Detection of Perioperative Coronary Vasospasm on Iodine-123-MIBG, Thallium-201 and Iodine-123-BMIPP Myocardial SPECT Images

Koji Kodama, Michiya Igase, Yukio Kazatani, Keisuke Matsuzaki, Eiki Murakami and Tatsuo Kokubu

Department of Internal Medicine, Kinki Central Hospital, Itami, Japan

A 64-yr-old woman, who had no history of anginal attack, underwent cholecystectomy under general anesthesia. A few hours after successful surgery, the EKG showed T-wave inversions with QT-interval prolongations and torsades de pointes. The [^{123}I]MIBG scintigraphic findings revealed marked denervation in the anteroseptal and inferoposterior myocardium, whereas ^{201}Tl myocardial SPECT showed only slightly reduced tracer uptake in those areas. The [^{123}I]BMIPP scans showed abnormal fatty acid metabolism in the anteroseptal myocardium. Coronary angiogram detected no fixed stenosis, but coronary vasoconstriction in the left anterior descending artery was induced by intracoronary injection of acetylcholine. In our patient, the findings of cardiac imaging with [^{123}I]MIBG, ^{201}Tl and [^{123}I]BMIPP led to coronary angiography and the final diagnosis of probable perioperative coronary vasospasm.

Key Words: perioperative coronary vasospasm; iodine-123-MIBG; thallium-201; iodine-123-BMIPP; single-photon emission computed tomography

J Nucl Med 1995; 36:2050–2052

The number of case reports on coronary artery spasm during or immediately after noncardiac surgery has been increasing (*1,2*). Transient ST-segment deviations, particularly ST-segment elevations, on EKG during surgery or in the immediate postoperative period are strongly suggestive of perioperative coronary vasospasm. We report on a patient with T-wave conversions to negative and long QT-intervals accompanied by torsades de pointes on EKG immediately after cholecystectomy. In our patient, ^{123}I-metaiodobenzylguanidine ([^{123}I]MIBG), ^{201}Tl and ^{123}I-β-methyl-iodophenyl pentadecanoic acid ([^{123}I]BMIPP) myocardial SPECT were useful in detecting probable perioperative coronary vasospasm.

Received Feb. 15, 1995; revision accepted Jul. 14, 1995.

For correspondence or reprints contact: Koji Kodama, MD, The Second Department of Internal Medicine, Ehime University School of Medicine, Shitsukawa, Shigenobu-cho, Onsen-gun, Ehime 791-02, Japan.

CASE REPORT

A 64-yr-old woman, who had a history of hypertension and diabetes mellitus but not angina pectoris, was admitted to our hospital for management of cholecystitis with cholecystolithiasis. She underwent cholecystectomy under general anesthesia after gallbladder inflammation was abated with antibiotic treatment. On the day of surgery, the patient was given 25 mg hydroxyzine hydrochloride and 0.5 mg atropine sulfate as premedication. General anesthesia was induced with thiopental sodium (250 mg) intravenously and fentanyl citrate (0.1 mg) intravenously; the trachea was intubated after administration of 4 mg pancuronium bromide and 60 mg suxamethonium chloride. Ventilation was controlled and anesthesia was maintained with 1% sevoflurane and 50% nitrous oxide in oxygen. After 2 hr and 25 min of uneventful surgery, sevoflurane and nitrous oxide were discontinued. Following 100% oxygen breathing, the trachea was extubated. ST-segment deviations were not found on EKG monitoring during surgery. Analysis of arterial blood gases was not performed.

Two hours after surgery, the EKG showed T-wave inversions in all leads except leads aVR and aVL, which were associated with QT prolongations of 0.64 sec as the corrected QT-interval calculated by Bazett's formula, compared with tracing recorded before surgery (Fig. 1). Moreover, nonsustained ventricular tachycardia of torsades de pointes was found. Treatment with intravenous administration of lidocaine hydrochloride was effective on ventricular arrhythmia. Creatine kinase peaked at 318 U/liter and myosin light chain I increased only to 4.4 ng/ml.

Myocardial imaging with [^{123}I]MIBG, ^{201}Tl and [^{123}I]BMIPP was performed 8, 13 and 18 days after surgery, respectively (Fig. 2). Prior to imaging, the patient fasted overnight and 111 MBq [^{123}I]MIBG, 148 MBq ^{201}Tl or 148 MBq [^{123}I]BMIPP were administered intravenously at rest while the patient was supine position. Initial images were obtained 20 min after intravenous injection of the tracers. For [^{123}I]MIBG or [^{123}I]BMIPP myocardial SPECT, a delayed scan was obtained 4 hr later. A rotating single-head gamma camera equipped with a low-energy, high-resolution, parallel-hole collimator interfaced to a dedicated computer was used to acquire the SPECT data from 32 projections over 180° orbits from 45° right anterior oblique to the 45° left posterior oblique views for 30 sec per projection for a total acquisition time of 20 min. Energy discrimination was carried out with a 20% window centered over the 80-keV (^{201}Tl) or 159-keV (^{123}I) photopeak. The images were acquired on a 64 × 64 matrix and stored on a hard disk for further processing. Data were preprocessed with a Butterworth filter, and the short-axis, horizontal long-axis and

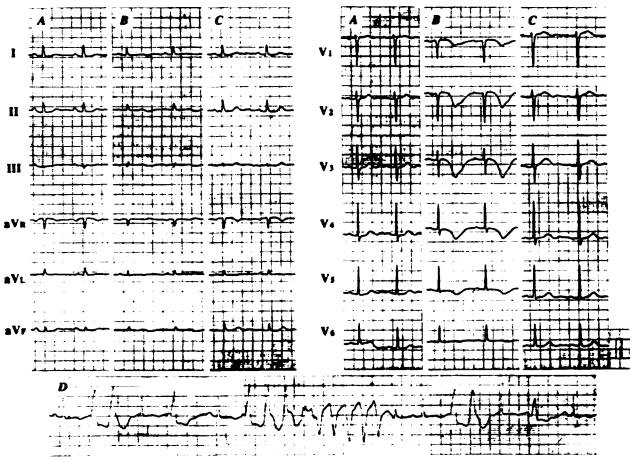

FIGURE 1. EKG recorded 2 hr after cholecystectomy (B) shows T-wave inversions in all leads except leads aVR and aVL with QT prolongations, whereas the tracing recorded before surgery (A) was almost normal. Torsades de pointes also was found (D). EKG recorded 7 mo after surgery (C) was normal.

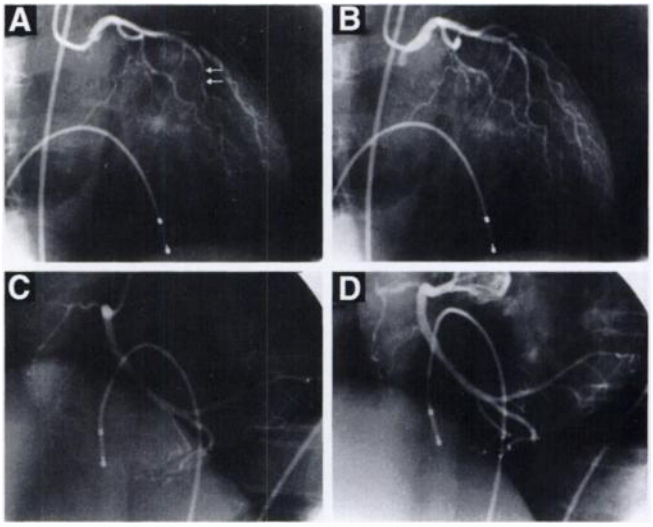

FIGURE 3. Coronary angiogram demonstrates severe vasoconstriction in the mid-LAD induced by intracoronary acetylcholine injection (A, arrow) and resolution of spastic changes after nitrate administration (B). No significant difference was found between the lumen diameter after injection of acetylcholine in the RCA (C) and after nitrate injection (D).

vertical long-axis images were reconstructed with a Shepp and Logan filter. Attenuation correction was not performed.

Markedly decreased uptake of [^{123}I]MIBG was observed in the anteroseptal and inferoposterior wall of the left ventricle in comparison with the ^{201}Tl rest images. In addition, [^{123}I]BMIPP uptake in the anteroseptal region was relatively lower than that in the other regions, particularly in the late images. Coronary angiography performed 13 days postsurgery showed no organic luminal narrowing. Therefore, acetylcholine provocation testing for coronary vasospasm was performed (Fig. 3). First, an incremental dose of acetylcholine (20 and 50 μg) was injected into the right coronary artery (RCA), but coronary vasospasm was not induced. Second, acetylcholine (50 and 100 μg) was injected into the left coronary artery and severe vasoconstriction occurred at the middle through distal portion of the left anterior descending artery (LAD). Hypo-

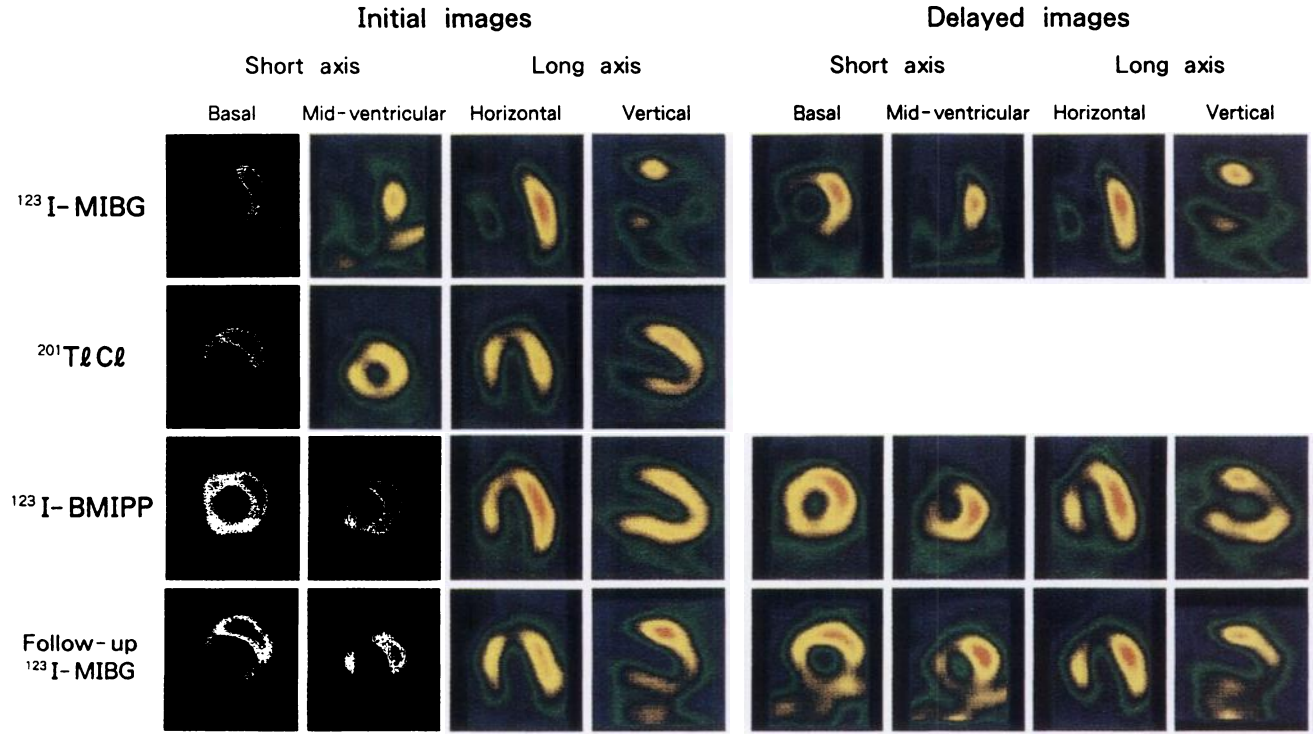

FIGURE 2. Iodine-123-MIBG myocardial SPECT image reveals marked denervation in the anteroseptal and inferoposterior myocardium; the ^{201}Tl image was nearly normal. Iodine-123-BMIPP image shows relatively lower tracer uptake in the anteroseptal region than in other regions. Follow-up [^{123}I]MIBG SPECT reveals reinnervation in the same area where denervation was found in the first study.

kinesis in the anterolateral, septal and apical regions was noted on left ventriculography with an ejection fraction of 0.55. Therefore, the patient was diagnosed as having probable perioperative coronary vasospasm.

Thereafter, she was treated with nitrates and had no anginal attack. The electrocardiogram recorded 7 mo after the operation was similar to the tracing recorded before surgery (Fig. 1). In addition, the echocardiogram showed normal wall motion of the left ventricle. Follow-up [^{123}I]MIBG myocardial scintigraphy also revealed marked reinnervation in the same area in which denervation was found in the first study (Fig. 2).

DISCUSSION

In our patient, [^{123}I]MIBG and ^{201}Tl myocardial imaging revealed de-enervated but viable myocardium in the area where the RCA and LAD perfused. On the other hand, [^{123}I]BMIPP myocardial SPECT showed abnormal metabolism of fatty acids only in the anteroseptal region perfused by the LAD. An acetylcholine provocation test for coronary arterial spasm also revealed severe vasoconstriction only in the LAD, and left ventriculography demonstrated hypokinetic wall motion in the LAD. Therefore, we speculated that coronary vasospasm occurred not only in the LAD but also in the RCA; myocardial ischemia of the LAD region, however, was more severe than that of the RCA region. Abnormal findings in the LAD on [^{123}I]BMIPP myocardial scintigraphy and left ventriculography despite a nearly normal finding on ^{201}Tl SPECT about 2 wk after the onset, and improvement of left ventricular wall motion on the echocardiogram 7 mo later could mean myocardial stunning (*3,4*). Marked cardiac sympathetic denervation might explain the ST-T changes with QT prolongations followed by torsades de pointes (*5*).

The ST-segment deviations on the EKG during surgery or in the immediate postanesthetic state are suggestive of perioperative coronary vasospasm. Initial detection of such a syndrome, however, is often provided by systemic hypotension or arrhythmias due to severe myocardial ischemia and not by EKG changes. Thus, perioperative coronary vasospasm may be overlooked if hemodynamic aberrations are absent or trivial. In our patient, EKG changes during an anginal attack, ST-segment deviations, were not recorded. Negative T-waves and prolongations of the QT-interval on the EKG, which were thought to be EKG abnormalities after an anginal attack, however, were found immediately after cholecystectomy. Therefore, it was unknown when the coronary vasospastic event occurred.

Coronary vasospasm during the early postoperative period following coronary artery bypass grafting has often been reported (*6*). Clinically recognized perioperative coronary artery spasm has been estimated to occur after 1%–2.5% of coronary artery bypass graft procedures. There are, however, few studies on vasospastic angina during or immediately after noncardiac surgery. What causes perioperative coronary vasospasm after noncardiac surgery? The mechanisms for the condition remain unclear and are thought to be multifactorial. Several possible mechanisms include hyperventilation and altered sympathetic or parasympathetic activation. Many drugs also affect epicardial coronary vascular tone, but the effects of volatile anesthetics or nitrous oxide on coronary circulation are extremely complicated (*7*). It was reported that preoperative angina at rest appeared to be an important identifying factor in patients who experienced coronary vasospasm following coronary artery bypass graft surgery.

CONCLUSION

In our patient, abnormal myocardial SPECT findings using [^{123}I]MIBG, ^{201}Tl and [^{123}I]BMIPP led to coronary angiography, including an acetylcholine provocative test for coronary vasospasm, and resulted in the final diagnosis of perioperative coronary vasospasm. Extreme care should be taken not to overlook myocardial ischemia, even in patients with no history of angina pectoris, during noncardiac surgery (*8*).

REFERENCES

1. Balagot RC, Selim H, Bandelin VR, Kwan BK, Ecanow B. Prinzmetal's variant angina in the immediate postanesthetic state. *Anesthesiology* 1977; 46:355–357.
2. Buffington CW, Ivey TD. Coronary artery spasm during general anesthesia. *Anesthesiology* 1981;55:466–469.
3. Uehara T, Nishimura T, Kumita S, et al. Diagnostic utility of myocardial imaging using ^{123}I-labeled beta-methyl-iodophenyl pentadecanoic acid in ischemic heart disease. *Jpn J Nucl Med* 1992;29:347–358. (in Japanese with English abstract)
4. Fujibayashi Y, Yonekura Y, Takemura Y, et al. Myocardial accumulation of iodinated beta-methyl-branched fatty acid analogue, iodine-125-15-(p-iodophenyl)-3-(R, S) methylpentadecanoic acid (BMIPP), in relation to ATP concentration. *J Nucl Med* 1990;31:1818–1822.
5. Müller KD, Jakob H, Neuzner J, Grebe SF, Schlepper M, Pitschner HF. Iodine-123-metaiodobenzylguanidine scintigraphy in the detection of irregular regional sympathetic innervation in long QT syndrome. *Eur Heart J* 1993;14:316–325.
6. Lemmer JH Jr, Kirsh MM. Coronary artery spasm following coronary artery surgery. *Ann Thorac Surg* 1988;46:108–115.
7. Larach DR, Schuler HG. Direct vasodilation by sevoflurane, isoflurane and halothane alters coronary flow reserve in the isolated rat heart. *Anesthesiology* 1987;66:273–278.
8. Eisenberg MJ, London MJ, Leung JM, et al. For the Study of Perioperative Ischemia Research Group. Monitoring for myocardial ischemia during noncardiac surgery. A technology assessment of transesophageal echocardiography and 12-lead electrocardiography. *JAMA* 1992;268:210–216.