PLAQUE RUPTURE POSSIBLY INDUCED BY CORONARY SPASM

—An Autopsy Case of Acute Myocardial Infarction—

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The histological picture of sites of coronary spasms has not yet been made sufficiently clear. A histopathological examination was performed on the coronary artery of a patient who died of acute myocardial infarction after a refractory coronary spasm was identified by coronary arteriography. In the site of the coronary spasm, intimal bleeding as well as infiltration by lymphocytes and plasma cells in the adventitia were seen. In the same region, fracture of intimal collagen fibers and rupture of atheromatous plaque were observed. Although it is very difficult to prove in individual cases of acute myocardial infarction that spasms played a part, some cases involving spasms may possibly exist among the cases of acute myocardial infarction showing atheromatous plaque rupture -- thrombus formation.

There is no doubt that coronary spasms play a part in the onset of some cases of acute myocardial infarction. In individual cases, however, it is not easy to prove that a coronary spasm has been involved in the pathogenesis even though it may be suspected. Histological pictures of sites of coronary spasms have not yet been made sufficiently clear. This report describes an autopsy showing an atheromatous plaque which is thought to have ruptured due to a coronary spasm.

CASE REPORT

A 59-year-old man was transferred to the CCU of this hospital from another institution on account of acute anteroseptal myocardial infarction. This was on May 2, 1986, 3 days after the onset. Hypertension and diabetes mellitus had been diagnosed 5 years earlier, and the patient had been taking oral hypotensives and following a diet since that time. On admission, the blood pressure was 110/60 mmHg and the pulse was 70 per minute and regular. Although a systolic ejection murmur of Levine 1/6 was heard at the apex, there were no rales in the lung field, nor was there any distention of the neck veins. Laboratory findings recorded by his previous physician were CK 864 IU/l, SGOT 319 IU/l, and LDH 1918 IU/l. The electrocardiogram taken on admission showed left axis deviation, QS waves in leads V1–3 and negative T waves in leads V2–5, I, and aVL (Fig. 1). There were no particularly severe complications and rehabilitation proceeded smoothly by oral treatment with 80 mg of isosorbide dinitrate (ISDN) and 120 mg of diltiazem daily until the tenth day after the onset. On May 10, atrioventricular dissociation occurred. The treatment with 120 mg diltiazem per day was changed to 15 mg of nicorandil daily, and the patient had chest pain at midnight of the following day. There was

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Fig. 1. Electrocardiographic changes. On admission on May 2, left axis deviation, QS waves in leads V1–3, and negative T waves in leads V2–5, I and aVL were seen. When chest pain attack occurred at 1 a.m. on May 11, there was a slight ST elevation in leads V1–3, but the chest pain disappeared and the ST segment returned to the base line with sublingual administration of ISDN and drip infusion of nitroglycerin. #: At the time of chest pain attack. $: After sublingual ISDN and drip infusion of nitroglycerin.

a slight ST elevation in leads V1–3 (Fig. 1). Although the chest pain disappeared with sublingual administration of 10 mg ISDN, drip infusion of nitroglycerin was given because of remaining chest discomfort. After the drip infusion, the ST elevation returned to the level observed on May 9. No enzyme elevation was seen at this time. Subsequently, ventricular tachycardia occurred many times and cardiac catheterization was performed on May 15. Coronary arteriography revealed occlusions in the left anterior descending artery and circumflex artery (Fig. 2A) and a 50% stenosis in the right coronary artery (Fig. 2B) was seen. Collateral circulation from the right coronary artery to the circumflex artery was observed. Coronary arteriography was completed without difficulty but the patient suddenly began to complain of chest pain while the brachial artery was being sutured. The electrocardiogram revealed ST elevation in leads II, III, and aVF (Fig. 3), and a right coronary arteriography which was promptly performed showed a complete occlusion at #1 (Fig. 2C). Injection of 1 mg ISDN into the right coronary artery produced a sufficient restoration of patency immediately without any filling defect (Fig. 2D). The electrocardiogram also showed a return of the ST elevation in leads II, III, and aVF to base line with the recovery of patency (Fig. 3). Soon afterward, however, #1 became occluded again (Fig. 2E) but it became patent once more with another dose of ISDN (Fig. 2F). This was repeated so that a total of 31.5 mg of ISDN in 14 administrations, 240,000 and 480,000 units making a total of 720,000 units of urokinase, and 50 mg of nitroglycerin by drip infusion were given. Although 5 mg nifedipine (sublingual) and 5 mg diltiazem (i.v. injection) were administered, the patency was only temporary. Occlusion occurred soon, and the condition became complicated by acute inferior myocardial infarction. The patient died on the following day due to a cardiogenic shock and ventricular fibrillation. During this time, ST elevation in leads II, III, and aVF, and returns to the base line were seen repeatedly in electrocardiogram (Fig. 3).

Autopsy findings: Autopsy was performed 2 hours after death. The heart weighed 550g and its ventricular septum as well as left ventricular free wall were hypertrophied. Histological examination revealed scars in the left ventricular
anterior wall and the anterior portion of the ventricular septum. Contraction band necrosis was observed in the left ventricular posterior wall and the posterior portion of the ventricular septum (Fig. 4). #7 was completely occluded by a relatively fresh thrombus (Fig. 5A) and at #13 a 99% atherosclerotic stenosis was noted. At a point about 1.2 cm more proximal from the occlusion at #7, hemorrhage other than this thrombus was seen in the intima (Fig. 5F, G). As the site of the hemorrhage was nearly in contact with the lumen, the site was remarkably stenosed. The histological pictures of the site where spasms of right coronary artery occurred are shown in Figs. 6 and 7. Considerably marked hemorrhage was seen in the intima (arrows in Fig. 6A; B; star in C) and the presence of hemosiderin suggested that there had been previous bleeding. In the adventitia, cellular infiltration consisting mainly of lymphocytes and plasma cells was observed (Fig. 6C arrows, D). As there have been reports of large numbers of mast cells

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found in the adventitia of the area where a spasm occurred, this aspect was examined in this case, but no significant increase was noted. Neither were any contraction bands observed in the smooth muscle cells of the media. Fig. 7A is a histological picture approximately 0.4 mm peripheral from Fig. 6A. Fig. 7B is a detail of the area indicated by an arrow in A, while B, C and D are histological pictures of serial step sections. The intimal collagen fibers are disrupted (asterisks in Fig. 7B through D), the atheromatous plaque protrudes into the lumen while a fresh thrombus is observed (arrows in Fig. 7B through D). However, no formation of large thrombi was found in the lumen.

**DISCUSSION**

A spasm was considered to have been unmistakably involved in the occlusion in the proximal region of the right coronary artery as the shape of the vascular lumen was tapered and patency was sufficiently restored with injection of ISDN without showing any filling defect.
Fig. 4. A: Distribution of fibrosis and contraction band necrosis. B: Contraction band necrosis (Masson's trichrome stain). Scars were seen in the left ventricular anterior wall and the anterior portion of the ventricular septum while contraction band necrosis was observed in the left ventricular posterior wall and the posterior portion of the ventricular septum.

Fig. 5. Histological pictures of left anterior descending artery. A to E are histological pictures by serial step sectioning. A is the distal portion and E is the proximal portion. The interval between sections is 240 to 480 μm. The lumen was occluded by a thrombus (A) and, on its proximal side, hemorrhage was seen in the intima (arrows in C and D). F is a histological picture about 1.2 cm proximal from E. G is an enlarged view of the part indicated by arrow in F. Hemorrhage was observed in the intima of the part which was nearly in contact with the lumen (arrows in G). (H. E. stain, A, F ×5, B~E ×10, G ×13.2.)
Fig. 6. Histological pictures of the spastic site of the right coronary artery. B and D are details of the parts indicated by arrows in A and C respectively. C is at about 1 mm more proximal than A. Remarkable intimal hemorrhage was seen (arrows in A, B, stars in C) while in the adventitia, cellular infiltration consisting mostly of lymphocytes and plasma cells was observed (arrows in C, D). (A, B: Azan-Mallory stain. C, D: H.E. stain. A, C: ×5; B, D: ×50.)

Fig. 7. Histological views of coronary spastic site. A is 0.4 mm more peripheral than Fig. 6A. B is an enlarged view of the part indicated by an arrow in A. B, C, and D are histological pictures by serial step sectioning. The intervals between B and C and between C and D respectively are 80μm. Fracture of intimal collagen fibers (asterisks) is seen. Rupture of an atheromatous plaque and its protrusion into the lumen as well as fresh thrombi were observed (arrows).
Although the cause of the spasm is unknown, it may have been induced by damage caused to the intima by the catheter as fracture was seen in intimal collagen fibers. In general, however, spasms induced by a catheter often occur at the time of insertion of the catheter, and it is extremely rare for a spasm to occur with a time lag, as it did in this case. It is more likely that the rupture of the intimal collagen fibers and rupture of the atheromatous plaque may have been a result of the spasm. The rupture of the atheromatous plaque is a lesion often seen in the coronary artery responsible for myocardial infarction. Horie et al. state that in myocardial infarction, an increase of intraplaque pressure resulting from blood infiltration through the injured endothelial cells is followed by fracture of intimal collagen fibers and rupture of the atheromatous plaque, after which thrombus formation takes place. In the right coronary artery of this case, there was a marked intimal hemorrhage so that it was thought that possibly a spasm caused bleeding in the intima after which increase of intraplaque pressure and rupture of the atheromatous plaque took place.

Although it is very difficult to prove that spasms have played a part in individual cases of acute myocardial infarction, existence of some cases where spasms had a part was thought to be possible even among the cases of acute myocardial infarction showing atheromatous plaque rupture – thrombus formation.

The ST elevation in leads V1-3 occurring in the course was thought to be related to the intimal hemorrhage directly under the lumen observed in the proximal pat of #7. Although it is not clear whether the lumen was temporarily occluded by bleeding or a spasm occurred in the same region, the hemorrhage was considered to be a lesion corresponding to the changes in ECG.

In cases of vasospastic angina like this which do not respond well to medical treatment with nitrates and calcium antagonists, percutaneous transluminal coronary angioplasty (PTCA) perhaps should have been tried. The main mechanism of luminal enlargement by PTCA is confirmed histologically to be an intimal and medial disruption which occurred in the arterial wall located opposite the atheroma. Therefore, it was speculated that if the media of the site of coronary spasm of this case were disrupted by PTCA, the lumen would not have become occluded even by a subsequent spasm.

REFERENCES


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