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Case Reports

Usefulness of a Perfusion Balloon for Intraprocedural Stent Thrombosis in a Patient With ST-Segment Elevated Myocardial Infarction Complicated With Cardiogenic Shock

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Intraprocedural stent thrombosis is a rare but serious complication of reperfusion therapy for acute coronary syndrome. There is currently no consensus on the intraprocedural management of intraprocedural stent thrombosis. It is difficult to attain thrombolysis in myocardial infarction flow grade 3, particularly in cases of cardiogenic shock.

A 49-year-old man who presented with anterior ST-segment elevated acute myocardial infarction with cardiogenic shock underwent emergency percutaneous coronary intervention to diffuse proximal lesions in the left anterior descending artery under the support of intra-aortic balloon pumping. Intraprocedural stent thrombosis occurred following the postdilations with a 3.5- × 38-mm everolimus-eluting stent. Despite administration of argatroban and nitroprusside, and after frequent balloon inflations using 3.5-mm noncompliant balloons and thrombectomy, the no-reflow phenomenon was repetitively established. However, after brief and prolonged balloon inflations using 3.5- and 3-mm Ryusei perfusion balloon catheters (Kaneka Medix), the diffusely protruded thrombus inside the stent regressed, and thrombolysis in myocardial infarction flow grade 3 was obtained. The final intravascular ultrasound image showed a well-suppressed, in-stent thrombus and 24% gain of stent area (from 7.5 to 9.3 mm^2).

A Ryusei perfusion balloon enabled frequent, long inflation times without deteriorating hemodynamics during reperfusion in ST-segment elevated acute myocardial infarction complicated with cardiogenic shock. Thus, extended balloon inflation using a perfusion balloon is deemed a viable option not only for intraprocedural stent thrombosis but also for cases with a high burden of thrombi during the primary stenting procedure for patients with acute coronary syndrome. ***(Tex Heart Inst J. 2022;49(6):e217555)***

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Intraprocedural stent thrombosis (IPST) is a relatively rare but serious complication of stenting.[1,2] There is currently no consensus on the management of IPST, and the restoration of good epicardial flow is considered difficult in cases of IPST.[2]

Although it was once discontinued, use of the Ryusei perfusion balloon catheter was revived because of its clinical utility for 3 indicative lesions, namely, coronary perforated lesion, flow-limiting coronary dissected lesion, and thrombus-containing lesion. This case showed the usefulness of a Ryusei perfusion balloon (Kaneka Medix) in a case of IPST for obtaining thrombolysis in myocardial infarction (TIMI) flow grade 3 by compressing a thrombus protruding inside a long stent in a patient with ST-segment elevation myocardial infarction (STEMI) complicated with cardiogenic shock.

Case Report

A 49-year-old man without any medical history presented with prodromal angina within a few days and suddenly collapsed with severe chest pain at work in extremely

hot weather. He was brought to the hospital with ventricular fibrillation. After defibrillation, electrocardiogram showed ST-segment elevation in lead aVR and precordial leads V_1 through V_4 with complete right bundle branch block (Fig. 1). An echocardiogram showed diffuse severe hypokinesis of left ventricular function without patent foramen ovale and mural thrombus. Emergency percutaneous coronary intervention for anterior STEMI complicated by cardiogenic shock was performed under endotracheal intubation and insertion of an intra-aortic balloon pumping support. Laboratory findings in the emergency department were as follows: white blood cell count, 17.6×10^3/L; hematocrit, 45.7%; creatine kinase myocardial band level, 39.5 U/L; troponin T level, 0.053 ng/mL; and brain natriuretic peptide, 200.1 pg/mL. The blood gas showed severe metabolic acidosis. Low-molecular-weight heparin (8,000 U) was intravenously administered before percutaneous coronary intervention.

The first angiogram revealed a TIMI flow grade 0 at the proximal left anterior descending artery (LAD) with fair collateral flow. Following predilation with 2- and 3-mm semicompliant balloons, an everolimus-eluting stent (3.5 × 38 mm) was placed at the proximal LAD. After postdilations with a 3.5-mm noncompliant balloon, a thrombotic filling defect rapidly progressed into the entire stent (Fig. 2). An activated clotting time of 252 to 332 seconds was maintained. Intracoronary argatroban (10 mg) was administered 3 times and nitroprusside was administered 6 times from the guiding catheter. With frequent aspiration using a 7F aspiration catheter with a Thrombuster (Kaneka Corp), a 3.5-mm noncompliant balloon was inflated several times. However, many thrombi remained, protruding inside the stent (Fig. 3), and were implicated in the repetitive no-reflow phenomenon. It was difficult to inflate a noncompliant balloon for a long time because of the ventricular fibrillation.

Inflations were then conducted approximately 10 minutes apart using a Ryusei perfusion balloon (Kaneka Medix Corp; 3.5 × 20 mm) with nominal pressure, which relatively maintained perfusion of the LAD (Fig. 4). We also used a 3- × 20-mm Ryusei balloon at the mid-LAD. After several long, high-pressure inflations of the Ryusei, TIMI flow grade 3 was obtained (Fig. 5). The final intravascular ultrasound image showed a well-suppressed, in-stent thrombus and a 24% gain of stent area (from 7.5 to 9.3 mm^2) by the Ryusei inflations (Fig. 6). After reperfusion, ST-segment elevation was largely resolved.

The maximum value of serum creatine kinase myocardial band was 1,253 U/L. The left ventricular ejection fraction was 42% on echocardiography. The serum antiplatelet factor 4–heparin antibody level (0.6 U/mL)

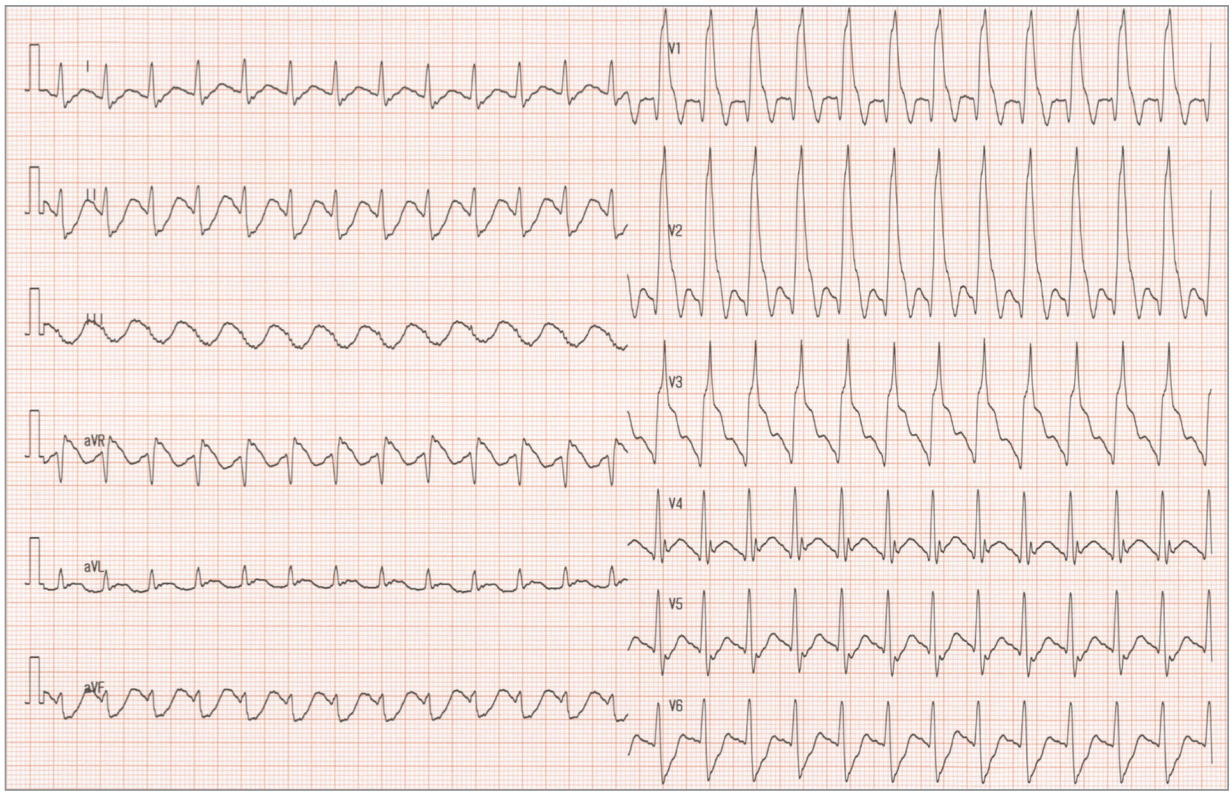

Fig. 1 *Electrocardiogram after defibrillation. After defibrillation, electrocardiogram showed ST-segment elevation in leads aVR and aVL and in precordial leads V_1 through V_4, with complete right bundle branch block. Vertical axis: 1 cm/mV; horizontal axis: 25 mm/s.*

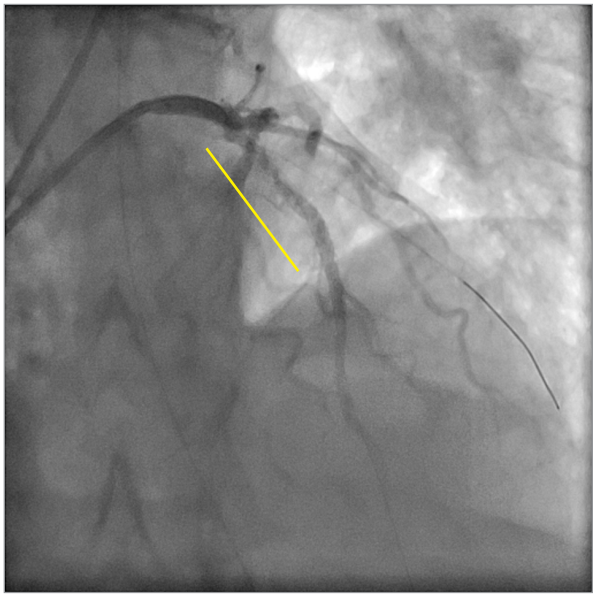

Fig. 2 *Coronary angiography of intraprocedural stent thrombosis. Straight cranial view after postdilations with a 3.5-mm non-compliant balloon inside the stent showing intraprocedural stent thrombosis. Intraprocedural stent thrombosis (diffuse thrombotic filling defect) can be seen inside the stent (indicated by the yellow line in parallel) with a slow-flow phenomenon in the left anterior descending artery.*

Supplemental motion image is available for Figure 2.

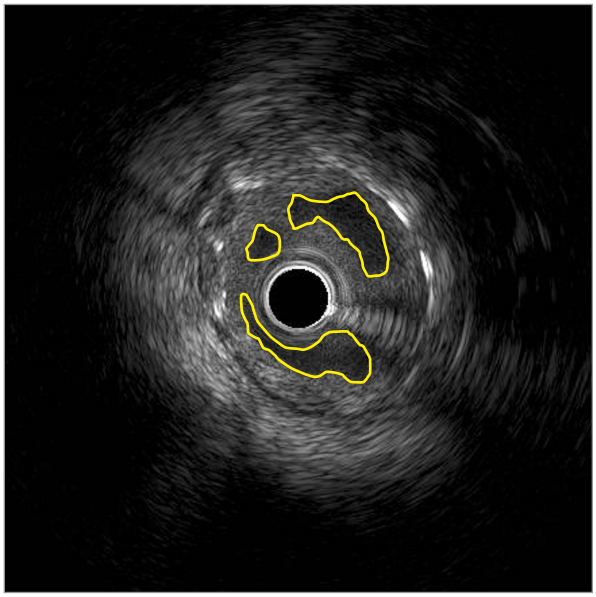

Fig. 3 *Cross-sectional intravascular ultrasound image of intraprocedural stent thrombosis after repetitive dilations using a 3.5-mm noncompliant balloon approximately 7.4 mm from the proximal edge of the stent. The cross-sectional stent area was 7.5 mm^2. Atherothrombotic plaques are protruding and floating inside the stent (the borders of the floating thrombus and lumen are delineated by yellow lines).*

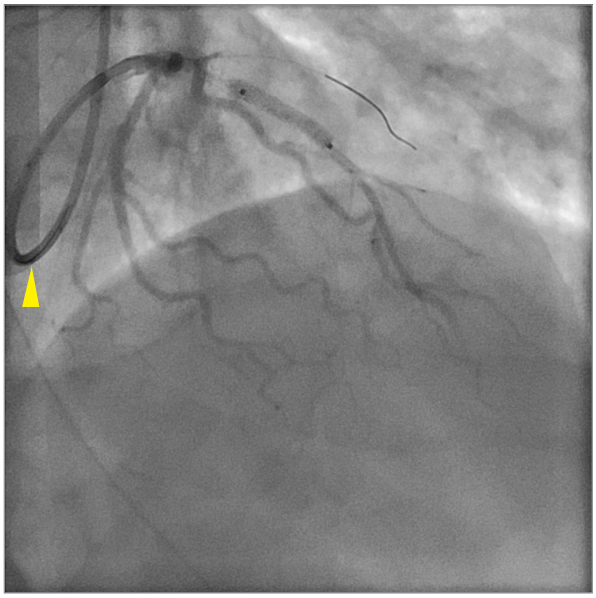

Fig. 4 *Coronary angiography during inflation of Ryusei perfusion balloon. Long dilation time of a perfusion balloon with nominal pressure due to pressing atherothrombotic plaques inside the stent and preserving the perfusion of the left anterior descending artery. The tip of the left anterior descending artery guide wire (indicated by the yellow triangle) was pulled back into the shaft of the perfusion balloon to increase the coronary flow through the guide wire lumen (details are shown in Fig. 7).*

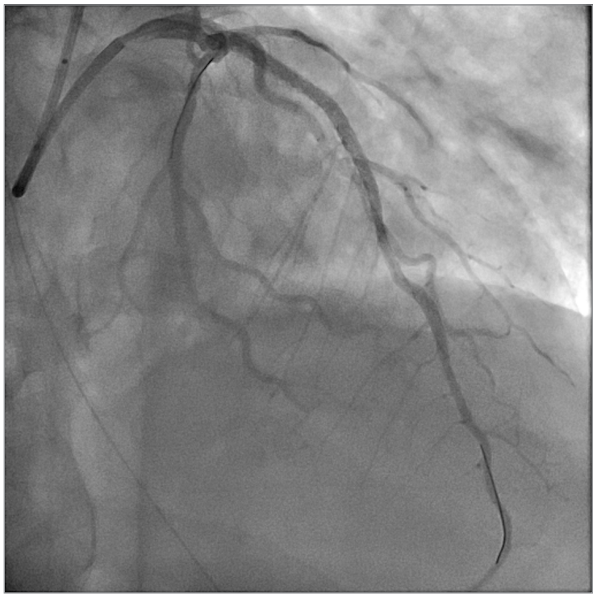

Fig. 5 *Final coronary angiography. Final right straight cranial view showing thrombolysis in myocardial infarction flow grade 3 of left anterior descending artery without filling defect inside the stent.*

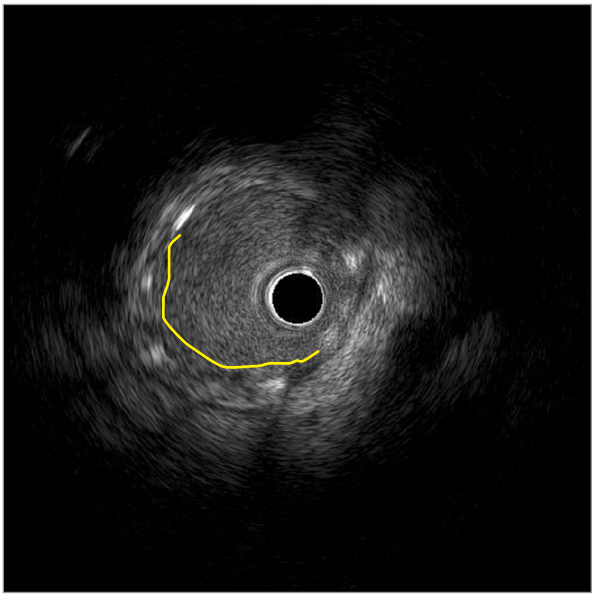

Fig. 6 *Final intravascular ultrasound image inside the stent at the point corresponding to Fig. 3 (7.4 mm from the proximal edge) after repetitive high-pressure inflations of a 3.5-mm Ryusei perfusion balloon. The final cross-sectional stent area was 9.3 mm², showing the optimal apposition and compressed thrombus inside the stent (delineated by a yellow line at 5 to 10 o'clock).*

examined on day 3 was within the normal range (<1.0 U/mL). A follow-up coronary angiogram showed TIMI flow grade 3 without visual thrombosis inside the stent on day 4. Therefore, intra-aortic balloon pumping was removed. Dobutamine was gradually tapered and stopped on day 5. Although the patient's hemodynamics stabilized, he died because of persistent respiratory distress with bacterial pneumonia on day 25. There was no clinical evidence of SARS-CoV-2.

Discussion

This is a case showing the usefulness of a Ryusei perfusion balloon for IPST in a patient with anterior STEMI complicated by cardiogenic shock. Even in the era of advanced reperfusion therapy for STEMI, IPST occurs in 0.7% to 0.8% of patients with acute coronary syndrome,[1,2] which is similar to the incidence of early definite stent thrombosis.[2,3] A pooled analysis of the Harmonizing Outcomes With Revascularization and Stents in Acute Myocardial Infarction and Trials Acute Catheterization and Urgent Intervention Triage Strategy trial[2] showed that IPST, representing 9.5% of overall intraprocedural thrombotic events, had the strongest association with adverse events. Intraprocedural stent thrombosis has been distinguished from definite stent thrombosis, and the details of the pathophysiology and treatments of IPST have not been fully understood compared with those of definite stent thrombosis.[2,3] According to the team's knowledge, this is the first report showing the usefulness of a perfusion balloon in the case of IPST to obtain TIMI flow grade 3. Therefore, the present case would contribute to the first-line treatment for not only IPST but also cases with a high burden of thrombi and intraprocedural thrombotic events during the primary stenting procedure.

Restraint and regression of thrombus formation, including protrusion into the placed stent, by combining pharmacological and mechanical interventions are essential supportive therapies during the primary stenting procedure. As a restraint therapy, antithrombotic regimens using antiplatelet, anticoagulant, and fibrinolytic agents, as well as glycoprotein IIb/IIIa inhibitors, antithrombin, heparin, argatroban, and tissue plasminogen activator, are commonly used. In the present case, aspirin (200 mg) and prasugrel (20 mg) were loaded as the Japanese standard dose of antiplatelet therapy before stenting. In addition, as the anticoagulant therapy, intracoronary argatroban was administered to keep the clotting time at more than 250 seconds. As a mechanical regression therapy, frequent thromboaspiration using a 7F aspiration catheter and 3.5-mm noncompliant balloon dilation under intra-aortic balloon pumping support were performed using conventional techniques. However, we were unable to inflate normal balloons for a long time during reperfusion therapy for STEMI because it worsened the hemodynamics. Because IPST is significantly associated with the occurrence of early definite stent thrombosis,[1] we did not place a secondary stent. The residual in-stent atherothrombotic burden is associated with adverse outcomes.[4] Therefore, it is essential to lessen these burdens in addition to the conventional methods.

A Ryusei perfusion balloon (Fig. 7) can resolve these difficulties in the case of IPST. This particular type of perfusion balloon, because the coil reinforcement layer is integrated into the inner shaft inside the balloon, enables thrombus regression by steadily pressing it against the vessel wall (Fig. 6). In addition, because the Ryusei balloon has a guide wire lumen and inflation lumen with 16 proximal and 8 distal perfusion holes (Fig. 7), it allows perfusion during balloon inflation (Fig. 4). The recommended inflation time is 15 minutes per inflation. Preserved epicardial coronary flow toward the culprit distal by longer balloon inflation times during the reperfusion procedure exerted the following advantages: (1) the reduction of microvascular obstruction, (2) the reduction of thrombogenic reactions, (3) the preservation of general hemodynamics, (4) the steady pressing of the thrombus against the stent strut, (5) an increase in distal flow by gaining a larger stent area, and (6) an improvement in myocardial salvage that is linked to improvement in the final TIMI grade flow.[5] Thus, the establishment of TIMI flow grade 3 was achieved for the management of IPST, owing to these advantages.

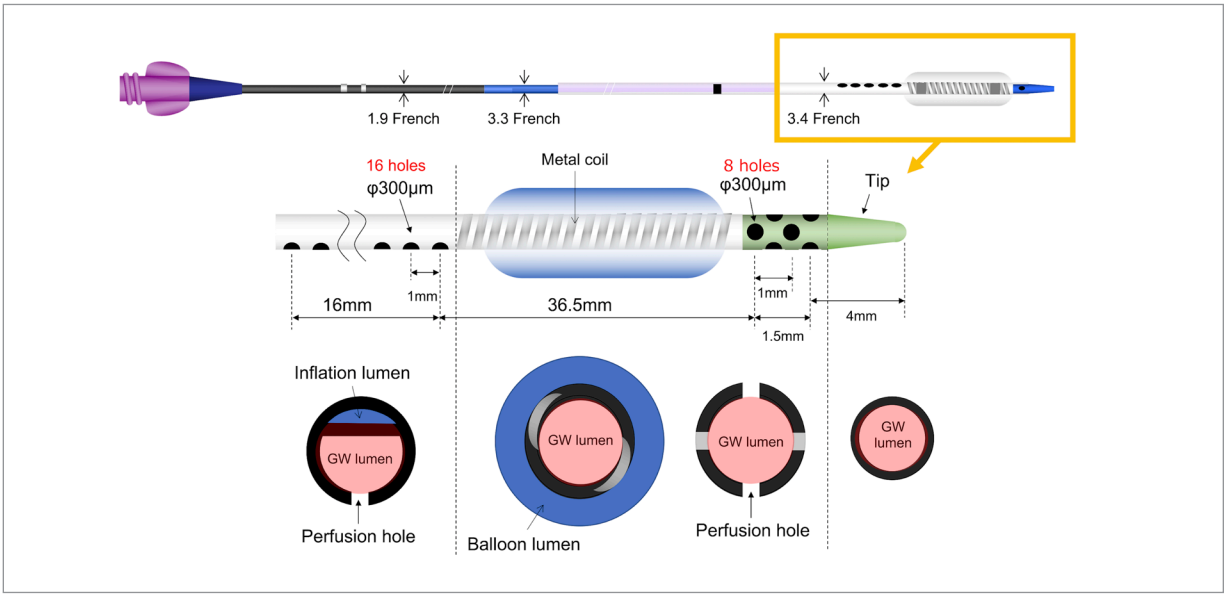

Fig. 7 *A scheme of the Ryusei perfusion balloon. The Ryusei balloon has a GW lumen and an inflation lumen with 16 proximal and 8 distal perfusion holes. A coil reinforcement layer is integrated in the inner shaft inside the balloon. The outer diameter of the perfusion balloon catheter was 3.4F (approximately 1.13 mm). (Courtesy of Kaneka Medix Corporation.)*

GW, guide wire

In conclusion, longer perfusion balloon inflation times using a Ryusei perfusion balloon are deemed to be effective not only for IPST but also for cases with a high burden of thrombi and other intraprocedural thrombotic events during the primary stenting procedure.

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