Stress/Rest $^{99mTc}$-MIBI SPECT and $^{123I}$-BMIPP Scintigraphy for Indication of Surgery With Coronary Artery to Pulmonary Artery Fistula

Fujio SATO,1 MD, and Tadashi KOISHIZAWA,2 MD

SUMMARY

A 45-year old man was admitted to our hospital with chest pain occurring suddenly upon exercise and disappearing with rest within several minutes. A continuous murmur was heard at the upper sternum border. Conventional electrocardiography showed no evidence of myocardial ischemia. Coronary angiography and cardiac catheterization demonstrated a fistula originating from the left coronary artery to the pulmonary artery with an aneurysm 2 cm in size, and Qp/Qs 1.08. Treadmill exercise testing showed no ST-T change at the maximum heart rate of 160 beats/min. Stress/Rest $^{99mTc}$-Technetium-MIBI single-photon emission computed tomography (SPECT) and $^{123I}$-15-(p-iodo-phenyl)-3,R,S-methylpentadecanoic acid (BMIPP) scintigraphy were performed to evaluate myocardial ischemia and ischemia was identified at the perfusion area of the left anterior descending artery. From these results, the patient was diagnosed as having a coronary artery to pulmonary artery fistula with myocardial ischemia. Consequently, surgical treatment was chosen under cardiopulmonary bypass. The determination of a surgical indication using stress/rest $^{99mTc}$-MIBI SPECT and BMIPP scintigraphy is useful in cases showing normal TMT, such as this case. (Int Heart J 2005; 46: 355-361)

Key words: Coronary artery to pulmonary artery fistula, Aneurysm, $^{99mTc}$-MIBI SPECT, $^{123I}$-BMIPP, Scintigraphy

CORONARY artery fistula (CAF) is a rare cardiovascular disease and most patients with CAF are asymptomatic. Symptoms generally develop depending on the amount of shunt with CAF. The surgical criteria have been reported to be the presence of a large shunt flow (pulmonary blood flow/systemic blood flow (Qp/Qs) > 2.0) with hemodynamic change and symptoms of heart failure. Some cases develop symptoms in spite of a low Qp/Qs. We report a case with a left coronary artery to pulmonary artery fistula in which surgery was indicated by $^{99mTc}$-MIBI SPECT and $^{123I}$-BMIPP scintigraphy.
A 45-year-old man was admitted to our hospital with chest pain occurring upon exercise and disappearing with rest within several minutes. A grade Levine 3/6 continuous murmur was heard at the upper left sternum border. The cardiothoracic ratio (CTR) was 0.55 and an electrocardiogram showed a normal sinus rhythm of 62 beats per min (bpm) with complete right bundle branch block and no significant ST-T changes. Transthoracic 2D-echocardiography in combination with Doppler color flow mapping showed an abnormal flow in the main pulmonary artery (PA). Cardiac catheterization indicated normal pressure on both sides of the heart. The Qp/Qs was 1.08 and the shunt rate was 9.2%. Coronary angiography (CAG) revealed a coronary artery to pulmonary artery fistula with an aneurysm 2 cm in size, which originated from the left anterior descending (LAD) artery to the main PA with no stenosis in the LAD (Figure 1). Treadmill exercise testing (TMT) showed no ST-T change at the maximum heart rate of 160 beats/min. Stress/Rest $^{99m}$Tecnetium-MIBI single-photon emission computed tomography (SPECT) using a bicycle ergometer revealed a moderate defect at the basal anterior and middle anterior walls (Figure 2). Stress testing with the bicycle ergometer was performed in 3-minute steps up to 85% of the maximum theoretical heart rate. No sign of myocardial ischemia was found in a stress ECG. There were no symptoms during examination. $^{123}$I-15-(p-iodo-phenyl)-3,R,S-methylpentadecanoic acid (BMIPP) revealed moderately low uptake in the basal infero-

**Figure 1.** Coronary angiography. Selective coronary angiography showing a fistulae (arrow #1) arising from the left anterior descending coronary artery (LAD) and appearing to empty into the main pulmonary artery (PA). There was an aneurysmal cavity approximately 20 mm in diameter (arrow #2) in the fistula. There was no stenosis in the LAD.
Figure 2. Stress/Rest ⁹⁹ᵐTc-MIBI SPECT.
Sections indicated through the vertical, horizontal, and short axes of the heart. Arrows indicate reversible myocardial perfusion defect in the basal and mid-anterior wall probably due to flow steal via an abnormal branch arising from the LAD to PA.

Figure 3. ¹²³I-BMIPP scintigraphy.
Sections indicated through the vertical, horizontal, and short axes of heart. Arrows indicate moderately low uptake in the basal infero-septal wall (#1) and slightly low uptakes in the anterior (#2) and inferior walls (#3).
septal wall and slightly low uptake in both the anterior and inferior walls (Figure 3).

From these results, the patient was diagnosed as having a coronary artery to pulmonary artery fistula, which caused myocardial ischemia, with an aneurysm. The decision to proceed with surgery was based on the presence of moderate myocardial ischemia and the aneurysm. The heart was exposed through a median sternotomy. A slight thrill was felt at the CAF and the main PA. After establishment of the cardiopulmonary bypass, the aorta was cross-clamped and cardiac arrest was obtained by antegrade cold cardioplegia. After opening the main PA, one orifice was found at the anterior wall of the main PA (Figure 4B). The orifice was closed within the main PA using 4-0 prolene. The anomalous vessel originated from the proximal side of the LAD. Epicardial ligation of the fistulous vessel was performed adjacent to the LAD. The pressure in the aneurysm did not disappear with the surgical procedure, suggesting that residual communication remained. The aneurysm was opened and the two orifices of the filling artery were closed using 4-0 prolene. No bleeding appeared at the aneurysm incision after this procedure. The PA wall was closed and the cardiopulmonary bypass was terminated.

Postoperative recovery, including the hemodynamic status, was uneventful. Postoperative CAG demonstrated normal coronary configuration without CAF. The patient was discharged on the 25th postoperative day.

Figure 4. Perioperative photograph.
Figure 4A shows coronary artery to pulmonary artery fistula with an aneurysm. Arrow (#1) indicates that a 2.0 × 1.5 cm coronary aneurysm was located at the left side of the right heart outflow and PA. Arrow (#2) indicates the orifice that was found at the anterior wall of the main PA (Figure 4B).
CAF is a rare cardiac anomaly. Although there are some cases in which symptoms appear after birth, most patients with CAF are asymptomatic. When they do appear, frequent symptoms are dyspnea, palpitations, and chest pain. The incidence of symptomatic cases ranges from 30 to 55%. These symptoms are related to the shunt flow of CAF that lead to the coronary steal phenomenon. Regarding an indication for surgery, Konno, et al suggested the following criteria: (1) a shunt-rate > 30%, (2) ischemic or hypertrophic changes in ECG, (3) anticipation of the progression of the pulmonary hypertension or congestive heart failure, (4) history of ischemia, (5) morphological saccular type aneurysm, and (6) social reasons. Rittenhouse, et al reported that the presence of a large shunt flow (Qp/Qs > 2.0) with hemodynamic changes and symptoms of heart failure indicate surgery. Since the amount of shunt flow is thought to be a major factor in the decision to perform surgery, it is important to evaluate the shunt flow.

In the present case, the patient complained of chest pain, which might have been associated with the coronary steal phenomenon because no coronary stenosis appeared in the CAG. Since CAG is useful to assess the configuration of the fistula, in this case, it showed the shunt flow of a fistula between the LAD and the main PA. It was necessary to confirm whether or not this chest pain was derived from CAF. Since the Qp/Qs was as low as 1.08 and the shunt rate was as low as 9.2%, additional examination was required to determine the ischemic changes in the heart. Also, it has been reported that the shunt flow was accurate at providing myocardial ischemia by cardiac catheterization in cases of low shunt flow.

The treadmill test (TMT) is one of the examinations for evaluating myocardial ischemia. Manca, et al reported that TMT had a sensitivity of 66.1% and a specificity of 88.2% regarding the detection of ischemic heart disease. Although TMT was performed to reveal myocardial ischemia in this case, none was found. Hence, additional examination was required to evaluate myocardial ischemia using a radioisotope examination. Yao, et al reported that 99mTc-MIBI SPECT had a sensitivity of 75.0% and a specificity of 93.7% in the detection of ischemic heart disease. Hambye, et al reported that stress 99mTc-MIBI SPECT had a sensitivity of 88% for the detection of ischemic heart disease. We believe that 99mTc-MIBI SPECT has a higher sensitivity and specificity than TMT in detecting myocardial ischemia. We performed stress/rest 99mTc-MIBI SPECT and 123I-BMIPP scintigraphy to evaluate myocardial ischemia. Stress/rest 99mTc-MIBI SPECT can be useful for assessing the hemodynamic significance of the coronary flow and the influence of a fistula. 123I-BMIPP scintigraphy can detect coronary artery disease based on persistently abnormal myocardial fatty acid metabolism after ischemia. 123I-BMIPP has high sensitivity for detecting myocardial ischemia, and
can be used to estimate recent ischemic events. The radionuclide examinations revealed myocardial ischemia in the LAD area due to the coronary artery to the pulmonary artery fistula. This is one of the reasons for the indication of surgery. The other was the presence of an aneurysm.

The purpose of surgery for a coronary artery fistula has been reported to be the abolition of the fistulous connection without interfering with the native coronary artery supply. In the present case, the orifice of the fistula was closed within the main PA and ligation of the orifice adjacent to the LAD was performed. Enlargement of the aneurysm did not disappear in spite of surgical closure at the inlet and distal end. Since it was thought that communication with the aneurysm remained, additional sutures at the aneurysm were added. The aneurysmal configuration subsequently disappeared, suggesting that some communication, which was not identified in preoperative CAG, was present.

In conclusion, the determination of a surgical indication by stress/rest 99mTc-MIBI SPECT and BMIPP scintigraphy is useful in cases showing normal TMT, such as this.

REFERENCES
