I. Introduction

Percutaneous coronary intervention (PCI) is widely used in Japan to treat ischemic heart disease, but serious complications associated with the procedure are also increasingly reported. Techniques to ensure the safe performance of PCI and to deal with complications are therefore required. Herein, we report the case of a patient who went into shock because of coronary artery dissection during PCI that caused occlusion of the left main coronary trunk (LMT), in which ischemia was alleviated by supplying arterial blood from the right radial artery to the left anterior descending (LAD) branch.

II. Case report

A 65-year-old man had been undergoing treatment at a local clinic for hypertension for the past two years. Owing to a complaint of becoming easily fatigued, the patient was transferred to our hospital for further investigation on February 10, 2016. The patient had a height of 165 cm, weight of 65 kg, blood pressure of 145/58 mmHg, and pulse rate of 56 bpm. The patient was not a smoker and underwent yearly health checkups, and no other comorbidities were present. Echocardiography showed normal cardiac function, and all blood biochemistry tests yielded normal results. Coronary angiography performed to check for ischemic heart disease revealed 90% stenosis with severe calcification at the bifurcation of the first diagonal branch (D1) in LAD (Fig. 1). Therefore, PCI was performed on February 25, 2016. A sheath introducer was first used to puncture the right radial artery, after which a guiding catheter (GC) was introduced. Two floppy guidewires (GWs) were then inserted into the LAD and D1. Both GWs passed through the lesion with ease, but an intravascular ultrasound (IVUS) device was unable to pass through the stenotic lesion. Furthermore, coronary dilatation balloon catheters measuring 2.0×12 mm and 2.25×12 mm successfully passed through, but they could not be dilated (Fig. 2). Therefore, an attempt was made to use the buddy wire technique by advancing the GW inserted into D1 into the LAD and then using both the

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GWs for balloon dilation. Although the IVUS device could be passed through with some difficulty, adequate dilation was not achieved. Severe circumferential calcification of the vessel existed, with an estimated 3.5 mm diameter at the lesion (Fig. 3). A larger balloon catheter, measuring 2.5x6 mm, was then dilated at a pressure <20 atm, at which point the blood pressure at the tip of the guiding catheter suddenly could not be measured. The balloon catheter was withdrawn, and coronary angiography was performed, revealing that the LMT was occluded by the guiding catheter tip and was not contrasted as far as the LAD. The left circumflex (LCX) artery and D1 were visualized late (Fig. 4). Dilation was attempted again using two smaller balloon catheters, measuring 2.5x6 mm and 2.0x12 mm, but neither could be advanced, and the patient suddenly went into shock. Systolic blood pressure dropped to 70 mmHg, the electrocardiogram (ECG) showed ST elevation, and the patient became disturbed (Fig. 5). Dissection, a common complication of PCI, was suspected. However, no obvious dissection was visible on the coronary angiography. A balloon catheter was inserted again, but the tip did not advance beyond the LMT. A FINECROSS (Terumo, Japan) microcatheter was inserted via the right radial artery, which was advanced into the LAD. Contrast enhancement of the LAD via the microcatheter showed, fortunately, no occurrence of dissection on the distal side (Fig. 6). To avoid shock induced by LMT occlusion, a 20 ml syringe was used to repeatedly inject arterial blood collected from the sheath introducer in the right radial artery into the LAD via the microcatheter. Each adminis-

Fig. 1 (a) Severe calcification is visible on the non-contrast imaging. (b) Contrast imaging of the same site reveals stenosis of the LAD. Calcification is easily visible even on the non-contrast imaging and extends as far as the LMT.

Fig. 2 The lesion in the LAD was dilated with a 2.25-mm balloon, but the dilation was not sufficient for the indentation to disappear.

Fig. 3 IVUS images of the LMT (A), LAD just proximal to the lesion (B), and lesion in segment 6 (C). Severe circumferential calcification extends from the LMT to the LAD.
The injection of arterial blood required a mean time of 80 seconds. When approximately 40–50 ml had been injected in 2–3 administrations, the elevated ST segment began to normalize, and by the time 2–3 further administrations had been performed, resulting in continuous injection of over 100 ml of arterial blood, the ST segment had returned to baseline. The systolic blood pressure also stabilized at around 90 mmHg, and premature ventricular contractions (PVC) and ventricular tachycardia (VT) resolved as well (Fig. 5). At this point, we considered continuing with PCI, but the balloon catheter would probably not pass through the lesion and that, even if it did, the lesion was so severely calcified that adequate dilation would be impossible. Thus, we converted to coronary artery bypass grafting (CABG). As our hospital is not equipped to perform CABG, the patient was transported to an affiliated hospital. During transportation, a two-way stopcock attached to the sheath was connected to the microcatheter, and arterial blood infusion was continued by manual pumping with a 20 ml syringe. CABG was performed at the affiliated hospital approximately 2 hours later. The chest was opened, and arterial blood infusion was continued via a pump oxygenator until the patient was on a cardiopulmonary pump. The surgery was successful. Percutaneous cardiopulmonary support (PCPS) remained in use temporarily because of the risk for postoperative heart failure, but was discontinued on Day 4. The patient's subsequent course until discharge was uneventful. Cardiac rehabilitation was implemented after discharge. Echocardiography showed hypokinesis of the anterior wall, and the ejection fraction was 45%, indicating a poor cardiac function. However, the patient continued to visit our hospital as an outpatient, with no chest symptoms, no need for readmission, no neurological deficit, and no heart failure exacerbation.

III. Discussion

A variety of complications may occur during PCI, and technical problems during catheter insertion alone include vascular injury, coronary vasospasm, thrombosis, and coronary artery dissection, which may cause coronary occlusion, shock, and even
death. For severe calcification and LMT lesions, CABG via open chest surgery is frequently indicated rather than PCI.

In the present case, although calcification was comparatively severe in the LAD, the stenotic lesion was less than 10-mm long; thus, PCI was performed. However, the patient went into shock when a balloon catheter was dilated during several attempts to insert catheters of varying sizes. CABG is the gold standard for LMT and multiple branch lesions, and numerous clinical research studies comparing PCI and CABG have concluded that CABG is superior to PCI. 1. Approximately 1,240 hospitals in Japan perform PCI, but CABG can be performed in only half of these hospitals 2. Therefore, it is important that cardiologists should not be wedded to PCI and should be aware of the complication risks and limitations of this procedure. Moreover, they should be open to other surgical options and be prepared to make immediate decisions in the case of complications.

As a strategy for calcified lesions, after abandoning PCI in this case, we learned that the use of a Rotational Atherectomy System (Rotablator, Boston Scientific, USA) may be indicated for severely calcified circumferential lesions around the bifurcation with the LAD, and that the use of a scoring device was helpful. On the basis of our hospital’s criteria, we carried out dilation with two GWs, without using a Rotablator, but dissection meant that the opportunity to use it was lost. According to a study by Boyle et al., coronary artery dissection caused by a guide catheter is relatively uncommon, with an incidence of 0.008%–0.02% on catheterization and 0.06%–0.07% on PCI 3; however, when it does occur, it may become serious 4, 5. Potential factors of LMT dissection include the presence of an LMT lesion 6; strong catheter backup and angle of advancement, deep engagement, or rough catheter manipulation 7; and excessive contrast medium injection pressure 8. In the present case, however, dissection during PCI was unlikely to have been caused by the guiding catheter as there was no stenotic lesion in the LMT, deep engagement was not performed, it coincided with balloon dilation, and there was no dissection at the distal side of LAD on contrast angiography with the microcatheter (Fig. 5). Although thrombotic occlusion was possible, it was not considered here because the balloon catheter could not pass through after guidewire reinsertion. We cannot deny the possibility that intramural hematoma caused vascular occlusion. Using IVUS, intramural hematoma was confirmed after 6.7% of PCIs, and the mechanism is reported to be dissection into the media where blood accumulated because of a lack of re-entry 9. However, we were unable to con-

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Fig. 7 Changes over time in 12-lead ECG: before PCI, immediately after PCI, and immediately before CABG.

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firm this in our case, as IVUS did not pass the obstruction.

The patient was able to recover from shock and had stable hemodynamics during the 2 hour interventions owing to the tip circulation by autologous arterial blood injection via the microcatheter. Physiologically, resting coronary artery blood flow is normally 40–80 ml/min, which is approximately 4% of the cardiac output. In this case, arterial blood was suctioned from the sheath using a 20 ml syringe and pumped manually with one hand to supply blood at an estimated rate of 15 ml/min. Although the amount was insufficient, over 100 ml of blood was injected within a period of less than 10 minutes, until the ST elevation on the ECG returned to baseline. Patients with chronic complete coronary artery occlusion who do not develop myocardial infarction because of small amounts of perfusion via collateral circulation are commonly encountered. Although it is uncertain whether this mechanism is related to the present case, it is likely that the continuous administration of arterial blood for over 2 hours was effective in preventing myocardial ischemia. We show the changes over time before PCI, immediately after PCI, and immediately before CABG of each 12 lead ECG (Fig. 7).

IV. Conclusion

We treated a patient who went into shock after LMT dissection during cardiac catheterization. Tip circulation by injecting arterial blood via a microcatheter to prevent myocardial ischemia during the time required for conversion to CABG might be an effective method for ischemia prevention after an unsuccessful coronary artery reperfusion.

Conflict of interest

Authors have no conflict of interest

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