
Tomographic Myocardial Perfusion Scintigraphy in Children with Kawasaki Disease

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Myocardial infarction and stenotic coronary lesions are serious late complications in children with Kawasaki disease. For the noninvasive assessment of myocardial perfusion, dipyridamole-redistribution ^{201}Tl emission computed tomography (ECT) was performed in seven children (age 2 8/12–8 7/12 yr) 3–20 mo after the acute stage of the disease. In all patients, coronary aneurysms had been demonstrated by cross-sectional echocardiography. The scintigrams of six children showed no significant regional reduction of myocardial thallium uptake. These children had remained asymptomatic since the acute stage of Kawasaki disease. Persistent and transient thallium defects were present in one child with documented myocardial infarction. For this patient, obstruction of corresponding coronary vessels was confirmed by contrast angiography. It is suggested, that ^{201}Tl ECT after dipyridamole-induced vasodilation may be used as a safe alternative to invasive coronary angiography for follow-up investigations in patients with Kawasaki disease.

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Prognosis of Kawasaki disease—an acute febrile mucocutaneous lymph node syndrome that affects predominantly young children (1)—depends on the extent of associated coronary disease (2,3). In 15–20% of the cases, coronary aneurysms develop during the acute stage of the disease, and myocardial infarction as a result of thrombotic occlusion of the coronary artery may occur (4,5). Aneurysms regress in more than 50% of the cases within 1 year after onset, but some may progress to obstructive coronary lesions (3,6). Whereas coronary aneurysms are usually diagnosed by cross-sectional echocardiography, coronary stenosis is assessed invasively by coronary angiography. In the present report, we describe the use of thallium-201 (^{201}Tl) emission computed tomography (ECT) for the noninvasive assessment of myocardial perfusion in young children with Kawasaki disease.

PATIENTS AND METHODS

Patients

The present study consists of seven children with cardiovascular complications of Kawasaki disease, who were referred

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to the department of pediatric cardiology between 1984 and 1985. In all children, aneurysms of coronary arteries were demonstrated by cross-sectional echocardiography at the acute stage of the disease (Table 1). Thallium-201 ECT was performed in these patients 3–20 mo after the acute stage of the disease. At the time of scintigraphy, the children were between 2 8/12 and 8 7/12 yr of age. Six of them had no clinical symptoms of coronary disease. Patient 1 was investigated 3 wk and again 9 mo after posterolateral infarction, which occurred 1 yr after the acute stage of Kawasaki disease and was documented by acute electrocardiographic changes and enzyme elevation. Only this patient underwent coronary angiography.

Scintigraphy

For maximal coronary vasodilation, dipyridamole (0.6 mg per kg body weight) was administered by i.v. injection over 2 min. The electrocardiographic signal was monitored on an oscilloscope and blood-pressure measurements were made at base line and at 1-min intervals during the first 10 min of the study. Parenteral aminophylline was available for the treatment of adverse effects of the dipyridamole injection. Three minutes after the injection of dipyridamole, 2 mCi ^{201}Tl were injected per 1.7 sqm body surface area. Sedation of the child was achieved by 20 mg/kg chloralhydrate intravenously 20 min before scintigraphy.

Image collection was started 5 min after ^{201}Tl injection and repeated at 3 hr after the injection. A rotating gamma camera

TABLE 1
Patient Data: Age of Patients and Echocardiographic Size of Coronary Aneurysms at the Acute Stage of Kawasaki Disease and Age at the Time of Scintigraphy

Patient no., sex	Acute stage of disease		Age at thallium ECT (yr/mo)
	Age (yr/mo)	Maximal diameter of coronary aneurysm (mm) [†] LMCA, [‡] LAD, [†] LCx, [‡] RCA [§]	
1, F	1/8	3, 8, 9, 3	2/9
—	—	—	3/5 ^{**}
2, M	2/6	4, 6, 0, 0	3/4
3, F	1/7	3, 5, 5, 0	2/8
4, F	3/7	0, 0, 3, 0	4/1
5, F	3/11	3, 0, 3, 0	4/5
6, F	8/1	4, 0, 0, 0	8/7
7, F	4/11	3, 0, 0, 0	5/2

[‡] Left main coronary artery.

[†] Left anterior descending artery.

[‡] Left circumflex artery.

[§] Right coronary artery.

[†] Maximal diameter 0 mm = no aneurysm detected.

^{**} Second ECT investigation of Patient 1.

tomographic unit* was used for image acquisition (low-energy, general-purpose collimator, 180° rotation, 32 projections for 40 sec each, 1.4 hardware zoom, 64 × 64 in. matrix). Transverse axial tomograms were reconstructed by filtered backprojection [ramp filter, Metz prefilter (7)] and reorganized into sagittal and oblique sections parallel to the long and short axes of the left ventricle (4.4 mm nominal slice thickness, 2.2 mm pixel width). The long and short axis sections were analyzed visually for the presence of defects of thallium uptake. Defects on the initial images were categorized as transient defects, if they filled in on the delayed images, or as persistent defects otherwise.

RESULTS

In six of the seven patients, no thallium defects were recognized in the initial and delayed scintigrams. None of these children had anginal symptoms during the dipyridamole infusion.

In the patient with documented infarction, a persistent thallium defect was found in the posterolateral myocardium (Fig. 1). The neighboring anterior wall and the apex revealed initially reduced thallium uptake compared to the septum, but redistribution was demonstrated by the 3-hr delayed scintigram. At the follow-up investigation 8 mo later, the persistent posterolateral defect had decreased in size (Fig. 2). There was still a transient defect in the adjacent lateral wall, but no defects were present in the anterior wall and the apex. At both investigations, abdominal pain as a sign of myocardial ischemia developed following the injection of dipyridamole, but was immediately reversed by the

administration of aminophylline 1 min after thallium injection.

Coronary angiography in this child revealed post-aneurysmatic stenoses of the left anterior descending artery and complete occlusion of the left circumflex artery with retrograde filling. The right coronary artery showed tubular aneurysmatic dilatation with wall irregularities. Left ventricular angiography confirmed posterolateral infarction by demonstrating akinesia of the posterior wall. Cardiac catheterization was complicated by femoral artery occlusion, and arterial thrombectomy had to be performed.

DISCUSSION

Thallium-201 ECT accurately demonstrated myocardial infarction and ischemia in a 2 9/12 yr old child with Kawasaki disease. In six asymptomatic children with Kawasaki disease and documented coronary aneurysms, no significant thallium defect was found.

Assessment of coronary anatomy by contrast angiography was not considered justified in the six asymptomatic children. The risk of cardiovascular complication of left heart catheterization became apparent in the child, who underwent coronary angiography 2 wk after myocardial infarction. In this child, catheterization (Seldinger technique) was followed by occlusion of the right femoral artery with the need for surgical desobliteration.

Thallium-201 scintigraphy is noninvasive, but carries the risk associated with the exposure to ionizing radiation. For the whole-body radiation dose incurred through i.v. ²⁰¹Tl in adults, an estimate of 0.2 rad/mCi has been reported (8). The integrated organ dose to the testes, where concentration of the tracer occurred, was calculated to 0.6 rad/mCi. Other integrated organ dose estimates in adults are 0.5 rad/mCi for the ovaries and 0.4 rad/mCi for the testes (9,10). The radiation absorbed dose estimates given for children are comparable to those for adults if the administered dose is corrected for body surface area or body weight. However, experiments with mouse testes have shown, that the actual dose to the gonadal cells may be higher by a factor of 3, due to the inhomogeneous distribution of the tracer in the testes and the short range of the low-energy electrons of the ²⁰¹Tl decay (11). This high gonadal dose requires a careful medical justification for the use of ²⁰¹Tl scintigraphy in a child.

It may be interesting to compare the radiation dose of ²⁰¹Tl scintigraphy with the dose associated with coronary and left ventricular angiography. For a standard pediatric investigation with modern x-ray equipment, a mean skin dose of 3.7 rad measured at the spinous process T9 has been published recently (12). The mean gonadal dose was estimated to 0.07 rad, which is considerably less than the dose with ²⁰¹Tl scintigraphy.

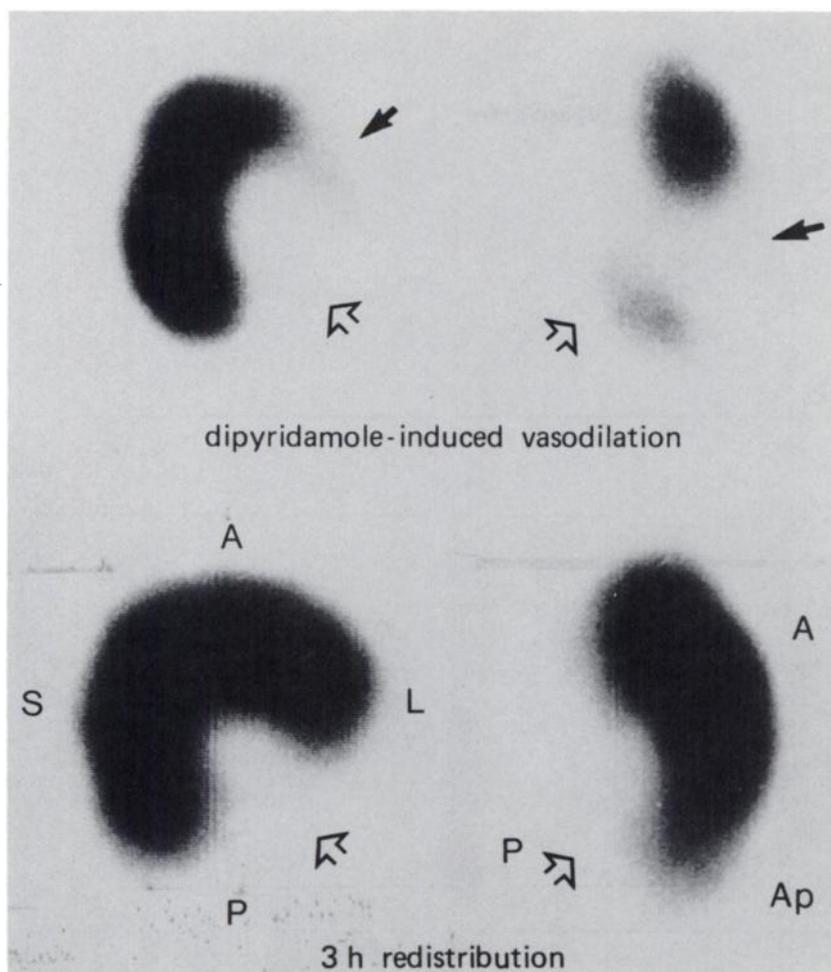


FIGURE 1
Scintigrams of a 2 9/12-yr-old child with posterolateral infarction 1 yr after the acute stage of Kawasaki disease. The midventricular short axis (left side) and vertical long axis sections (right side) demonstrate a persistent defect in the posterolateral wall (open arrows) and transient defects anterior and apical (closed arrows). The images are normalized to the maximum myocardial pixel count. S: interventricular septum; A: anterior wall; L: lateral wall; P: posterior wall; Ap: apex.

However, the radiation dose from myocardial perfusion scintigraphy may be significantly reduced in the near future, when currently developed technetium-labeled imaging agents become available in the clinic.

Thallium scintigraphy is a valuable tool for the detection of coronary stenosis and myocardial infarction. In a follow-up investigation of Kawasaki disease patients with coronary lesions (3), thallium uptake defects on planar rest scintigrams identified six out of seven patients with marked coronary stenosis. Small thallium defects may be detectable only with ECT (13).

Defects on the initial scintigrams represent disparities in regional myocardial perfusion that are enhanced under conditions that increase myocardial blood flow, such as physical exercise. Because exercise testing is not practicable in young children, we used i.v. dipyrindamole for pharmacologic coronary vasodilation. Dipyrindamole increases myocardial blood flow in regions supplied by normal coronary arteries, but not in myocardium perfused by obstructed vessels (14-16). This results in regional differences of myocardial thallium uptake even in the presence of moderate stenoses, that produce no reduction of myocardial perfusion at rest (15,16). The increase of coronary flow after an i.v.

bolus of 20 mg of dipyrindamole has been reported to persist for ~15 min (14).

In some patients, dipyrindamole induces clinical symptoms of myocardial ischemia that have been attributed to a fall in subendocardial perfusion distal to a stenosis (16). These symptoms can be reversed by the administration of aminophylline, which inhibits the vasodilating action of dipyrindamole (17). In the present study, one child developed abdominal pain after dipyrindamole that was promptly relieved by aminophylline. In the other patients, no adverse reactions to dipyrindamole were observed.

Dipyrindamole in combination with thallium myocardial imaging has been shown to have a sensitivity and specificity for the detection of coronary artery disease comparable to that of exercise thallium imaging (18, 19). As with exercise thallium scintigraphy, additional information is obtained by the acquisition of a delayed redistribution scintigram. Redistribution of thallium on the delayed images indicates hypoperfused, but viable myocardium, whereas infarct scars are represented by persistent defects (19).

The diameter of the coronary aneurysms at the acute stage of the disease has been reported to have prognostic

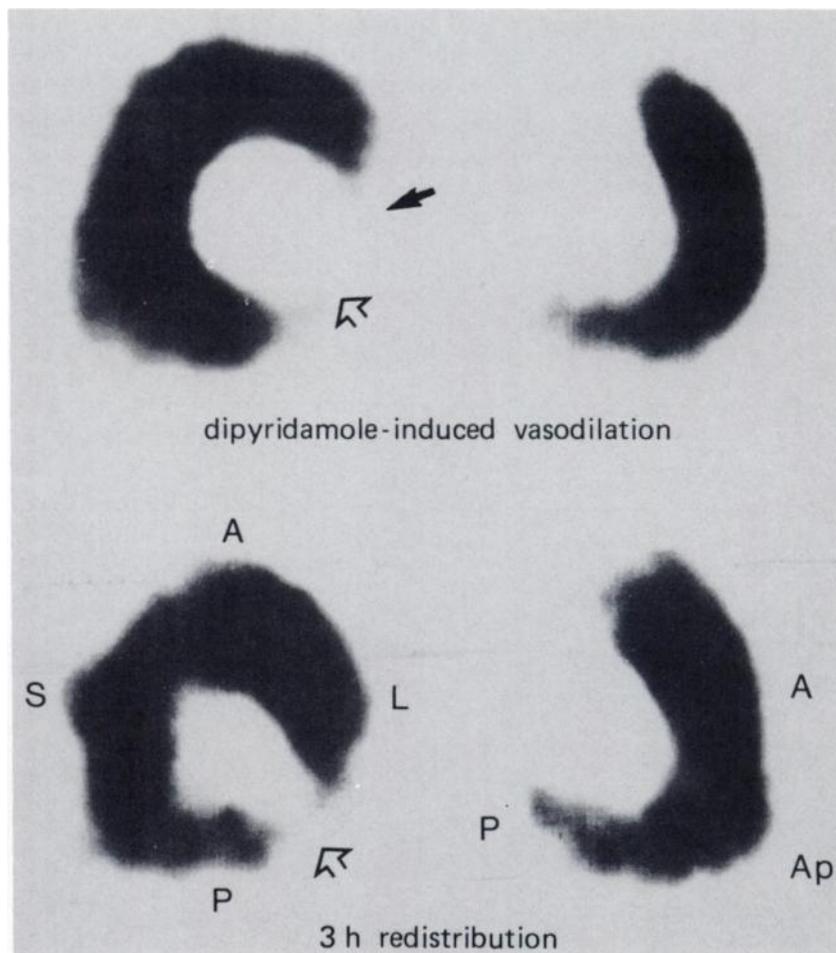


FIGURE 2
 Follow-up scintigraphy of the child of Figure 1 performed 8 mo later. The initial defect has decreased in size and is now confined to the posterolateral myocardium. The delayed scintigrams show thallium redistribution in the lateral part of the initial defect. Closed arrow: transient defect; open arrows: persistent defect.

implications (6). It was found, that 82 of 83 aneurysms with a diameter of <8 mm regressed without development of coronary stenosis. Aneurysms with diameter >8 mm progressed to stenotic lesions in 16 out of 17 cases. All six patients without thallium defects had aneurysms with diameter <8 mm, whereas the maximal diameter of the aneurysms in the patient with thallium defects and documented infarction was 9 mm (Table 1). It seems therefore reasonable to perform thallium scintigraphy in asymptomatic patients only if large aneurysms indicate an increased risk for coronary stenosis.

Repeat thallium investigations in the follow-up of patients at risk can reveal the occurrence of new infarction or the progression of coronary stenosis. The three-dimensional imaging of the myocardium by ECT seems especially suited to follow the size of thallium defects or to detect new additional defects of thallium uptake. Follow-up scintigraphy in Patient 1 9 mo after myocardial infarction demonstrated improvement of myocardial perfusion (Fig. 2). The decrease in size of the persistent uptake defect indicates that the persistent defect of the first study 3 wk after acute myocardial infarction represented both necrosis and ischemic, but

viable myocardium. At the time of the follow-up study, the child had no clinical symptoms of coronary disease.

In conclusion, noninvasive assessment of myocardial perfusion by ^{201}Tl ECT complements the follow-up of coronary aneurysms by echocardiography in children with Kawasaki disease, especially if large aneurysms at the acute stage of the disease indicate a high risk for the development of coronary stenoses.

NOTE

* Gammadiagnost, Philips.

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