

MINI-FOCUS ISSUE: CONGENITAL HEART DISEASE

ADVANCED

IMAGING VIGNETTE: DAVINCI CORNER

3D-Printed Visualization of a Complex Coronary-Venous Fistula With Additional Feeders From the Descending Aorta



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ABSTRACT

In a 32-year-old patient with chest pain, a large, complex coronary-venous fistula with additional feeders from the descending aorta was detected with computed tomography. Multimodality imaging, including multicolor 3-dimensional printing, allowed precise anatomic visualization of the origin, course and drainage site of the fistula. The patient was treated conservatively. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2020;2:1736-8) © 2020 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

A 32-year-old patient presented with acute chest pain, diffuse ST-segment elevation on the electrocardiogram, and elevated cardiac troponin. Coronary angiography excluded stenosis of the epicardial vessels but showed an ectatic left main coronary artery with suspicion of a coronary fistula (**Figure 1A, Video 1**).

For better anatomic visualization and assessment of hemodynamic significance a cardiac computed tomography (CT) scan was performed. A large coronary-venous fistula (maximum diameter 8 mm) arising from the proximal circumflex artery, running between the left ventricular outflow tract and the anterior wall of the left atrium and draining into the superior vena cava, was shown (**Central Illustration A, Figure 1B, Video 2**). In addition, a small vessel originated from the descending aorta and bifurcated into 2 branches: 1 running superior and 1 inferior to the left pulmonary artery (**Central Illustration B, Figure 1C, Video 3**). The 2 branches rejoined and drained into the distal part of the coronary-venous fistula. For further spatial assessment of the complex vessel anatomy a multicolor 3-dimensional (3D) printed model, using binder-jetting technology, was created (**Figure 1D, Video 4**). This technology allows creating a multicolored 3D model, while also identifying small substructures such as the fistula origin and adjacent arteries, which would be essential for a safe interventional or surgical treatment (1). A coronary aneurysm or dilatation of right chambers, as indirect sign of hemodynamic relevance, could be excluded. Furthermore, echocardiographically, there was no evidence of an elevated pulmonary artery pressure; a cardiac magnetic resonance scan showed a pattern of acute myocarditis without evidence of myocardial infarction with normal biventricular dimensions, equal and normal

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biventricular stroke volumes, as well as aortic and pulmonary flow volumes. Therefore, the patient was treated conservatively.

DISCUSSION

Coronary fistulae are rare, primarily congenital abnormal communications between coronary arteries and another cardiovascular structure without an interposed capillary bed ranging from 0.05% to 0.9% in several large selected series (2). Clinically, the drainage site of a fistula is more important than its origin; coronary cameral fistulae terminate in a cardiac chamber (commonly into low-pressure right-side cardiac structures), and coronary arteriovenous fistulae terminate into a venous structure such as venae cavae, coronary sinus, bronchial veins, and pulmonary arteries (2).

Recent guidelines have toned down indications for surgical or interventional repair and considered the elevated risk (11%) of post-operative myocardial infarction, for example, due to slow flow phenomenon in the dilated coronary artery proximal to the fistula, coronary dissection, or spasm, as well as thrombosis or device embolization leading to a reduced late survival (3). In general, presence of large, symptomatic coronary fistulae—with evidence of ischemia by steal phenomenon—require review by a knowledgeable multidisciplinary heart team to determine the role of medical therapy and/or percutaneous or surgical closure (3). Most coronary fistulae, however, are small, do not compromise myocardial blood flow, and are incidental findings.

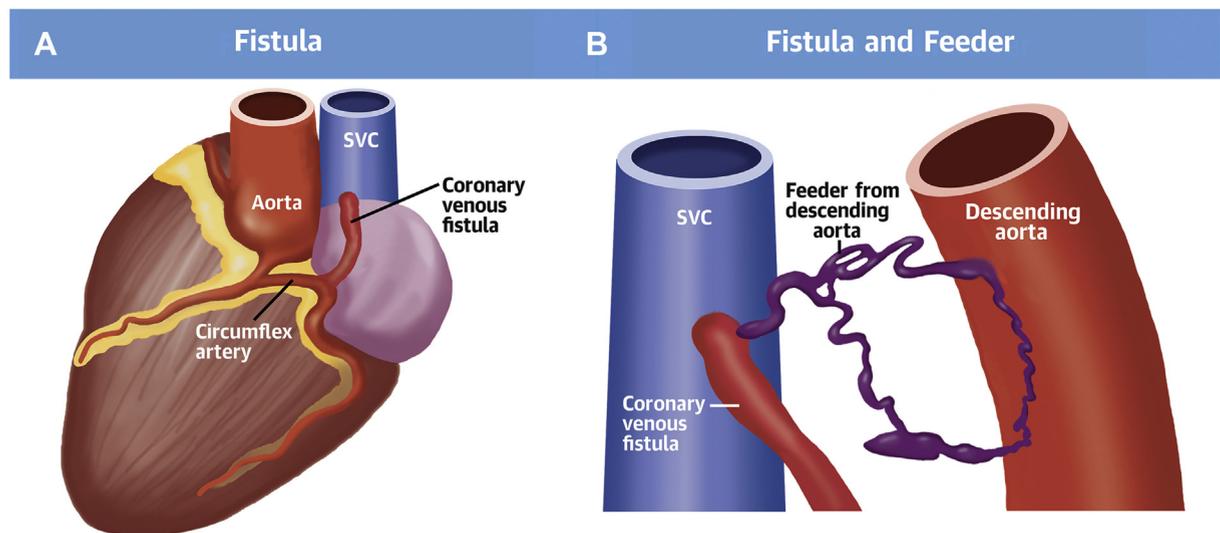
Multiplanar reconstruction with 3D volume-rendered imaging yields precise anatomic visualization of the size, origin, course and drainage site of the fistula; 3D printing may enhance visuospatial appreciation of the vascular anomaly, in particular with cases of complex anomalies with tortuosity, multiple origin, and drainage sites. A tangible heart model by 3D printing of complex coronary fistulae may be instrumental before interventions or surgery in treatment planning to improve sizing or designing of patient-specific devices. It may be helpful for intraoperative orientation, have educational value, and may be used in communication of the pathology with the affected patient (1).

ABBREVIATIONS AND ACRONYMS

CT = computed tomography

3D = 3-dimensional

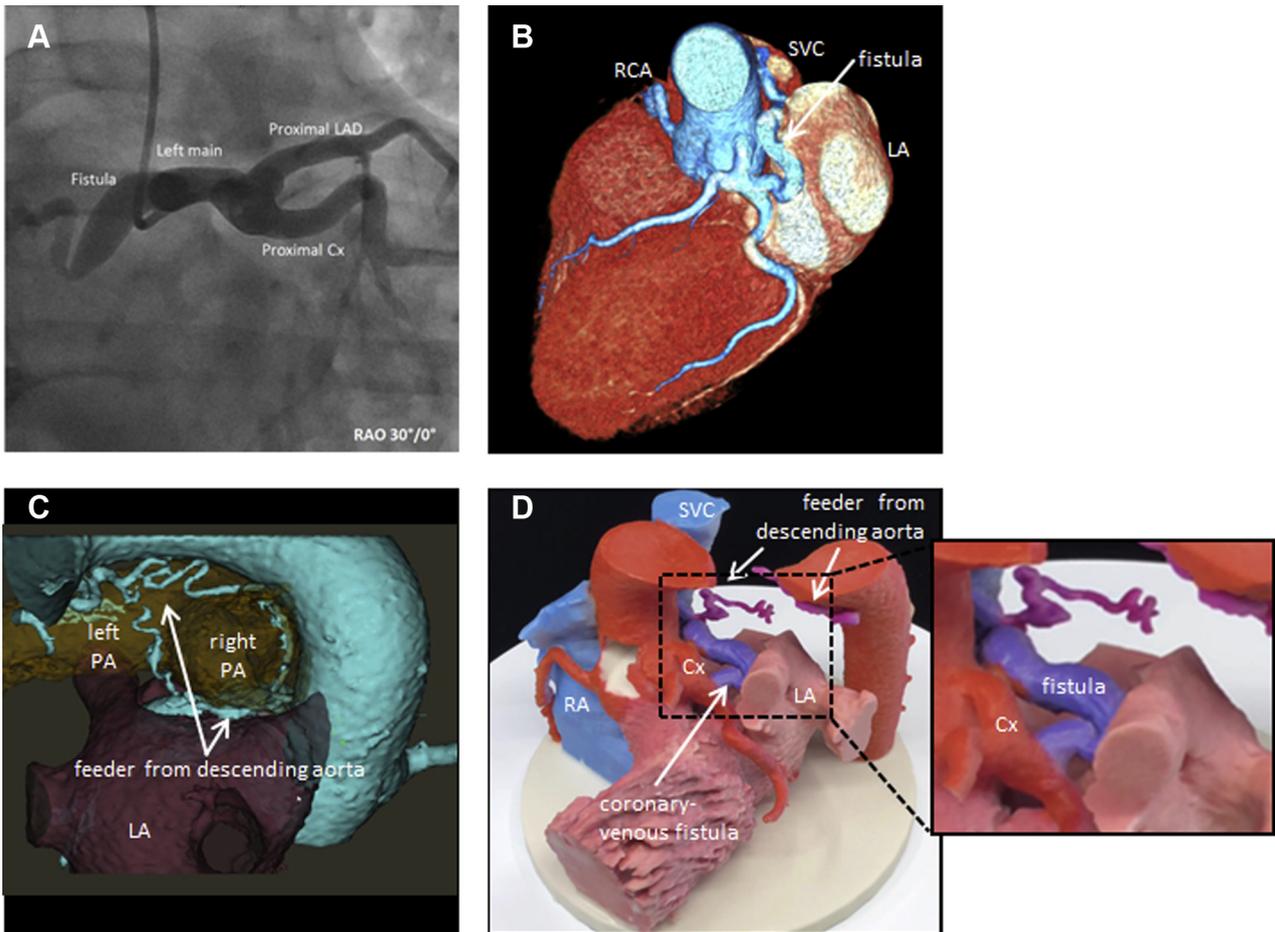
CENTRAL ILLUSTRATION Complex Coronary-Venous Fistula



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A large coronary-venous fistula (A) arising from the proximal circumflex artery with additional feeders (B) from the descending aorta draining into the distal part of the coronary-venous fistula.

FIGURE 1 Multimodal Illustration of the Coronary-Venous Fistula



(A) Catheter angiography. **(B)** Computed tomography (CT) 3-dimensional (3D) volume rendering of fistula. **(C)** CT 3D volume rendering of additional feeders. **(D)** 3D print using a binder-jetting technique, part of the left atrium (LA), a block of the ascending—as well as the left atrial appendage—were omitted. Segmentation of the CT data and creation of the model was performed on Mimics Innovation Suite (Materialise, Leuven, Belgium). Cx = circumflex coronary artery; LAD = left anterior descending coronary artery; PA = pulmonary artery; RA = right atrium; RCA = right coronary artery; SVC = superior vena cava.

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KEY WORDS binder-jetting technology, computed tomography, coronary artery fistula, multicolor 3-dimensional printed model

APPENDIX For supplemental videos, please see the online version of this paper.