The use of left heart bypass in adult and recurrent coarctation repair


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Abstract

Objectives: Paraplegia following coarctation repair occurs in 0.4% of infants. However, for older children, adults and re-operations, the incidence can be as high as 2.6%. Yet there is no consensus on the need for spinal cord protection or the optimal method. This paper reports our experience with left heart bypass (LHB) in adult and re-do coarctation. Methods: Between 1997 and 2000, nine patients underwent elective resection of coarctation (three re-dos, two balloons) with a mean age of 17.9 years (range, 8–44) and weight of 52 kg (range, 17.3–109). The mean trans-coarctation gradient was 29.6 mmHg (range, 20–45). Patients were placed on LHB using a centrifugal pump with full heparinization through a fourth-space thoracotomy. Patients were cooled to 31–34°C for additional spinal cord protection. Repair was carried out with an inter-positional graft (5/9), a Gore-Tex patch (2/9) or end-to-end anastomosis (2/9). The mean cross-clamp and bypass times were 36.4 (range, 19–65) and 40.3 min (range, 22–70), respectively. Results: No patient developed transient or permanent paraplegia. The mean peak creatinine was 80 μmol/l (range, 51–123). Conclusions: LHB is simple, easy and safe to implement, and is the only technique capable of maintaining independent upper and lower body perfusion pressure. Potentially, it provides the best spinal cord protection, and extends the margin of safety and time to execute an accurate repair. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Left heart bypass; Coarctation; Paraplegia

1. Introduction

Paraplegia following coarctation repair in infants and neonates is a devastating complication. In large series, the incidence is from 0.3 [1] to 0.4% [2]. However, the risk is significantly higher in older children, adults and for recurrent coarctation, with a published incidence of 2.6% [3]. Inadequate development of a collateral circulation due to lower gradients across the coarctation is the most probable aetiology.

Therefore, it is imperative that everything is done to protect the spinal cord during surgery in this group, but there is no consensus on the optimal technique.

An ischaemic insult to the spinal cord arises with the placement of an aortic cross-clamp. Shunts [4], cardiopulmonary bypass [5] and profound hypothermia with circulatory arrest [6] may reduce the impact. However, the avoidance of any ischaemic insult is essential to eliminate the possibility of paraplegia.

We have used left heart bypass (LHB) to maintain spinal cord perfusion during repair to provide additional protection.

2. Materials and methods

Between December 1997 and September 2000, nine patients underwent elective resection of coarctation. Three patients had previous surgical corrections and two had previous balloon dilatation of the coarctation. The patient mean age was 17.9 years (range, 4–44 years) with a mean weight of 52.0 kg (range, 17.3–109 kg); the mean pressure gradient across the coarctation was 29.6 mmHg (range, 20–45 mmHg).

The coarctation repair was performed in all patients through a fourth-space thoracotomy in the left lateral position. In all cases, the distal aortic pressure dropped to below 20 mmHg upon the temporary application of an aortic cross-clamp.

LHB was instituted after full heparinization using a centrifugal pump without a reservoir and minimal lengths of tubing. The left pulmonary vein was cannulated for venous drainage and the left atrial pressure was monitored though the atrial appendage [7]. Blood was returned to the descending aorta distal to the coarctation. The circuit was filled retrogradely with blood from the patient in adults, whilst in children, the circuit was primed with blood.

The core temperature was allowed to drift to a mean of
32.2°C (range, 31–34°C) for additional spinal cord protection.

Femoral blood and left atrial pressures were maintained about a mean of 55 and 7–9 mmHg, respectively during LHB by manipulation of the pump-flows, the use of volume replacement, and vasodilators and vasoconstrictors. Blood was collected separately and returned to the patient with a syringe driver.

An inter-positional gelatine-impregnated Dacron conduit was used in five cases (55.6%), a Gore-Tex patch in two (22.2%), and in the remaining two cases (22.2%), an end-to-end anastomosis was performed.

The mean cross-clamp and bypass times were 36.4 (range, 19–65 min) and 40.3 min (range, 22–70 min), respectively.

### 3. Results

All patients survived, and no patient developed transient or permanent paraplegia. There were no abdominal complications and the mean peak creatinine was 79.2 μmol/l (range, 51–123 μmol/l) with no patient requiring dialysis (Table 1).

Patients were discharged home after a median hospital stay of 6 days (range, 4–35 days). Two patients required hospital stays of 20 and 35 days for respiratory failure requiring prolonged ventilation. There was no evidence of re-coarctation or neurological dysfunction with follow-up of up to 30 months.

### 4. Discussion

Paraplegia is the most feared complication following coarctation repair because of the devastating consequences for the young patient’s quality of life. Fortunately, it occurs very rarely in neonates and infants [1,2]. However, it is of great concern that the reported incidence in older children, adults and recurrent coarctation is up to seven times greater [3]. It can be argued that this is a chance finding of a single series, but there is no other published data. Given that in any single institution, the numbers performed will be small, we believe that it is necessary to maximize the margin of safety by means of the use of LHB.

Paraplegia occurs due to an ischaemic insult to the spinal cord arising from the application of a cross-clamp to the descending aorta. In studies of adult descending thoracic aortic surgery, the most important aetiological factor is the cross-clamp time. Although there is no additional risk for cross-clamp times less than 20 min, the risk is not eliminated entirely.

The risk of paraplegia can only be eradicated if there is no interruption of spinal blood flow. This is impossible to achieve, but it may be approximated with the use of cardiopulmonary bypass and shunts.

Bypass allows active cooling, but profound hypothermia and circulatory arrest are needed to effect repair [6]. This has not been seen to produce a superior outcome and has obvious drawbacks.

The passive Gott-shunt has the attraction of being quick and simple to implement. However, maintenance of upper and lower body perfusion pressures is difficult. However, this can be achieved with LHB using simple manipulations, yet allowing passive cooling.

In adult thoracoabdominal aortic surgery, the use of LHB has been reported to improve the outcome [8]. However, it would be extremely difficult to prove that LHB reduces the incidence of paraplegia or renal dysfunction following coarctation repair without a large multi-centre trial. Therefore, in the absence of contrary evidence, it is logical to attempt to minimize disturbance to the spinal cord circulation, which is the cause of paraplegia.

We have shown that LHB can be carried out quickly, simply and safely. It maintains spinal cord perfusion during coarctation surgery and minimizes any ischaemic insult. Repair of the coarctation can then proceed properly, allow-

<table>
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<th>Previous CoA balloon</th>
<th>CoA gradient (mmHg)</th>
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<th>LHB bypass (min)</th>
<th>Temperature (°C)</th>
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* CoA, coarctation; tube, inter-positional tube graft; ETE, end-to-end anastomosis.
ing an accurate repair without time pressure. We would recommend its use to increase the safety margin in the high-risk population.

References