Successful Complete Revascularization With PCI Using Super-Low Volume of Contrast Medium in a Patient With Three-Vessel Disease Including 2 Chronic Total Occlusions With Severe Renal Dysfunction

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Summary

The most important factor for preventing contrast-induced nephropathy (CIN) during percutaneous coronary intervention (PCI) in patients with severe renal dysfunction is to minimize the contrast volume. Herein, we report a successful case of complete revascularization after 3 separate PCI procedures using a super-low volume of contrast medium in a patient with 3-vessel disease, including two chronic total occlusions (CTOs). A 70-year-old man having exertional angina despite maximal medical therapy was referred to our hospital. He had severe renal dysfunction (estimated glomerular filtration rate 19 mL/minute/1.73 m²). Coronary angiography, in which a total volume of 15 mL (over 3 injections) of contrast medium was used after hydration with normal saline, demonstrated 2 CTOs in the proximal left circumflex artery (LCX) and the proximal right coronary artery (RCA) as well as focal stenosis in the mid left descending artery (LAD). Because the patient refused coronary artery bypass grafting, we opted for revascularization with PCI, divided into 3 procedures. We made full use of microcatheter tip injection and evaluation with intravascular ultrasound and achieved complete revascularization with a total of 31 mL of contrast medium: 9 mL for RCA, 6 mL for LAD, and 16 mL for LCX, without the occurrence of CIN. Additionally, we present tips for performing PCI using super-low contrast medium. (Int Heart J 2017; 58: 624-628)

Key words: Low-dose contrast medium, Contrast-induced nephropathy

Contrast-induced nephropathy (CIN) is a serious complication caused by administration of iodinated contrast during percutaneous coronary intervention (PCI), and is associated with increased morbidity and mortality.1,2 CIN was defined as an increase in serum creatinine of either 0.5 mg/dL or 25% from baseline within 72 hours of exposure.1 Risk factors associated with increased occurrence of CIN are reported to be chronic kidney disease, hemodynamic instability, use of intra-aortic balloon pumping, heart failure, advanced age, anemia, and volume of contrast medium.3 However, except for contrast volume, it is difficult to modify these risk factors immediately before PCI. The efficacy of preventive strategies for CIN, including N-acetylcysteine, atrial natriuretic peptide infusion, ascorbic acid, statins, and prophylactic hemodialysis, has not been sufficiently established.4,5 Therefore, the established prophylactic approach is to administer adequate hydration and to minimize the volume of contrast medium for prevention of CIN in patients with severe renal dysfunction. However, the safe dose of contrast in patients with severe renal dysfunction remains unclear. Even when contrast volume (CV) used during PCI was less than twice the calculated creatinine clearance (CCC), which is a CV/CCC ratio < 2, CIN occurred in more than 6% of patients with a glomerular filtration rate (GFR) < 30 mL/minute.6 Furthermore, Nyman, et al also reported an association between the contrast dose (grams iodine/GFR) ratio and the risk of CIN after PCI.7 They recommended that the contrast dose should be restricted to less than the eGFR value.8 Thus, reducing the amount of contrast medium in patients with severe renal dysfunction is extremely important.

Although a few PCI cases using a very small amount of contrast medium have been reported,9 the target lesions of all those cases were not complex lesions, such as chronic total occlusion (CTO), but simple and focal stenotic lesions. Herein, we present a successful case of complete revascularization with 3 separate PCI procedures using super-low volume of contrast medium in a patient with 3-vessel disease (3VD) who had 2 CTOs and severe renal dysfunction.
CASE REPORT

A 70-year-old man with Canadian Cardiovascular Society grade III exertional angina of 3 months' duration despite maximal medical therapy was referred to our hospital for detailed examination of his heart condition. He had significant coronary risk factors, including diabetes, hypertension, hyperlipidemia, and severe renal dysfunction (estimated GFR [eGFR] 19 mL/minute/1.73 m²). Treadmill stress testing revealed positive coronary ischemia. Transthoracic echocardiography demonstrated no obvious asynergy in the left ventricle and a left ventricular ejection fraction of 69%. Coronary angiography, using a total volume of 15 mL (over 3 injections: 1 injection for the right coronary artery [RCA] and 2 injections for the left coronary artery [LCA]) of contrast medium after 1 night hydration with normal saline, demonstrated a focal lesion in the mid left descending artery (LAD), and two CTOs in the proximal left circumflex artery (LCX) and the proximal RCA (Figure 1). The

Figure 1. Coronary angiography. Coronary angiography, using a total volume of 15 mL (over 3 injections) of contrast medium, demonstrated a focal lesion in the mid LAD and two CTOs in the proximal LCX and proximal RCA.

Figure 2. PCI for RCA CTO. The selective angiography from Corsair™ (A), Gaia second™ wire advanced to the subintimal space (B). The parallel wire technique enabled successful passing of the CTO lesion (C). A 1.0 mm balloon was able to cross the lesion using a side branch anchor technique, and dilated (D). Angiography of distal RCA by tip injection (E). Promus Premier™ 2.5 × 38 mm and 2.75 × 16 mm stents were deployed (F,G). Final coronary angiography (H).
right ventricular branch and first septal branch provided collaterals to the distal RCA, and the high lateral branch provided collaterals to the distal LCX. We considered the fact that this coronary 3-vessel disease was suitable for coronary artery bypass grafting (CABG), and the off-pump CABG would enable us to preserve his renal function. However, the patient refused to undergo the surgical operation; therefore, we decided to perform PCI and attempted complete revascularization over 3 procedures using a very low volume of contrast medium.

First, we performed PCI to the CTO of the RCA (Figure 2). The RCA was engaged with a 6 Fr Amplatz Left 1.0 guiding catheter (Asahi Intecc) using a transradial approach. The Corsair™ microcatheter (MC) (Asahi Intecc) was advanced to the proximal site of the CTO, and a biplane angiogram was performed to show the proximal stump by injecting 1 mL of contrast from the tip of the MC. The XT-R™ (Asahi Intecc) and Gaia First™ (Asahi Intecc) guidewire-supported Corsair™ did not proceed into the CTO lesion. Selective contrast injection from the other MC placed in the proximal site of CTO showed that the Gaia Second™ (Asahi Intecc) wire advanced into the subintimal space. Therefore, we performed a parallel wire technique using a Gaia Second™ with Finecross GT™ (Terumo Corporation) and a Gaia Third™ (Asahi Intecc) with MIZUKI™ (Kaneka Medix); finally, the Gaia Second™ wire successfully crossed the CTO. The rotation angiogram injected from the tip of the MC showed the Gaia Second™ crossing the CTO. However, neither the Finecross GT™ (Terumo Corpora-

tion) nor the Corsair™ could pass the CTO. A 1.0 mm LAX-A™ (Goodman Corporation) balloon was advanced across the lesion using the side-branch anchor technique, and dilated. The lesion was then diluted with a 2.0 mm balloon. Intravascular ultrasound (IVUS) (Opticross™, Terumo Corporation) was used to evaluate the lesion length and characteristics. A Promus Premier 2.5 × 38 mm stent (Boston Scientific Corporation) was delivered via a supporting 6 Fr Guideliner™ (Lifeline Corporation) and deployed at the mid portion of the RCA. A Promus Premier™ 2.75 × 16 mm stent was positioned by tip injection from a MIZUKI™ MC, taking care not to protrude from the coronary artery to the aorta, and was deployed, followed by high-pressure dilation with a 3.0 mm balloon. After IVUS evaluation, coronary angiography was conducted to review the final result from the guiding catheter. The total amount of contrast agent used in this PCI was 9 mL (4 injections from the MC and 1 injection from the guide catheter).

After 1 week, we performed PCI to the stenotic lesion of the mid LAD (Figure 3). A 6 Fr EBU3.5 guide catheter was advanced to the LCA through the left radial artery. SION blue™ and SION™ guidewires advanced not only to the LAD but also to the first septal branch to use as a landmark during stent positioning. IVUS evaluated the lesion length and also calculated the distance from the first septal branch to the proximal reference. The lesion was dilated with a 2.5 mm balloon, and a Promus Premier™ 2.5 × 20 mm stent was deployed, followed by post-dilation with a 3.0 mm high-pressure balloon.

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**Figure 3.** PCI for LAD. Guidewires advanced to the LAD and first septal branch as a landmark, and assessed with IVUS (A). Dilation with a 2.5 mm balloon (B) and a Promus Premier™ 2.5 × 20 mm stent was deployed (C), followed by post-dilation with a 3.0 mm high-pressure balloon (D) with no contrast. Selective angiography by tip injection (E). Final angiography (F).
with no contrast agent. After preliminary confirmation with selective injection from the MC and IVUS, final confirmation with coronary angiography from the guiding catheter was performed. The total volume of contrast agent used in PCI to LAD was 6 mL: 1 injection from the MC and 1 injection from the guide catheter.

After 1 further week, we performed PCI to the CTO of the LCX (Figure 4). This lesion was heavily calcified and severely bent; therefore, we opted for a 7 Fr SPB 3.5 with a side hole (Asahi Intecc) guide catheter through a femoral approach. After a few attempts, the XT-R™ fortunately passed through the CTO and advanced to #14PL. The Corsair was advanced, and distal information was evaluated by tip injection. The lesion was dilated with a 2.0 mm balloon, and assessed by IVUS. After additional dilation with a 2.5 mm non-compliant balloon, a Resolute Integrity™ 3.0 × 18 mm (Medtronic) stent was positioned, guided by injection from the tip of a Mizuki™ MC, and deployed, followed by post-dilation with a 3.0 mm high-pressure balloon with no contrast medium. After assessing with IVUS, a 4.5 Fr child catheter (Cokatte™, Asahi Intecc) was advanced into a 7 Fr guide catheter in order to prevent the leaking of contrast agent from the side hole, and coronary angiography was first performed from the child catheter. However, angiography revealed other stenotic lesions of the distal LCX. Therefore, we also treated these lesions. Because IVUS could not pass the stenosis, we decided to perform rotational atherectomy. The Corsair was advanced into the distal LCX #15, and the correct position of the MC was confirmed by tip injection. Rotational atherectomy with a 1.5 mm Rota-Link™ (Boston Scientific Corporation) was performed at 120,000 rpm, and the lesion was passed. A Rota Floppy™ guidewire (Boston Scientific Corporation) was exchanged for a SION blue™, and a SION™ was also advanced to #14PL to protect the side branch. After evaluation with IVUS, the distal LCX lesion was dilated with 2.5 mm high-pressure balloon, and a Promus Premier™ 2.5 × 38 mm stent was deployed. The orifice of #14PL was rewired and dilated with a 2.0 mm balloon. The in-stent region was dilated with a 3.0 mm high-pressure balloon, and further dilation with kissing balloon inflation with 2.5 mm and 2.0 mm balloons was added. IVUS was assessed, and final angiography through a 4.5 Fr child catheter in a 7 Fr guide catheter confirmed perfect revascularization. The total volume of contrast medium in this procedure was 16 mL: 4 injections from the MC and 2 injections from the guide catheter.

Figure 4. PCI for LCX. Tip injection from Corsair™ (A). Selective angiography through tip of MC (B). Dilation with a 2.0 mm balloon (C). Confirmation of distal LCX by tip injection from MC (D). A Resolute Integrity™ 3.0 × 18 mm stent was positioned, guided by injection from tip of MC (E), and deployed (F) with no contrast medium. Coronary angiography was performed from the child catheter (G). Angiography revealed other stenotic lesions of distal LCX (G). After tip injection through MC (H), rotational atherectomy with a 1.5 mm Rota-Link™ was performed (I). Deployment with a Promus Premier™ 2.5 x 38 mm stent (J) and kissing balloon inflation (K). Final angiography through child catheter (L).
eter. Finally, the total volume used in the 3 procedures was 31 mL. The patient’s angina disappeared, and follow-up renal function was unchanged from baseline.

**DISCUSSION**

Although a few cases of super-low volume of contrast administration during PCI have been reported, the target lesions of all these cases were simple and focal stenotic lesions. On the other hand, we presented a successful case of complete revascularization with 3 PCI procedures using a super-low volume of contrast medium, in which a total of 31 mL of contrast medium was administered: 9 mL, 6 mL, and 16 mL, respectively, in a patient with 3VD, including 2 CTOs and severe renal dysfunction. To the best of our knowledge, this is the first report of PCI to complex lesions, including CTOs, with a very small amount of contrast medium.

The safe dose of contrast medium in patients with severe renal dysfunction remains unclear. In the present case, we estimated that 15–20 mL was a safe dose for one procedure based on previous data and experience that 15 mL of contrast medium had not impaired his renal function after coronary angiography in the previous week. Furthermore, the effective use of tip injections from MC and IVUS examinations made it possible to achieve complete revascularization using extremely-low-dose contrast medium. In spite of having two CTOs, this remarkable reduction in contrast medium was attributed to having no difficulty with the guidewire crossing through both lesions and the existence of ipsilateral collateral vessels around the CTOs.

The techniques of PCI using a super-low volume of contrast medium are the following. 1) Preliminary coronary angiography should be performed using low-dose contrast, and the previous angiographic images should be displayed next to an active fluoroscopic screen as a reference to advance a guidewire, balloon catheter, and IVUS (device crossing with no contrast). 2) A small-size guide catheter (5 Fr or 6 Fr) without side holes should be selected. If a large-size guide catheter (7 Fr or 8 Fr) with side holes is selected, when contrast was injected through the guide catheter, the child catheter should be inserted into the mother guide catheter to prevent contrast from leaking through the side holes. 3) Angiography should be performed selectively through the MC using a 2.5 mL syringe. Angiography through the guide catheter should be only performed to confirm a final result. If contrast puffing is unavoidable, residual contrast must be completely removed from the guide catheter. 4) The amount of contrast agent should be documented for each injection, and the operator should keep in mind the total volume of contrast administered. 5) As a landmark, the usage of a guidewire inserted into a side branch near the culprit lesion and coronary calcifications may be helpful to avoid puffing. 6) “IVUS marking” can obtain information concerning stent-landing position linked with landmarks such as a guidewire and coronary calcification without contrast, as well as an appropriate size and length of the stent. To avoid a geographical miss and stent-edge restenosis, a pre-dilation balloon that is smaller and shorter than usual and a stent that is longer than usual should be selected. 7) In cases of CTO, an MC should be inserted into the collateral vessel to inject the contrast selectively.

To take into consideration the above-mentioned concern, it is possible to apply this technique minimizing the volume of the contrast medium to most of the complex PCI’s. However, if unexpected hemodynamic and electrocardiographic changes occur or if residual lesions are revealed, additional angiography through the guide catheter to confirm the situations would be required. On the other hand, there are some cases in which reducing the amount of the contrast medium is difficult, eg, extremely complex CTO lesions, which make it difficult for the guidewire to cross and require the retrograde approach, and left main trunk lesions, especially with true bifurcation, which requires two stentings. In general, the volume of the contrast medium tends to increase during PCI for complex lesions because of unexpected events. Therefore, in patients with severe renal dysfunction, strict attention should be paid to reduce unnecessary administration of contrast medium.

**DISCLOSURE**

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**REFERENCES**


