Reconstruction of an Extracardiac Aortocoronary Collateral and Simulation of Selective Angiography With Multidetector-Row Computed Tomography

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A 48-year-old man with familial hypercholesterolemia was admitted to our hospital with stable angina pectoris. Stress myocardial perfusion imaging showed myocardial ischemia in the inferior left ventricular wall. Coronary angiography revealed a chronic total occlusion of the proximal right coronary artery (RCA; Figure 1A and Movie I in the online-only Data Supplement). An intercoronary collateral was observed from the atrial branch of the left circumflex artery to the posterolateral branch of the RCA (Figure 1B and Movie II in the online-only Data Supplement). Contrast material filled the distal RCA retrogradely through this collateral. However, the contrast material was flushed out antegrade by the pulsatile blood flow from the native RCA toward the posterior descending artery in systole (Figure 1B and Movie II in the online-only Data Supplement); this suggested that the second collateral flowed into a site proximal to the RCA crux. Because the second collateral could not be detected during the initial angiography, multidetector-row computed tomography (MDCT) was performed, which successfully detected and visualized the extracardiac aortocoronary collateral connecting to the mid RCA just distal to the chronic total occlusion (Figure 2). Figure 3 shows the location of the collateral on each axial image. The diameter of the collateral was measured as 1.5 mm. Figure 4 shows aortography-like volume-rendered images of the entire collateral pathway. For the subsequently scheduled percutaneous coronary intervention, the appropriate catheter for selective collateral angiography was chosen after simulation with 3-dimensional routing software (Figure 5). The shape like the Judkins Right 5.0 catheter was considered optimal for selective collateral angiography with the femoral approach. All analyses were performed with a commercially available workstation (Ziostation version 2.1.7.1, Ziosoft Inc, Tokyo, Japan).

During percutaneous coronary intervention, selective angiography of the collateral was successfully performed with a 5F Judkins Right 5.0 catheter (Goodman Co, Ltd, Nagoya, Japan; Figure 6).

The most common types of extracardiac aortocoronary collaterals are those between bronchial and coronary arteries and between internal thoracic and coronary arteries. In the present case, we were unable to conclude that the collateral was derived from the bronchial artery because other independent bronchial arteries were detected.

Subepicardial insertion of extracardiac aortocoronary collaterals is typically found at sites of pericardial reflections, which allows the collaterals to enter the subepicardial layer. In the present case, the insertion point was at the pericardial reflection around the left atrial roof vein located below the pericardial transverse sinus, as demonstrated in Figures 2 and 3E. Dewey and Dübel demonstrated a similar volume-rendered image of an extracardiac aortocoronary collateral to the RCA. However, in contrast to the present case, the subepicardial insertion point in their patient appeared to be at the pericardial reflection located at the top of the oblique pericardial sinus. The collateral descended along the posterior left atrial wall under the oblique pericardial sinus and then connected to the distal RCA. Selective angiography was reported to be impossible because of the small size (2.0 mm) of the collateral, despite MDCT reconstruction.

Using MDCT, we not only identified the extracardiac aortocoronary collateral but also successfully used a simulation to determine the optimal catheter for selective collateral angiography. Although the utility of aortography to detect extracardiac aortocoronary collaterals has been reported, selective collateral angiography is necessary to reduce contrast volume during percutaneous coronary intervention for chronic total occlusion.

As demonstrated in the present case, transformation of data obtained from MDCT into critical images would be extremely useful for diagnosis and treatment selection in clinical practice. Communication and cooperation among cardiologists, radiologists, and radiological technologists are essential to obtain high-quality images with minimal radiation exposure and contrast volume. To the best of our knowledge, this is the first reported case of successful selective angiography of the extracardiac aortocoronary collateral with the support of MDCT simulation.
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Disclosures
None.

References

Figure 1. Initial coronary angiography. 
A. Right coronary angiography reveals a chronic total occlusion (black arrow) of the proximal right coronary artery (RCA). 
B. Left coronary angiography. A tortuous intercoronary collateral (white arrowheads) is observed from the left circumflex artery (LCx) to the posterolateral branch (PLB) of the RCA. Contrast material was flushed out toward the posterior descending artery (PDA) of the RCA (white arrow). CRA indicates cranial; LAD, left anterior descending artery; and RAO, right anterior oblique.

Figure 2. Volume-rendered images of the extracardiac aortocoronary collateral. Three-dimensional orientation of the collateral (red) was reconstructed and viewed from the right anterior oblique (RAO) 140° and caudal (CAU) 20° views. 
A. The collateral ascends between the pulmonary bifurcation and left bronchi, passed tortuously behind the right pulmonary artery, and then inserted into the subepicardial layer under the pericardial reflection at the left atrial roof near the right superior pulmonary vein ostium. 
B. The surrounding structures were made more transparent to highlight the entire pathway of the collateral. The collateral passed around the posterolateral pericardial transverse sinus above the noncoronary aortic sinus (NCS) and connected to the mid right coronary artery (RCA). CS indicates coronary sinus; DAo, descending aorta; IVC, inferior vena cava; LA, left atrium; LIPV, left inferior pulmonary vein; LPA, left pulmonary artery; LSPV, left superior pulmonary vein; LV, left ventricle; RA, right atrium; RAA, right atrial appendage; RIPV, right inferior pulmonary vein; RPA, right pulmonary artery; RSPV, right superior pulmonary vein; SVC, superior vena cava; and Tr, trachea.
Figure 3. Location of the extracardiac aortocoronary collateral on each axial image. The location of slice A is most superior and the location of slice G is most inferior. Red arrows in each image denote the extracardiac aortocoronary collateral. The origin was at the right dorsal part of the distal aortic arch (A and B). The extracardiac aortocoronary collateral descended within the mediastinum between the pulmonary artery (PA) bifurcation and the left bronchi (Br; C) toward the posterior right pulmonary artery (RPA; D). Then it entered the subepicardial layer through the pericardial reflection (E) at the level of the left atrial roof vein (black arrowhead). After passing around the posterolateral pericardial transverse sinus (E and F), it anastomosed with the sinoatrial node artery running medial to the right atrial appendage (RAA; F) and then connected to the mid right coronary artery (RCA) just distal to the chronic total occlusion (G). AAo indicates ascending aorta; AoA, aortic arch; DAo, descending aorta; LA, left atrium; LAA, left atrial appendage; LMT, left main trunk; LVOT, left ventricular outflow tract; RA, right atrium; RSPV, right superior pulmonary vein; RV, right ventricle; RVOT, right ventricular outflow tract; SVC, superior vena cava; and Tr, trachea.

Figure 4. Volume-rendered images focused on the entire pathway of the extracardiac aortocoronary collateral. A, Aortography-like volume-rendered image. Entire collateral pathway is highlighted in red. B, Each corresponding structural volume-rendered image. AAo indicates ascending aorta; LA, left atrium; LAD, left anterior descending artery; LMT, left main trunk; LVOT, left ventricular outflow tract; RA, right atrium; RAO, right anterior oblique; RCA, right coronary artery; and RV, right ventricle.
Figure 5. Simulation of the catheter for selective collateral angiography. The shape like the Judkins Right 5.0 catheter (yellow-green line) was simulated on the aortography-like volume-rendered image using 3-dimensional routing software and viewed from the same directions as Figure 4A. Entire extracardiac aortocoronary collateral pathway is highlighted in red. The shape was considered to be appropriate for selective collateral angiography using the femoral approach. AoA indicates aortic arch; LAO, left anterior oblique; RAO, right anterior oblique; and RCA, right coronary artery.

Figure 6. Selective angiography of the extracardiac collateral. Selective angiography of the tortuous collateral (white arrowheads) was successfully completed with the Judkins Right 5.0 catheter. It anastomosed with the sinoatrial node artery (white open arrowhead) and then connected to the mid right coronary artery (RCA) just distal to the chronic total occlusion (black arrowhead). The black arrow denotes the native RCA. RAO indicates right anterior oblique.
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