Detection of Coronary Artery Aneurysms, Stenoses and Occlusions by Multislice Spiral Computed Tomography in Adolescents With Kawasaki Disease

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In patients with Kawasaki disease (KD), serial evaluation of coronary artery aneurysms (CAAs) and luminal narrowing is essential for risk stratification and therapeutic management. Therefore, non-invasive assessment of the status of the coronary artery is of utmost importance in patient management. Multislice spiral computed tomography (MSCT) permits non-invasive visualization of the entire coronary artery system and was used in the evaluation of 4 patients with KD. CAAs and high-grade coronary artery stenoses were detected by MSCT and corroborated the findings of coronary angiograms performed within the previous 2 years. MSCT has the potential to be the standard diagnostic tool in adolescents with KD. (Circ J 2003; 67: 427–430)

Key Words: Coronary artery aneurysm; Kawasaki disease; Multislice spiral computed tomography (MSCT)

K awasaki disease (KD) is an acute vasculitis of unknown origin that predominantly occurs in young children. It is associated with coronary artery aneurysms (CAA) in approximately 15–25% of untreated cases. Rupture and acute thrombosis may occur in the acute phase of illness, but occur rarely in adolescents and young adults. However, approximately 4% of cases subsequently develop stenotic lesions that lead to sudden death from myocardial infarction in adulthood. Serial assessment of the status of the coronary arteries is therefore essential for the management of patients with KD, but evaluation with coronary angiography (CAG) carries risk because of its invasive nature and is expensive. Multislice spiral computed tomography (MSCT) has brought a new era of coronary artery imaging because it allows non-invasive visualization of the entire coronary artery system. MSCT can detect obstructive coronary artery disease and coronary artery plaques. We describe the efficacy of MSCT for detecting coronary artery abnormalities in 4 adolescents with KD.

Methods

Subjects

Four consecutive adolescent patients with a history of KD who had been followed up at the Nihon University Hospital underwent MSCT during the period from August 22 to September 26, 2002 (4 males, age 15±2.4 years; range, 13–18 years). CAG was performed in all the patients 22±6.5 months (13–28 months) prior to the MSCT study. The study was approved by the hospital’s institutional review board and written informed consent was obtained from all patients and their families.

MSCT

MSCT was performed using a SOMATOM Volume Zoom (Siemens, Germany), which provided a 4-detector-row gantry and up to 1.0 mm spatial resolution on the z axis and up to 250 ms temporal resolution when the single-phase algorithm was applied. Our scan protocol and post-processing procedures have been described previously. In brief, metoprolol (20–40 mg) was administered orally 90–120 min prior to the scan to reduce the heart rate in order to perform the single-phase algorithm in all cases. In our series of patients, the heart rate was 52±3 beats/min (range: 46–60 beats/min) at the time of the scan. Nitroglycerin (0.6 mg) was also administered 5 min prior to the scan. After measuring the contrast transit time from the intravenous injection to the maximum contrast enhancement of the ascending aorta, the non-ionic contrast medium (Iomeron 350, 100 mL syringe, Eisai, Tokyo) was injected at the rate of 3.0 mL/s. The scan was performed with a collimation 1.0 mm, gantry rotation 0.5 per second and a pitch 1.5 (table feed 1.5 mm per rotation). The retrospectively ECG-gated image reconstruction was made under the ECG guidance. The end of the reconstruction window (250 ms) was positioned at the peak of P waves to avoid cardiac motion artifacts occurring during the ventricular rapid filling and atrial contraction periods. The reconstructed data were transferred to a workstation (3D Virtuoso, Siemens, Germany) to create volume rendering, curved multiplanar reconstruction (MPR) and oblique MPR images. The scan required approximately 10 min and postprocessing required 10–20 min depending on the status of the coronary artery.
Coronary angiography was performed using a standard Judkin's technique. Multiple selective projections of the right and left coronary artery system were digitally recorded with biplane fluoroscopy.

Results
Case 1
A 13-year-old boy with KD since he was 4 months old underwent a MSCT study for a follow-up examination. CAG performed on the 16th hospital day showed giant, multiple CAAs in the left main coronary artery (LMCA), the proximal portion of the left anterior descending artery (LAD), the left circumflex artery (LCx) and at the ostium of the right coronary artery (RCA). At age 5, he had experienced an anterior myocardial infarction. CAG revealed a complete occlusion at the proximal portion of the LAD and LCx. Coronary artery bypass grafting (CABG) using a left internal thoracic artery (LITA) was carried out for the LAD. Repeat CAG performed at the age of 10 revealed a subtotal occlusion at the proximal portion of the LCx and coronary angioplasty using a rotabulator was performed. The follow-up CAG at the age of 11 documented a complete occlusion at the LCx, but the LITA–LAD graft was patent (Fig 1A). CAG also showed a CAA at the ostium of the RCA with a braid-like appearance of the distal segments (Fig 1B). Fig 1C and D demonstrated MSCT images of this patient. Huge, calcified multiple CAAs were visualized together with complete occlusions at the distal sites of CAAs with retrograde contrast enhancement of the distal LAD segments via the bypass graft and the distal LCx segments presumably via the collateral channels (Fig 1C). There was a non-calcified CAA at the ostium of the RCA with a braid-like appearance at the proximal segment of the RCA (Fig 1D).

Case 2
A 13-year-old boy with a history of KD from the age of 7 underwent MSCT. CAG performed 13 months earlier had revealed a CAA in the proximal portion of the LAD with mild, but significant stenosis in the proximal portion of the first diagonal artery (D-1, Fig 2A). The RCA system was normal (Fig 2B, MSCT images Fig 2C–E). The CAA of the proximal portion of the LAD with mild stenosis of the proximal portion of D-1 (arrows) was also documented on the volume rendering (Fig 4C) and the curved MPR (Fig 4E) images.

Case 3
An 18-year-old man with KD from the age of 19 months underwent MSCT for follow-up evaluation after CABG. He had had effort angina at the age of 12 and underwent CAG, which showed significant stenosis of the proximal portion of the LAD immediately proximal to a CAA. CABG was performed using the LITA to the LAD and follow-up CAG performed 2 years previously had revealed complete patency of the graft. Significant stenoses of the LAD immediately proximal to the CAA (Fig 3A, dark arrow) and at the D-1 (white arrow) were noted. The volume rendering MSCT image (Fig 3B) showed CAAs with stenoses in the proximal portion of segment #6 (dark arrow) and at the D-1. Curved MPR images of the LAD (Fig 3C) and the D-1 (Fig 3D) depicted the same findings.

Case 4
A 16-year-old boy with a history of KD since the age of 8 months had serial echocardiographic studies that consistently showed mild dilatation of the LMCA, but no stenotic lesions. CAG performed 28 months prior to the MSCT study revealed a mild vessel irregularity of the LAD (segment #6, Fig 4A). The LCX and RCA systems were normal (Fig 4A,B). The MSCT images are shown in Fig 4C–E. Vessel irregularity was demonstrated on both the volume rendering (Fig 4C) and curved MPR (Fig 4D) images. A cross-sectional image obtained by the oblique MPR technique showed a CT-low-signal layer at the anterior site of the vessel, suggesting a thickened intima–media complex (arrow, Fig 4E).
**Discussion**

We have described the MSCT findings in 4 adolescents with KD. MSCT detected CAAs (n=6), complete occlusions (n=2) and stenoses (n=3) that were present on CAG. To our knowledge, this is the first report of the MSCT findings in KD being evaluated in reference to CAG.

The braided appearance of the RCA observed in Case 1 deserves mention. Although intracoronary ultrasound was not performed to confirm the presence of arteries within the artery or ‘lotus root’ appearance, the CAG and MSCT images both suggested the presence of a multilayered structure in the RCA. In addition, MSCT depicted a thin-layered CT-low-dense mass in the proximal portion of the LAD in Case 4. This finding mimics coronary artery soft plaque, but considering the patient’s age, it is more likely to represent the thickened intima–media complex following vasculitis.

In Japan, KD is the leading cause of coronary artery disease in young children and adolescents, and although gamma-globulin therapy reduces the incidence of CAAs, coronary artery stenoses still develop in a certain number of patients. The size of the CAAs and the severity of the coronary artery stenoses often change long term and are associated with fatal thrombotic events. Serial evaluation of the coronary arteries is therefore essential for young patients with KD. Transthoracic echocardiography is the most frequently used technique, but adequate images of the coronary artery cannot be obtained as the patient grows. Dobutamine stress radionuclide ventriculography and positron emission tomography are alternative methods for detecting myocardial ischemia, but these imaging modalities, which reflect myocardial metabolism, are not feasible for therapeutic decision making. Recently, direct visualization of the coronary artery system by high-resolution magnetic resonance imaging has been reported, but although this technique enables detection of CAAs and coronary artery stenoses of the proximal portion of the major coronary arteries, its ability to detect abnormalities of the distal portions of the coronary arteries, vessel wall thickening and plaque is limited because of poor spatial resolution. MSCT is a recently introduced imaging technique that provides spatial resolution of 0.6×0.6×0.6 mm on the x and y axes, and 1.0 mm on the z axis. Previous studies have indicated that MSCT can accurately detect coronary artery stenoses of the proximal and distal portions of the coronary artery, and it has the potential to be the diagnostic modality of choice for the detection of coronary artery abnormalities in adolescents and young adults with KD.

**Study Limitations**

The number of patients in the present study was small and serial data were not available. Serial evaluation of the coronary artery morphology would be desirable for patients with KD, but the maximum temporal resolution of currently available MSCT is 250 ms for a 4-detector-row and 210 ms for a 16-detector-row equipment, which is incapable of imaging coronary arteries in younger patients with high heart rates. Multi-segment ECG-gated reconstruction (data acquisition from multiple cardiac cycles) gives increased temporal resolution, but spatial resolution is sacrificed. The future improvement of the temporal resolution may permit coronary artery imaging in younger patients.

In conclusion, we demonstrated good agreement between the MSCT and CAG findings in this small series of patients with KD. However, analysis of a larger number of patients is definitely needed to derive a conclusive statement.

**Acknowledgment**

We thank Mr Y. Hori for his invaluable technical assistance.

**References**