MEASUREMENT

Coronary sinus blood flow and coronary haemodynamic function in children: measurement by the continuous thermodilution method with coronary sinus cannulation via the femoral vein

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Abstract

In 19 children with Kawasaki disease without any cardiac sequelae the coronary sinus was cannulated via the femoral vein with a specially designed flow catheter and coronary sinus blood flow was measured by the continuous thermodilution method. There was a statistically significant positive correlation between coronary sinus blood flow and age, body surface area, and left ventricular mass, but coronary sinus blood flow per left ventricular mass (100 g) was negatively correlated with age, body surface area, and left ventricular mass. Coronary vascular resistance was negatively correlated with age, body surface area, and left ventricular mass.

Younger children require a much greater coronary blood flow per left ventricular mass and have a higher coronary vascular resistance than older children and adolescents. These results may indicate that coronary blood flow is less efficient in childhood than in adolescence or adulthood.

The supply of oxygen to the myocardium is determined mainly by the volume of the coronary blood flow. Therefore, measurement of coronary blood flow is a useful way of evaluating coronary lesions and myocardial ischaemia. Measurement of coronary blood flow and the evaluation of the coronary haemodynamic function by arteriography provides important clinical information for the management of children with the coronary sequelae of Kawasaki disease. However, there has been no systematic report on the coronary blood flow or coronary haemodynamic function in childhood because catheterisation of the coronary sinus is difficult in children. We have reported a technique for easier cannulation of the coronary sinus via the femoral vein during routine cardiac catheterisation.¹ To investigate the characteristics of coronary haemodynamic function in childhood, we measured the coronary sinus blood flow by the continuous thermodilution method using our

specially designed flow catheter in children with Kawasaki disease without any sequelae.

Patients and methods

In the past two years, coronary angiography was carried out in 30 patients to detect the coronary sequelae of Kawasaki disease and to evaluate the coronary haemodynamic function. In the present study we analysed the findings in 19 (15 boys and four girls, aged 2 to 18 years (mean 8)) of the 30 patients who were shown to have normal coronary arteries despite echocardiographic evidence of dilatation. The interval from the onset of Kawasaki disease to the time of this study in the 19 patients ranged from one to 15 years (mean 6.7 years). The nature of the study was discussed with the patients' parents and then written consent was obtained.

After left ventricular angiography and selective coronary angiography, the coronary sinus flow catheter (fig 1A) (Webster Co, CCU-7U-90B), which was designed in our laboratory, was introduced through the femoral vein into the coronary sinus by a technique reported previously¹ (fig 1B). The coronary sinus flow catheter has an injection orifice at the tip and an external thermistor 12 mm from the tip. The position of the catheter was confirmed by angiography. In addition, a pigtail catheter was inserted through the femoral artery into the ascending aorta. Coronary sinus blood flow was measured by the continuous thermodilution method² > 30 minutes after the angiographic studies. The coronary vascular resistance was calculated as the ratio of mean arterial pressure (mm Hg) to coronary sinus blood flow (ml/min). Left ventricular mass was calculated from the left ventricular angiogram.³

Results

In the 19 patients, coronary sinus blood flow at rest increased significantly with age: age 2-4 years, 51.9 (10.4) (mean (SD)) ml/min; age 5-9 years, 75.8 (8.7) ml/min; age 10-18 years, 102.4 (17.7) ml/min (fig 2A). Coronary sinus blood flow was positively correlated with age, body surface area, and left ventricular mass

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Figure 1 (A) Specially designed coronary sinus flow catheters; type 1 was for young and older children and type 2 for adolescents and adults. (B) Coronary sinus flow catheter inserted through the femoral vein into the coronary sinus.

Figure 2 Relations between coronary sinus blood flow (CSBF) and aging (A), body surface area (BSA) (B), and left ventricular (LV) mass (C).

Figure 3 Relations between coronary sinus blood flow per 100 g left ventricular mass (age) (A), body surface area (B), and left ventricular mass (C).

(fig 2). Coronary sinus blood flow per left ventricular mass (100 g), however, was negatively correlated with age, body surface area, and left ventricular mass (fig 3). Furthermore, in the 19 patients, coronary vascular resistance was negatively correlated with age (fig 4), body surface area ($r = -0.55$, $p < 0.02$), and left ventricular mass ($r = -0.53$, $p < 0.02$). The rate-pressure product did not correlate with age ($r = -0.20$, $p < 0.5$) or coronary sinus blood flow ($r = 0.22$, $p < 0.5$), and the coronary sinus blood flow did not correlate with heart rate ($r = -0.44$, $p < 0.1$).

Discussion

This study showed that coronary sinus blood flow in childhood was positively correlated with age, body surface area, and left ventricular mass. Coronary sinus blood flow in adults

Figure 4 Relation between coronary vascular resistance (CR) and age.

ranged from 90 to 130 ml/min.^{2,4-6} Our findings indicate that coronary sinus blood flow in children over 10 years of age was comparable to that in adults. But younger children required a greater coronary sinus blood flow per left ventricular mass than older children or adolescents. Furthermore, the coronary vascular resistance in early childhood was higher than in late childhood and adolescence. These results suggest that coronary blood flow in early childhood was less efficient than in late childhood or adulthood. Therefore, these characteristic coronary flow patterns should be borne in mind during the evaluation of coronary haemodynamic function in childhood.

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