Coronary Artery Perforation During Percutaneous Coronary Intervention in a Patient with a Prior Modified Bentall Procedure

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Summary
The Bentall procedure is a surgical technique for an ascending aortic or aortic aneurysm in combination with valve disease. A well-known uncommon complication of after the Bentall procedure is coronary artery stenosis related to coronary anastomosis of an interposed graft. We report on a 73-year-old woman who presented with heart failure secondary to graft stenosis of the right coronary artery 6 months after undergoing a modified Bentall procedure. Percutaneous coronary intervention (PCI) was performed and type II coronary artery perforation occurred during PCI of the right coronary artery. We used a perfusion balloon and achieved hemostasis successfully. We report a case of coronary artery perforation that was treated with perfusion balloon during PCI in a patient with a prior modified Bentall procedure. In addition, we present a case series of PCI for ostial coronary stenosis after the Bentall procedure.

Key words: Aortic root replacement, Coronary anastomosis, Coronary ostial stenosis, Perfusion balloon, Heart failure, Case series

Case Report
A 73-year-old woman presented at the emergency department with severe dyspnea. She had a history of aortic valve replacement with a 19-mm mechanical valve (Regent; St. Jude Medical, St. Paul, MN, USA) for severe aortic stenosis and coronary artery bypass grafting (CABG) for severe coronary artery disease 7 years ago. We had performed CABG with a left internal thoracic artery bypass to the left anterior descending artery. In addition, we performed sequential bypass using a saphenous vein graft (SVG) to the left circumflex artery and right coronary artery (RCA). Because of prosthetic aortic valve endocarditis she had required reoperation for perivalvular abscess and pseudoaneurysm. A modified Bentall procedure (Piehler method) was performed 6 months ago. A composite biologic valve conduit, the Carpentier-Edwards Permount Bioprosthetic valve (Magna EASE 19 mm; Edwards Lifesciences, Irvine, CA, USA) and a vascular prosthesis (Triplex 22 mm: Terumo, Tokyo, Japan) were implanted. After the operation she received medical therapy with aspirin and warfarin.

She was admitted to hospital for heart failure treatment, six months after this operation. Her blood pressure was 106/59 mmHg, pulse was 71 beats/minute, and SpO₂ was 88% (room air), on admission. A 12-lead electrocardiogram showed normal sinus rhythm and ST depression in leads V4-6. The cardiothoracic ratio was 55% and pulmonary congestion was present on chest X-ray examination. Troponin I was positive, and the maximum serum creatine phosphokinase level was 539 U/L (normal: < 153 U/L) and creatine phosphokinase of muscle band was 52 U/L (normal: < 12.0 U/L). The level of brain natriuretic peptide was 1196 pg/mL (normal: < 18.4 pg/mL). She underwent coronary angiography, after heart failure treatment, which showed proximal SVG and proximal RCA stenoses (Figures 1, 2). The SVG graft distal to the anastomosis of the left circumflex artery branch was occluded. The left internal thoracic artery graft to the left anterior descending artery was patent without significant stenosis.
On the same day, she was loaded with clopidogrel and we performed PCI of the SVG. A 2.5 × 23-mm drug-eluting stent (Xience; Abbott Vascular, Santa Clara, CA, USA) was implanted successfully (Figure 3).

Seven days after PCI of the SVG, we performed PCI of the RCA because the anastomosis of the SVG and left circumflex artery branch was occluded and there was concern about the risk of SVG restenosis. To achieve an activated coagulation time between 250 and 300 seconds, unfractionated heparin was administered. A 6 Fr Judkins right 4.0 guiding catheter (Asahi Intecc, Aichi, Japan) was inserted through the RCA. A guidewire, Sion Blue (Asahi Intecc), with a Caravel microcatheter (Asahi Intecc) was passed through the RCA. Intravascular ultrasound (IVUS) showed stenosis of anastomosis between the graft and the RCA. At the distal segment (Figure 4C), moderate calcification was observed and the vessel diameter was greater than 3.5 mm at the stenotic segment (Figure 4B). The RCA and vascular prosthesis (arrow) were in close proximity at the proximal segment (Figure 4A). Predilatation was carried out with 2.0 × 15-mm and 2.5 × 15-mm semi-compliant balloons (Tazuna; Terumo). We used a 3.0 × 13-mm non-slip element balloon also (Lacross NSE; Goodman, Aichi, Japan). A drug-eluting stent (Resolute Integrity; Medtronic Vascular, Santa Rosa, CA, USA) was deployed with a Guideliner catheter (Vascular Solutions, Minneapolis, MN, USA) for stable back-up support. Post-stent deployment IVUS showed optimal stent expansion at the distal segment (Figure 5C). The stent, however, did not expand in a circle and was only in an oval shape at the stenotic and proximal segments (Figure 5A, B). Post-dilatation was carried out with a 3.5 × 12-mm low-compliance balloon (Hiryu, Terumo) up to 16 atm. Type II coronary perforation was detected on an angiogram after postdilatation (Figure 6). We delivered a 3.5 × 20-mm perfusion balloon (Ryusei; Kaneka Medix, Osaka, Japan) to the bleeding site and maintained low-pressure dilatation for longer than 1.5 hours. We achieved hemostasis successfully, and there was no contrast leak at the end of the procedure (Figure 7). Transthoracic echography showed no pericardial effusion, and the patient remained hemodynamically stable. The postoperative course was uneventful, and the patient was discharged.

Discussion

Since Bentall and De Bono introduced the Bentall procedure in 1968, this procedure is widely used for aortic root and aortic valve replacement.9) Reconstruction of the coronary artery is often associated with complications of hemorrhage and pseudoaneurysm at the site of anastomosis, however.10) Several modifications of the Bentall procedure were developed, including the Pichier method by which an interposed short graft is applied to reconstruct each coronary artery.11) The prevalence of coronary ostial stenosis is between 5% and 6% in the original Bentall procedure and is less than 2% in the Pichier and Cabrol procedures.12-15) This complication is observed usually within the first 6 postprocedural months, but it may
Figure 4. Pre-intervention IVUS of the RCA. A: The vascular prosthesis can be seen at the proximal segment (white arrow) and the vessel diameter is 4.5 × 3.0 mm. B: At the stenotic segment, the vessel diameter is 3.8 × 3.0 mm. C: Moderate calcification is at the distal segment and the vessel diameter is 4.3 × 4.6 mm.

CAP is a rare, but serious, complication, and it has an incidence of 0.5%. The risk factors of CAP include an older age, hypertension, previous CABG operation, a history of congestive heart failure, PCI for non-ST elevation myocardial infarction or unstable angina, prior clopidogrel use, and lower creatinine clearance. The patient had several risk factors of CAP, such as an older age, hypertension, prior CABG, a history of heart failure, and prior clopidogrel use in our case. Because of strong adhesion and severe arteriosclerosis with calcification, the RCA was difficult to mobilize during surgery. Thus, the interposed Piehler graft for the RCA was lifted up and attached to the main graft. These findings suggested stress at the level of coronary anastomosis was high and the coronary arterial wall tended to be injured. IVUS findings during PCI showed the RCA was lifted up; however, no severe calcification or narrowing of vessels was observed. Hence, we assume that prediction of CAP is difficult.

We were able to treat our patient with protamine and prolonged inflation of a perfusion balloon successfully. However, the long-term outcome of PCI for ostial stenosis after the Bentall procedure is unclear. To check the PCI site, follow-up angiography is required.
Figure 5. Post-stent deployment IVUS of the RCA. A, B: At the stenotic and proximal segments, stent expansion shows an oval shape. C: Optimal stent expansion at the distal segment.

Figure 6. Coronary perforation in the proximal part of the RCA (white triangle).

Figure 7. Final angiogram of the RCA.

Conclusions
Coronary ostial stenosis after the Bentall procedure is a rare, but important complication. PCI is an effective treatment for coronary ostial stenosis, especially after root replacement surgery. We should carefully check the PCI site to avoid a fatal complication because the method of
coronary reconstruction is one of the risk factors of CAP.

### Disclosure

Conflicts of interest: The authors have no conflict of interests to declare.

### References


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