

High take-off of the left coronary artery from the distal ascending aorta



Gabriele M. Iacona, MD, Gosta B. Pettersson, MD, PhD, Lars G. Svensson, MD, PhD, and Faisal G. Bakaen, MD, Cleveland, Ohio

From the Department of Thoracic and Cardiovascular Surgery, Coronary Center, Heart Vascular & Thoracic Institute, Cleveland Clinic, Cleveland, Ohio.

Disclosures: The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

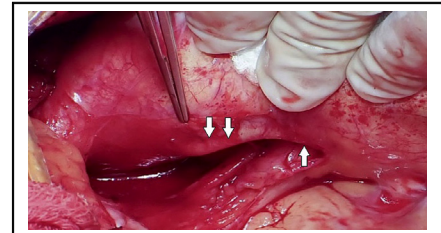
Received for publication March 4, 2021; accepted for publication May 25, 2021; available ahead of print June 2, 2021.

Address for reprints: Faisal G. Bakaen, MD, Department of Thoracic and Cardiovascular Surgery, Heart Vascular & Thoracic Institute, Cleveland Clinic, Desk J4-1, 9500 Euclid Ave, Cleveland, OH 44195 (E-mail: bakaef@ccf.org).

JTCVS Techniques 2021;8:53-5
2666-2507

Copyright © 2021 The Author(s). Published by Elsevier Inc. on behalf of The American Association for Thoracic Surgery. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.xjtc.2021.05.020>



High take-off of the left coronary artery from the distal ascending aorta.

CENTRAL MESSAGE

High take-off of the left coronary artery is a very rare occurrence. It requires precise preoperative imaging and surgical planning to conduct safe and successful cardiac surgery.

See Commentaries on pages 56 and 58.

▶ Video clip is available online.

High take-off of the left coronary artery (LCA) from the distal ascending aorta is a rare occurrence reported in 0.016% to 0.36% of general population.¹ It represents an unusual finding with potentially catastrophic consequences in heart surgery.² Institutional review board approval and patient's informed consent were not required for this report.

A 79-year-old female patient with angina and shortness of breath was diagnosed with 3-vessel coronary artery disease and severe tricuspid aortic valve stenosis/regurgitation. She had a dilated ascending aorta (4.4 cm) and normal left ventricular ejection fraction. After difficulty identifying her LCA on the first attempt at coronary angiography, a computed tomography (CT) scan revealed a high take-off of the LCA 5.0 cm above the sinotubular junction (Figures 1 and 2). On repeat coronary angiography, the LCA was engaged and interrogation identified severe occlusive atherosclerotic disease in the left anterior descending and circumflex arteries.

After pericardial opening, we visualized the origin of LCA from the ascending aorta running underneath it (Figure 3) (Video 1). Aortic clamp application was possible between the origins of the innominate artery and the LCA with aortic cannulation of the aortic arch at the level of the left common carotid artery. Four-to-one blood cardioplegia was delivered in antegrade and retrograde fashion, achieving diastolic arrest. We constructed 3 distal coronary

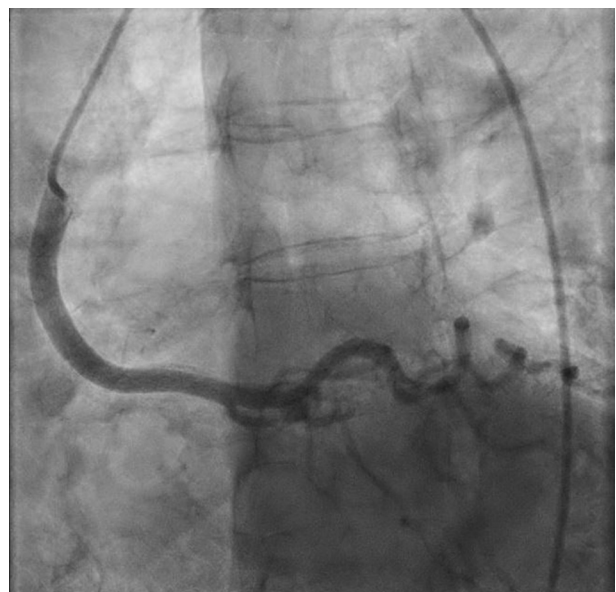


FIGURE 1. Left heart catheterization: high take-off of the left coronary artery from the distal ascending aorta.

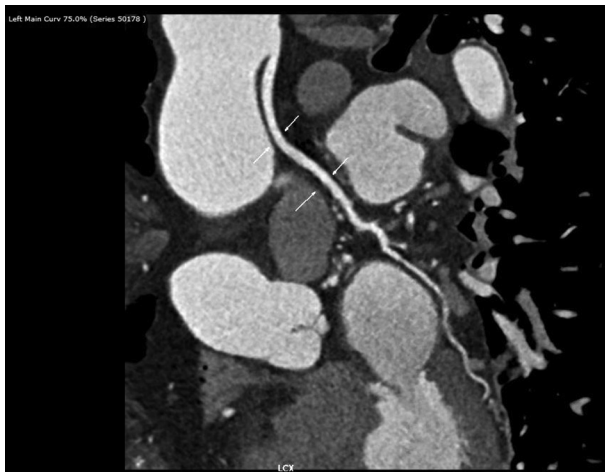


FIGURE 2. Multislice computed tomography of the coronary arteries: high take-off of the left coronary artery.

anastomosis (saphenous vein graft to obtuse marginal, free right internal thoracic artery to right coronary artery, in situ left internal thoracic artery to left anterior descending artery). Then, we created a longitudinal aortotomy, implanted a biological aortic valve, and reduced the size of the ascending aorta with an aortoplasty. Finally, we constructed the proximal anastomoses of the conduits onto the clamped ascending aorta. The patient did well after surgery. Her first month follow-up CT scan showed patent grafts and intact LCA.

High take-off of coronary arteries refers to their origination above the sinotubular junction. It is a rare anomaly that more frequently affects the right coronary artery compared with the LCA and is often associated with other congenital

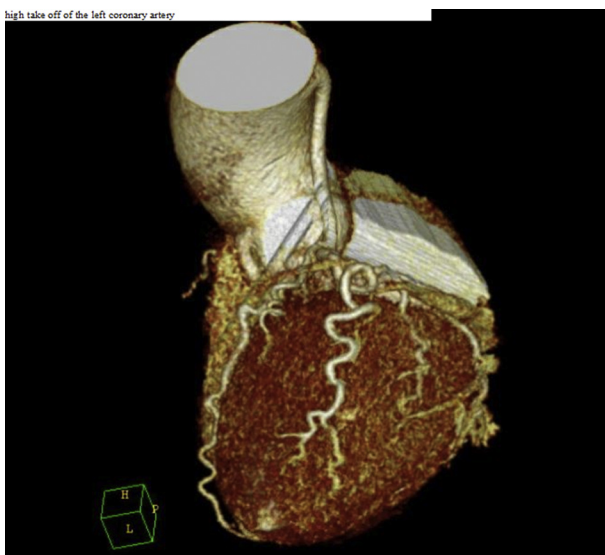
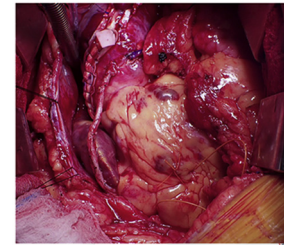


FIGURE 3. Multislice computed tomography of the coronary arteries: 3-dimensional reconstruction of the left coronary artery.

High take-off the LCA

For safe cardiac surgery:
Precise preoperative imaging
Detailed surgical planning



VIDEO 1. High take-off of the left coronary artery from the distal ascending aorta represents an unusual finding with potentially catastrophic consequences in cardiac surgery. Herein, we present some background and details about surgical management. Video available at: [https://www.jtcvs.org/article/S2666-2507\(21\)00387-4/fulltext](https://www.jtcvs.org/article/S2666-2507(21)00387-4/fulltext).

cardiac malformations.¹ Embryologically, when the cells of the capillary plexus surrounding the aorta and pulmonary artery fail to reach and/or penetrate the 2 normal sites on the aorta (a phenomenon regulated by the vascular endothelial growth factor C), an anomalous origin of a coronary artery from the aorta is generated.³ Interestingly, all surgical case reports in the English literature described the high take-off of the right coronary artery except for Bini and colleagues,⁴ who described the high take-off of the LCA in a pediatric patient with a large ventricular septal defect undergoing open heart surgery in 1988. To our knowledge, this case report is the first description of a very high take-off of the LCA in an adult patient undergoing surgery. Whether or not the high take-off of the LCA has a pathologic significance leading to myocardial ischemia is still a matter of debate. Impaired coronary perfusion may be more related to the associated coronary anomalies either at the level of the coronary ostia or more distal segments, such as intramural or interarterial course.⁵

Coronary angiography can identify the abnormal origin of the LCA, but a detailed anatomical description and 3-dimensional reconstruction with a multislice CT angiography is informative and helps with surgical planning.^{1,5} In our patient, knowing the exact origin and course of the LCA allowed us to safely cannulate at aortic zone 1, to apply the aortic clamp between the cannula and the origin of the LCA just proximal to the innominate artery, to deliver antegrade cardioplegia in addition to retrograde cardioplegia, to open the ascending aorta using an anterior longitudinal aortotomy far away from the LCA. A higher take-off of the LCA may necessitate dual arterial cannulation of the right axillary artery and arch/femoral artery, clamping of the origin of the innominate artery, and clamping of the arch at zone 1 just proximal to cannula and the left carotid artery to allow for antegrade cardioplegia delivery down the LCA. Alternatively, the LCA may be occluded with aortic

crossclamping and myocardial protection can be achieved by delivery of retrograde cardioplegia and down the bypass conduits with mild systemic hypothermia. If ascending aortic replacement is necessary, the LCA can be mobilized and selectively cannulated for delivery of cardioplegia. It can then be reimplanted at an appropriate location to avoid kinking. A more proximal intramural course could allow for an unroofing option at the level of the coronary sinus. In conclusion, high take-off of the LCA from the distal ascending aorta requires precise preoperative imaging and surgical planning to conduct safe and successful cardiac surgery.

References

1. Loukas M, Andall RG, Khan AZ, Patel K, Muresian H, Spicer DE, et al. The clinical anatomy of high take-off coronary arteries. *Clin Anat*. 2016;29:408-19.
2. Tarhan A, Kehlibar T, Yilmaz M, Arslan Y, Pancaroglu C, Yigit S, et al. Right coronary artery with high takeoff. *Ann Thorac Surg*. 2007;83:1867-9.
3. Tomanek R, Angelini P. Embryology of coronary arteries and anatomy/pathophysiology of coronary anomalies. A comprehensive update. *Int J Cardiol*. 2019;281:28-34.
4. Bini RM, Nicolosi L, Alfieri O. Origine anomala dell'arteria coronaria sinistra dall'aorta. Implicazioni chirurgiche in un caso [Anomalous origin of the left coronary artery from the aorta. The surgical implications in a case]. *G Ital Cardiol*. 1988;18:148-50 [in Italian].
5. Rosenthal RL, Carrothers IA, Schussler JM. Benign or malignant anomaly? Very high takeoff of the left main coronary artery above the left coronary sinus. *Tex Heart Inst J*. 2012;39:538-41.