CARDIOVASCULAR IMAGES

Left Coronary Artery Aneurysm Causing a Third Mogul

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63-year-old woman was pointed out a growing abnormal shadow on her chest x-ray film in an annual medical check by a general practitioner. She was referred to our hospital despite being asymptomatic. A physical examination revealed no abnormal findings except for a continuous murmur of grade 2 intensity best heard in the third intercostal space. Laboratory data showed a normal brain natriuretic peptide levels of 11.1 pg/mL (normal range ≤ 18.4 pg/mL). A chest radiograph demonstrated an extra convexity along the upper left cardiac border, referred to as a third mogul sign (Figure 1A, arrow). An electrocardiogram showed normal sinus rhythm and mild left axis deviation. Transthoracic echocardiography detected a mass located in front of the pulmonary artery and multiple small vessels bridging the left and right coronary artery (LCA and RCA) with the pulmonary artery. The echocardiography showed no dilation of the left and right ventricles and normal systolic function of the left ventricle. Coronary computed tomography angiography revealed a coronary-pulmonary artery fistula (CPAF) originating from both of the RCA and the left anterior descending artery and a giant saccular coronary artery aneurysm (CAA) with a diameter of 40 mm just in front of the pulmonary artery comes into the CPAF (Figure 2A and 2B). Coronary angiography demonstrated a CPAF originating from the proximal left anterior descending artery and the conus branch of the RCA, complicated with a giant CAA (Figure 3A through 3C; Videos S1 through S4). The pulmonaryto-systolic blood flow ratio (Qp/Qs) was 1.02, and the hemodynamic state was compensated. There was no significant coronary artery stenosis. Although the patient was asymptomatic, she underwent surgical resection and ligation of the CAA and the CPAF because the aneurysm carried a risk of rupture (Figure 3D and 3E). The third mogul disappeared postoperatively (Figure 1B). A coronary computed tomography angiography on postoperative day 1 showed no contrast effect from the left anterior descending artery (Figure 2C) and she was discharged on postoperative day 11 uneventfully.

The term mogul was used by Daves in 1970 to define protuberances on the cardiac silhouette: a mogul being a mountainside mammillation of packed snow sculptured by turning skis.1 Normal moguls on the left arc the aortic knuckle (first), pulmonary artery (second), and cardiac apex (fourth). A third mogul lies below the left main bronchus and is usually formed by a prominent left atrial appendage, which is frequently seen in patients with rheumatic mitral stenosis. Since the incidence of rheumatic disease has recently decreased, other causes of a third mogul have been relatively increasing; these include CAA, cardiac aneurysm, pericardial cyst, mediastinal tumor, pericardial defect, sinus of Valsalva aneurysm, and dilated right ventricular outflow tract. A CAA is defined as an abnormal connection that directly links 1 or more coronary arteries to a heart chamber or to major thoracic vessels without an interposed capillary bed.² It has been reported that CAAs occur in ≈19% of patients with coronary artery fistulas, which arise from the RCA in \approx 50% of patients, the LCA in \approx 42%, and both of the RCA and LCA in ≈5% of patients.² Drainage occurred into the right ventricle (41%), right atrium

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(26%), pulmonary artery (17%), coronary sinus (7%), left atrium (5%), left ventricle (3%), and superior vena cava (1%). Interestingly, reviewing previous literatures, we found almost all giant CAAs with CPAF arising from the LCA are located close to the pulmonary artery near the left atrial appendage.³ On the contrary, CAAs arising from the RCA can exist in the proximal and distal portion of the RCA.⁴ We presume that giant CAAs with CPAF arising from the LCA (either the left anterior descending artery, the left circumflex artery, or both) can appear only in the proximal portion of the LCA because the anterior space of the pulmonary artery is the only anatomically suitable place where CAAs can grow hugely, away from the high pressure of the left heart system. Accordingly, CAAs from the LCA can make a third mogul on a chest x-ray film. In summary, a CAA could be in either the proximal or distal portion of the RCA and formed a right first or second mogul on a chest x-ray film, whereas an LCA aneurysm always formed a third mogul, not a left first, second, or fourth mogul, which could be due to both anatomy and the left ventricular pressure. When we encounter a third mogul on a chest x-ray film, CAAs should be considered as an important differential diagnosis.



Figure 2. Coronary computed tomography angiography.

This shows that a coronary artery aneurysm (asterisk) is located right anterior to the pulmonary artery and that the coronary-pulmonary artery fistula drains into the pulmonary artery (**A**: arrow). Volume rendering image shows inflow from the conus branch of the right coronary artery (**B**: arrow) and the left coronary artery (**B**: arrowhead) into the coronary artery aneurysm. After surgery, there was no contrast effect of the coronary artery aneurysm (**C**).



Figure 3. Coronary angiography and intraoperative images.

Coronary angiography shows a coronary artery aneurysm (arrowhead) and a coronary-pulmonary artery fistula (arrow) originating from the left anterior descending artery (LAD; **A**: right anterior oblique cranial projection) and the conus branch of the right coronary artery (RCA; **B**: cranial projection). The antero-posterior projection view demonstrates the coronary aneurysm forms a third mogul (**C**). The coronary aneurysm is located close to the root of the pulmonary artery (**D**). The fistula ostium from RCA and LAD, and to the pulmonary artery are confirmed in the incised coronary aneurysm (**E**).

ARTICLE INFORMATION

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None.

Supplemental Material Videos S1–S4

REFERENCES

- 1. Daves ML. Skiagraphing the mediastinal moguls. *New Physician*. 1970;19:49-54.
- Loukas M, Germain AS, Gabriel A, John A, Tubbs RS, Spicer D. Coronary artery fistula: a review. *Cardiovasc Pathol.* 2015;24:141–148. doi: 10.1016/j.carpath.2014.01.010
- Egashira K, Ootsubo H, Fukuyama T, Tomoike H, Takeshita A, Nakamura M. Multiple coronary-to-pulmonary artery fistulas with progressive aneurysmal dilatation. *Am Heart J.* 1984;108:1038–1040. doi: 10.1016/0002-8703(84)90477-0
- Guerrero Becerra AF, Palacio AM, Camacho J, Sandoval N. Surgical management of a giant right coronary artery aneurysm with coronary arteriovenous fistula: case report. *Eur Heart J Case Rep.* 2020;4:1–6. doi: 10.1093/ehjcr/ytaa290