paediatric cardiac operations (two patients undergoing correction of transposition of the great arteries and three patients with an anomalous origin of the left coronary artery). Angiographic data are presented to support the appropriateness of this conduit even in neonates.

1. Results (Table 1)

1.1. Case 1

Follow-up echocardiography at 3 months demonstrated excellent ventricular function. Angiography performed at 3.5 years post-operatively shows good flow through graft (Fig. 1a).

1.2. Case 2

Transoesophageal echocardiography performed at 4 months showed good ventricular function. Angiography at 4 months post-operatively revealed an internal mammary artery graft with a distal stenosis but good filling of the distal right coronary (Fig. 1b).

1.3. Case 3

Seven months post-operatively, she was well with no evidence of cardiac failure. However, she remained on diuretics and an angiotensin converting enzyme inhibitor (ACE) inhibitor. Angiography at 2 years post-operatively showed good flow into the left coronary system (Fig. 1c).

1.4. Case 4

Echocardiography 4 months post-operatively revealed volume loading of the left ventricle but systolic function was acceptable. Aortic Doppler flow velocities were nor-
Table 1

Summary of cases requiring internal mammary artery grafting. TGA, transposition of the great arteries; LIMA, left internal mammary artery; RIMA, right internal mammary artery; ALCAPA, anomalous left coronary artery arising from the pulmonary artery; LAD, left anterior descending coronary artery; RCA, right coronary artery.

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Sex</th>
<th>Weight (kg)</th>
<th>Pathology</th>
<th>Reason for IMA graft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9 Days</td>
<td>F</td>
<td>3.3</td>
<td>TGA</td>
<td>Eccentric origin of LCA and minimal tissue to effect satisfactory re-implantation. LIMA-LAD</td>
</tr>
<tr>
<td>2</td>
<td>10 Days</td>
<td>M</td>
<td>3.1</td>
<td>TGA</td>
<td>Technical problem with RCA implantation. RIMA-RCA</td>
</tr>
<tr>
<td>3</td>
<td>21 Months</td>
<td>F</td>
<td>10.5</td>
<td>ALCAPA</td>
<td>Unable to transfer anomalously arising LCA to aorta. LIMA-LAD</td>
</tr>
<tr>
<td>4</td>
<td>3 Months</td>
<td>M</td>
<td>3.8</td>
<td>ASD, VSD, ALCAPA</td>
<td>Not feasible to translocate LCA to aorta. LIMA-LAD</td>
</tr>
<tr>
<td>5</td>
<td>4 Months</td>
<td>F</td>
<td>6.7</td>
<td>ALCAPA</td>
<td>Preferential to perform LIMA-LAD</td>
</tr>
</tbody>
</table>

Fig. 1. Angiographic appearance of (a) case 1: left internal mammary artery-left anterior descending coronary artery (LIMA-LAD) during correction of transposition of the great arteries (TGA) (3.5 years post-operatively). (b) Case 2: right internal mammary artery-right coronary artery (RIMA-RCA) during correction of TGA (4 months post-operatively). (c) Case 3: LIMA-LAD during correction of anomalous left coronary artery arising from the pulmonary artery (ALCAPA) (2 years post-operatively). (d) Case 4: LIMA-LAD during correction of ALCAPA (16 months post-operatively). (e) Case 5: LIMA-LAD during correction of ALCAPA (11 months post-operatively).
The baby remained on a diuretic and an ACE inhibitor. Angiography at 16 months post-operatively demonstrated satisfactory flow (Fig. 1d).

1.5. Case 5

At 4 months follow-up, echocardiography demonstrated improved ventricular function, though there was persistent cardiomegaly. Her ECG showed disappearance of the lateral ischaemic changes present early post-operatively. Medication included diuretics and ACE inhibitors. Angiography at 11 months showed excellent graft function (Fig. 1e).

2. Discussion

Coronary artery bypass grafting in children is most often indicated in patients suffering the coronary arterial sequelae of Kawasaki’s disease and was first reported in 1976 [1] though a similar technique had been described earlier for children with anomalously originating left coronary artery from the pulmonary artery [2,3]. In these reports, autogenous saphenous vein or knitted dacron was used as conduit. Early follow-up revealed 85% patency in saphenous vein conduits at 1 month, though this falls to about 50% at 1–3 years [4]. Patency rates are better the older the patient [5]. Saphenous vein conduit used in children appears susceptible to late intimal hyperplasia as seen in adults [6].

With the disappointing late patency rates in saphenous vein grafts and the report of better outcome when using pedicled internal mammary artery grafts in adults [7], interest grew in the use of this arterial conduit in children with Kawasaki’s disease [8,9] and in the neonatal arterial switch operation [10] and substantially improved patency rates of the order of 100% and growth of the arterial conduit were demonstrated at 1–3 years [9].

Other arterial conduits have been used including the subclavian artery [11] and the right gastro-epiploic artery. Indications for the use of the internal thoracic artery in the paediatric population include Kawasaki’s disease, anomalous course of the left anterior descending artery between aorta and pulmonary artery, anomalous origin of the left coronary artery, damage to, or inadequacy of the coronary arteries intra-operatively during the arterial switch operation, or right ventricular outflow tract augmentation during repair for tetralogy of Fallot, coronary ostial stenosis and transplant coronary artery disease.

The success of the arterial switch procedure depends on the quality of the transfer of the coronary arteries. Problems with coronary transfer were not anticipated in cases 1 and 2 pre-operatively as echocardiographic coronary assessment had identified the origins of the coronary arteries as arising from facing sinuses.

Reports have discussed the successful use of internal mammary artery grafting in children following insufficient myocardial perfusion during repair of tetralogy of Fallot [12], complex transposition of the great arteries [10,13] and as a graft following Kawasaki coronary artery disease [14]. Concerns have been expressed that the internal mammary artery size may be too small in the neonatal period for effective grafting [13] but there have been reports of its use as a salvage procedure during the neonatal switch operation [10,15–17] and our angiographic studies show that a satisfactory result can be obtained. The adequacy of the grafts in our patients in the long-term remains speculative but it has not proved inadequate during the early rapid growth phase. We believe that these cases provide a timely reminder that the internal mammary artery can be used safely as a coronary bypass graft in the paediatric population undergoing open heart surgery even in small neonates.

References

[12] Cooley D, McNemara D, Duncan J, Ott D. Internal mammary anom-


