CASE REPORT

Acute Myocardial Infarction Caused by Coronary Spasm and Dissection Treated with Medical Therapy

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Summary
We report the case of a 33-year-old woman with no history of coronary risk factors or chest pain who experienced intermittent chest pain at rest for several minutes from 2 PM. At 8 AM the next day, chest pain recurred and persisted for about 1 hour. She was transported to our hospital by ambulance, where electrocardiogram showed ST-elevation in the precordial leads, and blood tests showed elevation of cardiac markers. She was diagnosed with ST-elevation myocardial infarction. Because she was a young woman without any risk factors, coronary spastic angina was suspected. Coronary angiography without intracoronary nitrate administration revealed diffuse 75% stenosis in the proximal right coronary artery (RCA) and diffuse 90% stenosis in the left anterior descending artery (LAD). A coronary spasm provocation test elicited chest pain; coronary angiography showed 99% diffuse stenosis of LAD; and electrocardiogram showed precordial ST-segment elevation. Although intracoronary nitroglycerin injection attenuated the coronary spasm in the RCA and proximal LAD, 90% stenosis and coronary dissection were observed in the midportion of the LAD. When the imaging test that was carried out before the provocation test was reexamined, the dissection was recognized, and there was no clear dissection progress after the test. Intravascular ultrasound showed dissection of the LAD, as did angiography. We treated the patient using medical therapy instead of percutaneous coronary intervention.

The patient did not suffer any anginal attack and improved sufficiently to be discharged. She remained free of attacks for about 10 years to the present time, and follow-up is continuing.

Key words: Coronary dissection, Woman, Medication

Primary spontaneous coronary artery dissection (SCAD) is a rare disease, but the involvement of acute coronary syndrome and sudden death has been reported. In a single-institution retrospective observational study, 24.2% of the myocardial infarctions that were reported in women younger than 50 years were attributed to SCAD. Furthermore, 70%-80% of SCAD cases occur in young women with a reported mean age of 39 years, with a higher incidence of SCAD in the perinatal period. Recent advances in imaging techniques have made it possible to diagnose SCAD before death, and the clinical features of the condition have gradually been clarified. However, no consensus has been reached on the exact causes and treatment method of SCAD.

We report the case of a young woman who developed acute myocardial infarction due to coronary spasm of the left anterior descending artery (LAD) and right coronary artery (RCA) and partial coronary dissection of the spastic region of LAD. She was treated with medication for about 10 years and has remained free of anginal attacks.

Case Report
We present the case of a female, 33 years old, with no history of pregnancy or delivery. At the annual checkup, no abnormal electrocardiograms or chest pains were reported. The patient had no history of smoking or drinking and no family history of ischemic heart disease. She did not take oral contraceptives and had been under stress for about 2 months. Menstruation began 2 days before the crisis. From 2 PM on a certain day, she experienced intermittent chest pain when at rest, which lasted for several minutes. At 8 AM the following day, the chest pain recurred and persisted for about 1 hour. She was brought to our hospital by ambulance.

Clinical characteristics on admission were as follows: height, 160 cm; weight, 54 kg; body mass index, 21.1 kg/m²; body temperature, 36.5°C; pulse rate, 70 beats/minute and regular; blood pressure, 104/74 mmHg; SpO₂, 96% (room air); clear consciousness; no carotid bruit; chest, no III or IV sounds, no heart murmur, or lung rales; and abdomen, flat, soft, and without hepatosplenomegaly. No bilateral leg edema was observed.

Examination findings on admission were as follows:

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white blood cell count, 6,380/μL; red blood cell count, 413 × 10^6/μL; hemoglobin, 12.3 g/dL; hematocrit, 38.4%; platelet count, 19.7 × 10^9/μL; aspartate aminotransferase, 125 IU/L; alanine aminotransferase, 23 IU/L; lactate dehydrogenase, 402 IU/L; bilirubin, 0.5 mg/dL; total serum protein, 6.8 g/dL; albumin, 3.9 g/dL; blood urea nitrogen, 8.8 mg/dL; creatinine, 0.65 mg/dL; sodium, 141 mEq/L; potassium, 4.0 mEq/L; chloride, 107 mEq/L; low-density lipoprotein cholesterol, 80 mg/dL; high-density lipoprotein cholesterol, 73 g/dL; triglycerides, 63 mg/dL; creatinine phosphokinase, 939 U/L; creatinine kinase-MB, 64.0 IU/L; C-reactive protein, 0.04 mg/dL; troponin I, 16.37 ng/mL; prothrombin time, > 100%; prothrombin time-international normalized ratio, 1.00; activated partial thromboplastin time, 35.7 seconds; brain natriuretic peptide, 37.2 pg/mL; thyroid-stimulating hormone, 0.79 µIU/mL; free triiodothyronine, 2.47 pg/mL; and free thyroxine, 0.97 ng/dL. All of the examined autoantibodies (rheumatoid factor, < 3 IU/mL; antinuclear antibody, < 40×; cytoplasmic antineutrophil cytoplasmic antibodies (C-ANCA), 0.6 IU/mL; and myeloperoxidase-anti-neutrophil cytoplasmic antibody (MPO-ANCA), 0.5 IU/mL) were negative. Chest X-ray showed a cardiothoracic ratio of 44%, and there were no significant findings in the lung fields. Electrocardiography (ECG) showed a heart rate of 75 beats/minute, sinus rhythm, and ST-elevation in II, III, aVF, and V1-5. From these findings, the patient was diagnosed with ST-elevation myocardial infarction. As she had persistent chest pain, emergency cardiac catheterization was performed. Because she was a young woman without any risk factors, coronary spastic angina was suspected, and coronary angiography was performed without intracoronary nitrate administration. The results showed diffuse 75% stenosis in the proximal RCA (Figure 1A) and diffuse 90% stenosis in the LAD (Figure 2A). Subsequently, a coronary spasm provocation test was performed. Coronary injection of 20-μg acetylcholine into the LAD caused enhanced chest pain, and 99% stenosis diffusely from the proximal LAD was observed (Figure 2B). ECG revealed ST-elevation in the precordial leads. Intracoronary nitro-

Figure 1. Coronary angiogram in the left anterior oblique view demonstrates the following: A: Diffuse stenosis of the proximal part of the right coronary artery (RCA) at baseline (red arrow); B: Release of the stenosis of the RCA after nitrate injection.

Figure 2. Coronary angiogram in the left anterior oblique cranial view demonstrates the following: A: Diffuse narrowing and dissection of the midportion of the left anterior descending artery (LAD) at baseline (red arrow); B: Severe diffuse spasm of the LAD after the 20-μg acetylcholine injection (yellow circle); C: Residual diffuse narrowing and dissection in the midportion of the LAD after nitrate injection. The inset shows the intravascular ultrasonogram of the dissection in the midportion of the LAD (indicated by the yellow line).
gyecerin administration relieved the spasm, and the ST-elevation in II, III, and aVF leads returned to baseline values, but 90% stenosis and coronary dissection were observed in the midportion of the LAD (Figure 2C) with sustained ST-elevation in V1-5 leads. When the pre-induction coronary angiogram was reexamined, the dissection was already recognized in the midportion of the LAD, and clear dissociation progress was not recognized after the induction examination. Right coronary angiography after coronary nitroglycerin injection showed no significant stenosis (Figure 1B). In the coronary angiograph only, the form of the lesion including the dissected part was unknown, and so we carried out intravascular ultrasound (IVUS) in the LAD, which revealed the dissection in the midportion of the LAD. This was in line with imaging findings (Figure 2C). Based on a combination of clinical findings, coronary angiography results, and the presence of coronary spasm induced by provocation, we diagnosed the patient with coronary spastic angina.

We thought that stent implantation was possible on the basis of the lesion length and the diameter of the reference vessel evaluated by IVUS. The patient wanted to have a baby, so we avoided antithrombotic therapy and stent implantation.

Urticaria, probably due to contrast media, was observed after catheter examination. Following this, oral administration of diltiazem was started at a dose of 90 mg/day, and the patient did not have anginal attacks. The stress myocardial scintigraphy showed no myocardial ischemia. A search for the causes of coronary artery dissection in this patient revealed no physical findings suggestive of type IV Ehlers-Danlos syndrome or Marfan syndrome, and no hematological findings suggestive of collagen disease or vasculitis. Carotid echography and pulse-wave velocity analysis showed no evidence of atherosclerosis. Aortographic computed tomography (CT) and magnetic resonance imaging showed no evidence of fibromuscular dysplasia (FMD) or dissecting lesions in the great vessels.

The patient was discharged from the hospital on day 7, and stress myocardial scintigraphy was performed at 2, 5, and 10 years after discharge. This revealed no ischemia, and she has now been free of cardiac events for approximately 10 years.

Written informed consent was obtained from the patient regarding the publication of clinical information, and data are presented in a way that ensures individual anonymity.

Discussion

First reported by Pretty, et al. in 1931, SCAD is defined as the separation of coronary arteries by hemorrhage, with or without a tear in the coronary artery intima. The condition is often identified in autopsy cases of young women, but recent improvements in diagnostic imaging technology has meant that the number of ante-mortem diagnoses has increased and the clinical features of SCAD have been gradually clarified. Recently, it has been suggested that use of the term SCAD should be limited to non-atherosclerotic SCAD. The incidence rate varies according to the reporting period, subjects, and diagnostic methods. In a recent report, the incidence of SCAD in patients with acute coronary syndrome was 1.7%-4%. Two hypotheses have been proposed regarding the mechanism of SCAD. One is the intimal tear theory, which suggests that, firstly, an intimal entry tear forms, then an intramural hematoma emerges, and a false lumen forms. Second is the medial hemorrhage hypothesis, which suggests that the density of the vasa vasorum increases and it spontaneously ruptures to form a hematoma, which enlarges and ruptures into the true lumen. In either case, SCAD results from stress on a coronary wall with a predisposition to fragility. Predisposing factors include FMD, pregnancy-related conditions, recurrent pregnancy, connective tissue disease (Marfan syndrome, Ehlers-Danlos syndrome, etc.), systemic inflammatory disease (systemic lupus erythematosus, antiphospholipid syndrome, Crohn disease, etc.), hormone therapy, coronary spasm, and idiopathic factors. Triggering stresses include excessive exercise, intense mental stress, labor, Valsalva-type activity, drugs, and hormonal intensification.

In the present case, tests for rheumatoid factor, antinuclear antibody, C-ANCA, and MPO-ANCA were all negative, as was the involvement of collagen disease. Normal thyroid hormone levels and no substance abuse (including cocaine) or use of oral contraceptives were reported. Imaging studies showed no evidence of FMD. Coronary dissection was observed within the range of coronary spasm, and it is highly possible that the coronary dissection was caused by coronary spasm. Excessive mental stress at work was considered to have induced coronary spasm in this case.

In this case, the incidental complication of coronary spasm and dissection cannot be completely ruled out. Coronary artery dissection may result in endothelial damage, resulting in severe spasm and positive provocation test. However, in this case, the diffuse severe coronary spasm of the LAD induced by provocation test was observed in a wide range of coronary arteries including the dissecting part, and the dissection was shown in the limited site where the spasm was the most severe. This is considered to be a finding that suggests that severe spasm may have caused dissection.

The association of SCAD and coronary spasm has been reported for a long time. Bertrand, et al. also reported an association between coronary dissection and coronary spasm, but we found no report presenting imaging confirmation of dissection consistent with coronary spasm in our search. In this report, we have shown on the image that the dissection occurs in the part causing coronary spasm.

In the present case, the dissection was recognized before the coronary spasm provocation test, but this test may cause coronary dissection. Therefore, indications for procedures must be considered carefully.

The most common site of SCAD has been reported to be the LAD, accounting for about 60%-80% of total cases. In addition, 20% of all SCAD cases have been reported to have multivessel dissection. In the present case,
coronary spasm was also observed in the RCA. The development of new dissection of other branches is often observed within 2 months of onset.\textsuperscript{21,22} Therefore, careful management is required.

Although there are no guidelines for the treatment of SCAD, revascularization procedures such as percutaneous coronary intervention and coronary artery bypass grafting have been performed in the acute phase of treatment in patients with ongoing ischemia or hemodynamic deterioration and in patients with lesions in the left main trunk. In a case report, SCAD with coronary spasm was initially treated with medical therapy, but it was difficult to control the attacks, and the dissection progressed from the LAD to the left main trunk, so a long stent was implanted.\textsuperscript{23} Thereafter, the LAD was patent during 6 months of coronary angiography. The long-term prognosis of stent implantation in SCAD with coronary spasm is unknown.

In the present case, dissection of the LAD remained at the time of coronary angiography, but the spasm was relieved by the administration of nitrate, and peripheral blood flow improved. Therefore, a conservative treatment approach with a calcium antagonist was followed. Maryland \textit{et al.} reported that there were no significant differences in 5-year mortality, target vessel revascularization, or recurrence of SCAD between patients who received conservative treatment and those who underwent early reperfusion.\textsuperscript{24} Careful selection of treatment strategy is necessary, with consideration of the condition of the lesion including vital signs, symptoms, and spasms.

It has been reported that once the acute phase is overcome, the recurrence rate of SCAD is low and the prognosis is good in the chronic phase.\textsuperscript{25} However, the recurrence rate of SCAD has been reported to be as high as 22\% within 3 years, and the prognosis is not always good.\textsuperscript{26} Therefore, it is necessary to treat the cause and observe the progress carefully in order to prevent recurrence. In the present case, drug therapy was continued for coronary spasm, and no cardiac event was observed. Coronary CT was not performed because contrast agent allergy was observed. However, ischemia was not observed by stress myocardial scintigraphy, and no cardiac events have occurred in approximately 10 years.

\textbf{Conclusions}

We report the case of a young woman with acute myocardial infarction in whom coronary spasm was thought to be involved in the development of coronary artery dissection. The administration of calcium channel blockers for spasm has enabled the patient to be free of cardiac events for about 10 years; this case highlights the importance of considering the cause of the dissection.

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\textbf{Disclosure}

\textit{Conflicts of interest:} The authors declare no conflict of interest.

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