described transient wall motion abnormalities in 22 of 22 patients. Thus, our finding provides supplemental information to explain the mechanism of myocardial dysfunction during and early after rotational atherectomy.

CONCLUSION

Despite the absence of elevation of myocardial enzymes, significant scintigraphic perfusion defects could be demonstrated in the majority of patients. Thus, transient myocardial ischemia seems to be common and a closely procedure-related phenomenon. Lesion calcification could be identified as a risk factor for larger perfusion defects. Serial SPECT imaging with quantitative analysis as proposed in this study may be used in the future to evaluate pharmacological approaches to reduce rotational atherectomy-induced hypoperfusion.

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Combined Thallium-201 Myocardial with Technetium-99m-HMPAO Brain SPECT: Myocardial Ischemia Induced by Acetazolamide in Severe Coronary Artery Disease

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Since the perioperative mortality of coronary artery bypass surgery is high in patients with cerebrovascular disease, it is crucial to assess a cerebrovascular risk before operation. Acetazolamide (ACZ) was applied to brain SPECT to evaluate the vascular reserve, and ACZ stress brain imaging was useful for predicting perioperative cerebrovascular events. We performed ^{201}Tl myocardial and ^{99m}Tc-hexamethyl-propyleneamine oxime (HMPAO) brain SPECT with ACZ stress simultaneously to a patient with severe coronary artery disease and experienced the abnormality of ^{201}Tl myocardial imaging with ACZ, as did that with dipyridamole. Technetium-99m-HMPAO brain SPECT showed no defect. Brain SPECT with ACZ demonstrated the region of poor coronary vascular reserve, which suggested myocardial ischemia induced by ACZ in a patient with severe coronary artery disease.

Key Words: acetazolamide; myocardial ischemia; coronary artery disease; cerebrovascular disease; SPECT

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In Doppler scanning, 6%–16% of patients with coronary artery disease had significant internal carotid stenosis (*1*). Since the perioperative mortality of coronary artery bypass surgery is high in patients with cerebrovascular disease (*2*), it is crucial to know the cerebral vascular reserve for such patients in the preoperative assessment of the cerebrovascular risk. Acetazolamide (ACZ), a cerebral vasodilator, is a stress agent for brain SPECT in evaluating cerebral blood flow reserve. ACZ-augmented brain imaging was applied to predict cerebrovascular events during open heart surgery (*3*). ACZ stress brain imaging could be performed in patients with severe coronary disease because coronary and cerebral atherosclerosis often coexists (*4*). It is necessary to recognize whether ACZ affects coronary blood flow, which has not been evaluated. Therefore, to assess the effect of ACZ to cerebral and coronary blood flow reserve at the same time, we performed ACZ augmented ^{99m}Tc-hexamethyl-propyleneamine oxime (HMPAO) brain and ^{201}Tl myocardial SPECT simultaneously to a patient with severe coronary artery disease considered coronary artery bypass graft. Myocardial SPECT with ACZ revealed the region of poor coronary vascular reserve, suggesting that ACZ might induce myocardial ischemia.

CASE REPORT

A 68-yr-old woman, with a history of hypertension, had chest oppression after more than 100 ft walking for 6 yr. She had sudden dizziness and was admitted for a complete examination. After admission, the symptom of chest pain on effort disappeared after administration of nitrate and beta-blocker. Doppler scanning revealed 75% stenosis of the right internal carotid artery, but no low-density area was observed in brain x-ray CT. Coronary angiography revealed 90% stenosis in the left main trunk, 75% proximal stenosis in the left anterior descending artery and 90% stenosis in the left circumflex artery with poor collateral blood flow to each artery. Cineventriculography showed mild hypokinesis in the septal wall. As coronary artery bypass surgery was indicated, preoperative assessment of cerebral vascular reserve was necessary. Because we wanted to assess the effect of ACZ to cerebral and coronary blood flow reserve simultaneously, we performed ACZ-augmented ^{201}Tl myocardial SPECT with ^{99m}Tc-HMPAO brain SPECT to the patient.

MATERIAL AND METHODS

After giving informed consent, the patient in a fasting state was placed in the supine position with her eyes covered by a mask during the test. Ten minutes after administration of 1 g ACZ for 1 min, 111 MBq of ^{201}Tl and 555 MBq of ^{99m}Tc-HMPAO were injected simultaneously. Thallium-201 myocardial planar and SPECT images were acquired 15 min after injection. Technetium-99m-HMPAO brain SPECT was performed 1 hr after injection. Thallium-201 myocardial imaging with dipyridamole was performed 5 days after ACZ stress imaging. Seven minutes after dipyridamole (0.56 mg/kg) was infused for 4 min and 111 MBq ^{201}Tl was injected, early and delayed images were acquired 15 min and 4 hr after injection, respectively. Using a 12-lead electrocardiogram, the blood pressure and heart rate were recorded at baseline and at 1-min intervals for 15 min.

Image Acquisition

Technetium-99m-HMPAO brain SPECT was performed with a ring-type gamma camera with an 8-mm FWHM. Image data from a 20-min acquisition in the SPECT study were collected into a 128 × 128 matrix using a general, all-purpose collimator. All data were corrected for an attenuation of 0.1 cm^{-1}, and the tomographic data were reconstructed using a filtered backprojection.

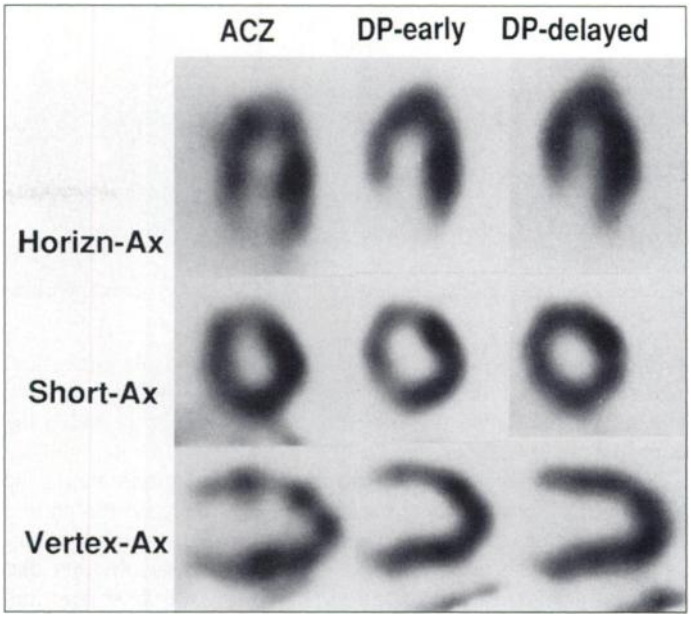

FIGURE 1. Thallium-201 myocardial SPECT with ACZ shows a defect in anterior and septal walls (left row). Thallium-201 myocardial SPECT with dipyridamole also reveals a defect in anteroapical and septal walls in the early images and redistribution in the delayed images (middle and right rows).

Myocardial images were acquired using an L-shape two-headed SPECT system equipped with low-energy, all-purpose collimators. Planar images were also acquired for 3 min in the anterior view using a 512 × 512 matrix before obtaining each myocardial SPECT image. A total of 30 projection images were obtained over 180 ° in 6 ° increments, with 40 sec/step. The energy discriminator of ^{201}Tl was centered on 70 keV in ACZ-augmented ^{201}Tl imaging, and 70 keV and 168 keV in ^{201}Tl imaging with dipyridamole, all of which were with a 20% window. To reconstruct transverse tomograms of 5 mm per slices, filtered backprojection was executed with a Butterworth filter.

Each region of interest (ROI) sizing 3 × 6 pixels was placed in the septal and lateral walls at the mid portion of the short-axis images. The ratio of mean counts in the septal wall to those in the lateral wall were calculated in the myocardial SPECT image with ACZ and in the early and delayed images with dipyridamole.

RESULTS

The ^{201}Tl SPECT with ACZ showed a defect in the anteroapical and septal walls. Thallium-201 SPECT with dipyridamole also showed a defect in the anterior and septal walls in the early images that redistributed in the delayed images (Fig. 1). The septal-to-lateral ratio was 0.80 in the image with ACZ, 0.83 in the early images with dipyridamole and 0.93 in the delayed images with dipyridamole. The blood pressure and heart rate revealed no change, and the patient had no chest pain, no ischemic ST-T changes and no arrhythmia on the electrocardiogram during the ACZ test. On the other hand, the patient had chest pain and significant ST-T changes on the electrocardiogram after dipyridamole administration, and the ischemic sign disappeared without any complication after aminophylline infusion and nitroglycerin administration.

The ^{99m}Tc-HMPAO brain SPECT with ACZ revealed normal perfusion image (Fig. 2).

DISCUSSION

ACZ stress myocardial with brain SPECT detected impaired coronary blood flow reserve in a patient with severe coronary artery disease. The defect in ACZ stress imaging was located in the same region with that in dipyridamole imaging. Also, the

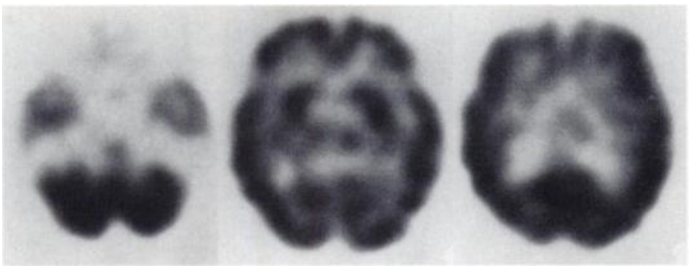

FIGURE 2. Technetium-99m-HMPAO brain SPECT shows normal perfusion image.

septal-to-lateral ratio in the ACZ test showed an equivalent value as that in the early images in the dipyridamole test. Therefore, the defect of both images substantially revealed the equality in flow difference.

Perfusion defect in anterior and septal regions might be detected in the resting myocardial imaging because the patient had significant stenosis in the left anterior descending artery with hypokinesis in the septal wall. But it was obvious that dipyridamole caused myocardial ischemia with chest pain and electrocardiographic ST-T change, and severity of the defect in ACZ stress imaging was equal to that in dipyridamole stress imaging. These results suggested that ACZ might reduce coronary blood flow in a stenotic area. ACZ-augmented combined ^{201}Tl myocardial SPECT with ^{99m}Tc-HMPAO brain SPECT was useful for simultaneously evaluating both the perioperative cerebrovascular risk and the effect of ACZ on the myocardium in this patient with severe coronary artery disease.

ACZ, a carbonic anhydrase inhibitor, is known to increase the cerebral blood flow when administered intravenously (*5,6*). ACZ increased the cerebral blood flow, which was detected as early as 2 min after injection (*7*). Using ^{15}O-H_2O PET, a maximal average response of a 42% increase in the cerebral blood flow was seen after 10 min in normal sites (*8*). Therefore, the radioactivity distribution showed the myocardial flow at the time of the maximal effect of ACZ. ACZ might act directly on the vascular smooth muscle in the cerebral arterioles (*7*). As the amount of carbonic anhydrase was scantily distributed in the cardiac muscle (*9,10*), and in the rat heart, adenosine triphosphatase activity was unaffected by ACZ (*11*). In patients with various cardiovascular diseases, ACZ increased the cerebral blood flow by 70%, inducing a 10% increase in the cardiac output ratio (*12*). ACZ might increase myocardial oxygen consumption by increasing the cardiac output and this might result in induction of myocardial ischemia. On the contrary, dipyridamole was reported to have a vasodilatory effect not only on coronary arteries but also on cerebral arteries that could cause cerebrovascular ischemia (*13*).

Neither ST-T changes on the electrocardiogram nor chest pain was observed after administration of ACZ, whereas ST-T changes and chest pain occurred after injection of dipyridamole. Myocardial ischemia might be induced without ST-T changes on the electrocardiogram. This suggests that myocardial ischemia induced by ACZ might be milder than that by dipyridamole.

Because the initial distribution of ^{99m}Tc-HMPAO in the myocardium was the same as that of the ^{201}Tl distribution (*14*), simultaneous administration of ^{99m}Tc-HMPAO and ^{201}Tl could not influence essential ^{201}Tl myocardial images. In addition, ^{201}Tl might not affect ^{99m}Tc-HMPAO brain SPECT images because ^{201}Tl does not cross the blood-brain barrier (*15*), and the cross talk of ^{201}Tl is ignorable in terms of the lower energy of ^{201}Tl.

CONCLUSION

ACZ induced the reduction in myocardial blood flow in the coronary stenotic area in a patient with severe coronary artery disease.

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