Some patients cannot undergo coronary angiography (CAG) because of the adverse effects of contrast media. In the present study gadolinium, (gadodiamide hydrate: Gd DTPA-BMA) commonly used for magnetic resonance imaging (MRI), was used as the contrast agent for diagnostic CAG in 3 patients with severe allergy to iodine or iodinated contrast agents. The indications for CAG were recurrent chest pain, evaluation of peri-operative risk of gastric cancer and abdominal aortic aneurysm, and evaluation of graft patency after coronary artery bypass grafting. The procedure was well tolerated by each patient and the amount of the gadolinium-based contrast media did not exceed 40 ml, which is twice the volume used for MRI. The images were of fair quality. In patients with allergy to iodinated contrast media, CAG with gadolinium-based contrast media is an alternative technique for evaluating coronary artery disease. (Circ J 2005; 69: 507–509)

Key Words: Anaphylactoid reaction; Coronary angiography; Coronary artery disease; Gadolinium

X-ray coronary angiography (CAG) is an indispensable examination technique for the diagnosis of coronary artery disease and for determination of therapeutic strategies. However, an anaphylactic reaction to the iodinated contrast media can be life-threatening. Gadolinium-based contrast media have been developed to improve the quality of magnetic resonance imaging (MRI) and are considered to be safer and less nephrotoxic than the iodinated agents. It has been recently reported that computed tomography (CT) and digital subtraction angiography (DSA) using gadolinium can provide images of large- and medium-sized vessels of acceptable quality in patients with allergy to iodinated media.1–5 However, only a few studies of using gadolinium for CAG have been reported and only its safety in patients with renal insufficiency has been discussed6–8 We report successful CAG using gadodiamide hydrate (Gd DTPA-BMA; Omniscan® Nycomed, Oslo. Norway) in 3 patients with allergy to iodinated contrast media. Written informed consent for the use of the contrast media was obtained from all patients.

Case Reports

Case 1
A 70-year-old woman (52 kg) with a history of thyroidectomy for thyroid cancer and allergic reaction to iodinated contrast media was admitted to hospital after presenting with chest pain and dyspnea. Electrocardiography showed ST-segment elevation in leads V1–3 leads and T wave inversion in V2–4, and echocardiography showed hypokinesis in the apico-anteroseptal wall of the left ventricle. After sublingual administration of nitroglycerin, her symptoms and the electrocardiographic findings improved. CAG was performed using 40 ml of undiluted Gd DTPA-BMA in a total of 7 injections because she had a previous, unspecified history of shock as a severe allergic reaction to treatment with an iodinated disinfectant. CAG revealed no significant stenoses in the major coronary arteries (Fig 1) and so we considered her anginal attack might be coronary arterial vasospasm in the left anterior descending artery.

Case 2
A 71-year-old man (68 kg) with gastric cancer and abdominal aortic aneurysm was admitted to hospital for gastric resection and artificial vessel replacement. He had a history of acute myocardial infarction at 63 years of age and an allergic reaction to an unspecified iodinated contrast media during abdominal CT performed when he was 60 years of age,99mTc-tetrofosmin myocardial scintigraphy on admission showed multivessel disease in his coronary arteries, so he underwent preoperative CAG using 40 ml of undiluted Gd DTPA-BMA in a total of 5 injections. Digital subtraction post-processing showed significant stenoses in the mid right coronary artery (segment 2: 75% stenosis), in the circumflex artery (segment 11: 75%, segment 13: 90%), and total occlusions in the distal right coronary artery (segment 4, posterolateral branch) and the mid left anterior descending artery (segment 7) with contralateral collateral feedings (Fig 2). He underwent coronary artery bypass grafting before the planned non-cardiac operation.

Case 3
A 73-year-old man (62 kg) underwent coronary artery bypass grafting because of significant stenoses in the left main coronary artery (segment 5: 50%) and proximal left anterior descending artery (segment 6: 75%) shown on the preoperative CAG. In-situ arterial grafting was planned for the left internal thoracic artery to the left anterior descending artery and for the right internal thoracic artery to the left circumflex branch. Unfortunately, the proximal portion of the left internal thoracic artery was injured during the
Two weeks later, the patency of the bypass grafts and the repaired left internal thoracic artery were evaluated by conventional CAG; however, immediately after iodinated contrast media was injected into the native coronary artery, the patient went into shock with bradycardia and hypotension, but recovered after administration of methylprednisolone and dopamine. Because the shock may have been caused by an anaphylactic reaction to the iodinated contrast media, angiography of the left internal thoracic artery only was continued using 40 ml of undiluted Gd-DTPA-BMA in a total of 5 injections. The left internal thoracic artery had excellent graft patency and there was no abnormality in either the repaired site or the anastomosis (Fig. 3).

**Discussion**

Major and minor side effects of the iodinated contrast media are less common since the development of non-ionic agents, but allergic reactions to iodinated media are still a major complication in angiography. Adverse reactions range from mild inconvenience, such as itching, nausea or vomiting, to life-threatening emergencies, such as dyspnea, shock or cardiopulmonary arrest. Katayama et al reported the incidence of a life-threatening reaction to the non-ionic contrast media as 0.04% and 70% of cases developed within 5 min of the injection of contrast media.9 Allergic reactions to the contrast agent can be either an anaphylactoid reaction or a chemotoxic one.10 An anaphylactoid reaction would be caused by activation of the kinin system and the activated basophils or mast cells would be either directly stimulated by the contrast agent or indirectly by non-specifically activated complements such as anaphylatoxin (C3a, C5a). A chemotoxic reaction would be caused by the hydrophobicity and hyperosmoticity of the contrast media itself.

Gadolinium chelated with gadodiamide hydrate is a commonly used contrast agent for MRI. Gadolinium is a heavy metal element that attenuates X-ray photons and therefore is potentially able to be used as a radiographic contrast material. The incidence of all side effects has been reported as 1–2% for gadolinium-based contrast media (Gd) and 3.0% for iodinated contrast media, and the incidence of critical life-threatening side effects with Gd was...
Gadolinium as Contrast Medium for CAG

one-tenth that for iodinated contrast media. Gd has been advocated as an alternative to iodinated contrast media for DSA or CT. Although Gd-based contrast media are obviously safer than the iodinated ones, there are 2 major side effects that must be considered in relation to angiography. One is a hemodynamic or arrhythmic effect resulting from ionicity when the agent is directly injected into the coronary artery. Gd-based contrast media are either ionic (Gd DTPA) or nonionic (Gd DTPA-BMA), so selection of a nonionic agent is preferable to reduce the incidence of side effects. Another is a nephrotoxic effect because acute renal failure after angiography with a high dose of Gd has been reported, although Gd is less nephrotoxic than the iodinated media. The first study of CAG using Gd was in patients with renal insufficiency.

There are several limitations to the use of Gd as an X-ray contrast agent. First, it is inferior to iodinated agents for image contrast, although digital subtraction post-processing can resolve that problem. The technique requires the same silhouette without dye injection for making a masking image, and accurate framing and fixation of the patient is essential. However, detection of life-threatening ischemia such as stenoses of the main coronary artery is important and the contrast of Gd may still be sufficient. Second, the total dosage of Gd is limited to 0.4 mmol/kg per examination, and the safety dose is ≤40–70 ml of Gd at one examination per patient. An image of diagnostic quality of the coronary artery would be obtained with this dosage. Biplane exposure technique or an intravascular ultrasound system might be useful for complicated disease or percutaneous coronary intervention. We could obtain images of both the right and left coronary arteries with acceptable quality using up to 40 ml of Gd DTPA-BMA, and the angiographic procedures uneventful in all cases.

Conclusion

In patients with allergy to iodinated contrast media, X-ray CAG with Gd-based contrast media is a potential alternative technique for evaluating coronary artery disease.

References