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Bilateral Anterior Descending Artery Variant Mistaken as Chronic Occlusive Disease on Coronary Angiography: A Case Report

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Abstract
The bilateral left anterior descending artery (LAD) variant is a rare congenital coronary anomaly defined by the presence of two LADs within the anterior interventricular groove. The shorter LAD terminates proximally, while the longer LAD extends distally to supply the apical region of the heart. This report describes a patient with typical stable angina pectoris in whom a bilateral LAD variant was identified. Coronary angiography revealed a proximal LAD occlusion, no ostial lesion was found in intravascular ultrasound examination. Subsequent coronary computed tomography angiography (CCTA) confirmed the presence of bilateral LADs. The shorter LAD originated from the left main coronary artery, and the longer LAD arose from the proximal conus branch of the right coronary artery, passing between the aorta and the right ventricular outflow tract. These imaging findings are consistent with a type VI bilateral LAD variant. Recognition of this rare anatomical configuration is crucial, as it may complicate the diagnosis and management of coronary artery disease. This case underscores the importance of multimodal imaging, particularly CT angiography, in accurately identifying coronary artery variations that can significantly influence clinical decision-making and interventional planning.

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Introduction

Dual left anterior descending (LAD) coronary artery is a rare congenital anomaly with an incidence of only 1%, as reported by (Şeker, 2020). It is defined as the existence of two distinct segments of LAD at the anterior inter- ventricular sulcus (AIS) of the heart. It comprises a short LAD that usually ends high in the AIS and a long LAD that enters the distal AIS ending at the apex. Initially classified by based on coronary angiography (Şeker, 2020), a few more types of dual LAD were added later based on computed tomography coronary angiography (CTCA). Usually benign in itself, knowledge of dual LAD and its variants is indispensable for its occasional malignant (inter-arterial) course and appropriate management of patients undergoing coronary intervention or surgery for various indications. To date, eleven variants of dual LAD have been described (Bhargav et al., 2021).

Knowledge of existing patterns of dual LAD and its variants is crucial and be a unique challenge for interventional cardiologist for doing PCI. Firstly, lack of awareness may lead to misdiagnosis as total distal occlusion. Secondly, complete coronary evaluation is vital for optimal revascularisation during the percutaneous coronary intervention (PCI) or coronary artery bypass grafting. Under recognition may lead to residual ischemia due to disease in the missed part of dual LAD. Thirdly, its knowledge is indispensable for planning surgical correction in patients with congenital heart disease, such as the tetralogy of Fallot and transposition of great arteries (Dheeraj et al., 2020). Finally, its malignant interarterial course may be associated with significant ischemia.

A 63-year-old woman was admitted to the hospital with a chief complaint of recurrent chest pain on exertion for one year, which had worsened during the past week. Initially, she experienced chest tightness during physical activity that subsided within minutes. One week prior to admission, the chest pain became more severe and occurred even after light exertion, such as climbing stairs or lifting objects, resolving spontaneously within five minutes.

Her past medical and family histories were unremarkable. Physical examination on admission revealed no positive findings. Laboratory tests, including complete blood count, liver and renal function, fasting glucose, and lipid profile, were within normal limits. Electrocardiography, Holter monitoring, and echocardiography showed no significant abnormalities. Due to the presence of typical exertional chest pain, coronary artery angiography was conducted to determine the underlying etiology.

Method

Coronary angiography, performed due to the patient's typical chest pain symptoms, revealed no significant abnormalities in the left main (LM) artery. The proximal left anterior descending (LAD) segment exhibited 60% stenosis, resulting in a high first diagonal branch (D1), beyond which the LAD morphology was unclear. Head position (AP 0°-Cranial 30° view) coronary angiography shows 60% stenosis in the proximal segment of the left anterior descending artery. In the leg position (AP 0°-Caudal 30° view), coronary angiography showed no obvious stenosis in the left main coronary artery and the left circumflex artery. The left circumflex artery (LCX) was large, without significant stenosis, and demonstrated grade 3 TIMI flow. The right coronary artery (RCA) showed no significant stenosis; however, a relatively long conical branch was present, supplying branches to the mid to distal. Based on the clinical presentation and angiographic findings, a chronic total occlusion (CTO) lesion in LAD was considered, so revascularization was undertaken. A 7F catheter (SAL1.0, Medtronic, USA) was

introduced into RCA via right radial artery, and another 7F catheter (EBU 3,5 American Medtronic Corporation) was inserted via right femoral artery introduce into LCA.

SION guide wire (Japan ASAHI Company) was advanced into the LAD-D1 branch, and intravascular ultrasonography (IVUS) was utilized to find LAD occlusion segment. Subsequently, a 2.6 F microcatheter (130 cm, Xiangtan EPT Company) combined with a guidewire (UB3/AIA3, ASAHI, Japan) failed to identify the conventional LAD track. Following bilateral coronary angiography and repeated IVUS assessments, vascular variation was considered, and the procedure was discontinued (Figures 1C and 1D).

Figure 1 explained the results of coronary angiography. Figure 1A is left coronary angiography, which fails to show that the anterior descending branch runs to the apex of the heart; 1B is proximal segment of the right coronary artery is considered run to the left side of the sinus node and is connected to the middle and distal segment of the anterior descending branch; 1C is bilateral coronary angiography, and there is no vascular connection in the middle segment of the anterior descending branch, suggesting that it may be chronic coronary occlusion; 1D is an intravascular ultrasound examination of the left anterior descending branch, which is repeatedly examined near the chronic occlusion segment, and no large-diameter vascular branch opening is shown.

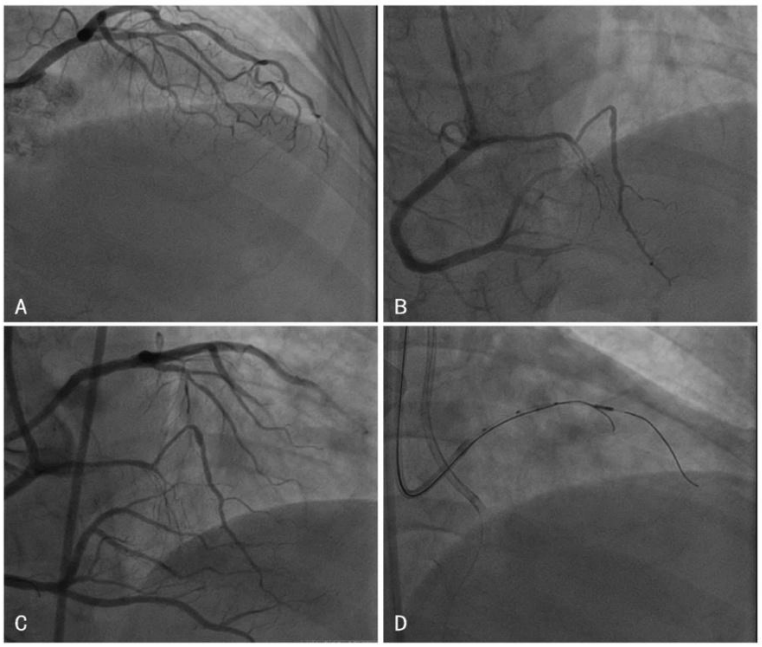

Figure 1. The results of coronary angiography

Result and Discussion

1. Result

Postoperative coronary CT angiography (CTA) demonstrated that branches originated from the proximal right coronary artery (RCA), traversed between the aortic root and the right ventricular outflow tract, and continued within the middle and lower segments of the interventricular sulcus, forming the mid- to distal left anterior descending artery (LAD). The left main (LM) was not visualized. Calcified plaques were identified in the proximal and middle segments of the LAD, resulting in approximately 20% stenosis and forming a short left anterior descending artery (S-LAD), which terminated in the high anterior interventricular sulcus and gave rise to high diagonal and septal branches.

Punctate calcified plaques were also observed in the proximal left circumflex artery (LCX), with approximately 10% luminal stenosis. The diagnosis was a LAD variant, characterized by the proximal segment as shorter LAD originated from the left main coronary artery (S-LAD) and mid to distal segments originating from the proximal RCA as long left anterior descending artery (L-LAD).

Coronary CT angiography (CTA) in this patient revealed an unusual coronary artery anatomical configuration, a dual left anterior descending artery (dual LAD). The proximal LAD segment, originating from the left main coronary artery, appeared relatively short and terminated at the top of the anterior interventricular sulcus, thus classifying it as a short LAD (S-LAD). The S-LAD gave off high diagonal and septal branches, but did not reach the apex. In contrast, the longer LAD segment (long LAD/L-LAD) originated from the proximal branch of the right coronary artery (RCA) and coursed between the aortic root and the right ventricular outflow tract before re-entering the anterior interventricular sulcus in the mid- to distal segments. This pathway then supplied the distal portion of the interventricular sulcus, approaching the apex.

In addition to these anatomical variations, the CTA also revealed mild calcified plaques in several coronary artery segments. In the proximal and middle LADs, calcified plaques were identified, resulting in approximately 20% stenosis. In the proximal left circumflex artery (LCX), a small calcified plaque was observed, resulting in approximately 10% lumen narrowing. No significant coronary stenosis (>50%) was found. These findings indicate that the patient has a type VI dual LAD variant, characterized by an S-LAD originating from the left ventricular system and an L-LAD arising from the RCA and traveling toward the distal segment of the anterior interventricular sulcus.

Figure 2 explained results of coronary artery CT angiography (CTA). Figure 2A shows that the right coronary artery (RCA) branch supplies the middle and distal segment of the left anterior descending branch (LAD); Figure 2B shows that the LAD emitted from the left main is relatively short; Figure 2C shows the three-dimensional coronary CTA image of the distal LAD; Figure 2D shows the RCA branch running between the aorta and the pulmonary artery toward the middle and distal LAD.

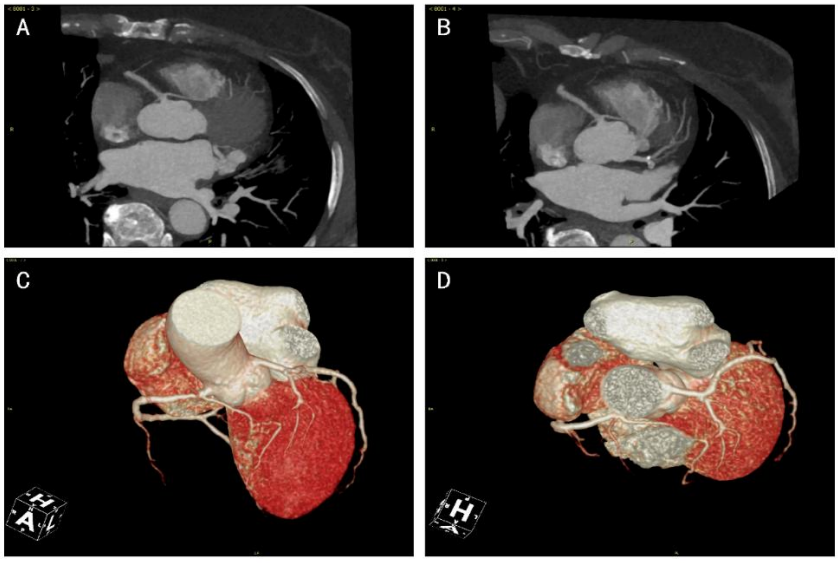

Figure 2. Results of coronary artery CT angiography (CTA)

2. Discussion

Congenital coronary artery anomalies are rare, with angiographic prevalence ranging from 0.6% to 1.3% (Baz et al., 2024). Dual LAD was first described and classified in 1983, with an incidence of approximately 1% on coronary angiography (Spindola-Franco et al., 1983; Yamanaka & Hobbs, 1990). The development of coronary computed tomography angiography (CCTA) technology over the past few years has significantly improved the ability to detect anatomical variations in the coronary arteries. Compared with conventional coronary angiography, CCTA provides clearer three-dimensional visualization of the origins, courses, and terminations of coronary arteries, making it a very important modality in the evaluation of congenital coronary anomalies (Maggialetti et al., 2023).

With the increasing use of coronary CTA, the detection of dual LAD variants has grown, and several classification systems have been expanded to include newer subtypes(Jariwala & Jadhav, 2022). An extensive national CTA screening study involving 23,845 patients reported a 0.14% incidence of dual LAD, with Type I being most common(WU Qi-yuan et al., 2025).

A recent multicenter study evaluating over 2,000 CCTA examinations reported a prevalence of dual LAD of approximately 5.96%, a figure higher than previously reported figures of approximately 1% based on invasive angiography. This suggests that CCTA may improve the detection of coronary anatomic variations that may have previously been missed with conventional examinations (Maggialetti et al., 2023).

Dual LAD is typically categorized into a short LAD (S-LAD) and a long LAD (L-LAD). The S-LAD often originates from the main LAD and terminates high in the interventricular septum. At the same time, the L-LAD demonstrates variable origins and courses, often rejoining the distal anterior interventricular groove.

In this case, the configuration corresponds to Type VI dual LAD, with an S-LAD from the left coronary artery and an L-LAD from the RCA, with the widespread use of coronary CTA, more asymptomatic LAD variants are being screened. Based on CTA imaging results, LAD can be divided into nine types, primarily according to the origin and course of the S-LAD and L-LAD. A new type was discovered in 2019, resulting in type 10 (Natraj Setty et al., 2019)

Based on the origin and course of the S-LAD and L-LAD, this case is designated as type 6 in the current double LAD classification. This patient had two LADs: an S-LAD arising from the LAD and an L-LAD arising from the RCA. Although patients with double LADs are usually asymptomatic, physicians should be aware of an absent or significantly shortened LAD and consider whether it is a double LAD variant. This identification is crucial for interventional cardiologists, as it can prevent unnecessary interventional procedures and surgical bypass grafting caused by misidentification.

The S-LAD should not be diagnosed as a CTO lesion in the LAD, and the S-LAD should not be considered simply a conical branch. Suppose coronary angiography shows the absence of blood vessels at the apex and the presence of a small left anterior descending artery (LAD). In that case, a double LAD should be considered.

Coronary angiography can demonstrate vessel morphology and coronary artery stenosis and it is the gold standard for diagnosing coronary heart disease. However, accurately depicting coronary artery variations is relatively complex because it cannot display the three-dimensional space of the coronary arteries, thereby not directly demonstrating their origins, courses, and positions relative to other cardiac tissue (Aziz & Singh, 2021; Clemente et al., 2020; Widmer et al., 2024).

Coronary CT (Computed Tomography) helps visualize the three-dimensional anatomy of the coronary arteries, and understanding the coronary artery course and its spatial position relative to other cardiac tissue is crucial for detecting coronary artery variations. The results showed that the left anterior descending artery (LAD) originated from the LAD itself. In this case, no occluded segment was found below the S-LAD.

Understanding the dual LAD variation is also important in assessing the relationship between the arterial pathway and surrounding cardiac structures. In some cases, the arterial pathway, which passes through the space between the aorta and pulmonary artery, can potentially cause vascular compression during exercise, increasing the risk of myocardial ischemia or even sudden cardiac death in certain circumstances. Therefore, identifying the correct arterial pathway on CCTA is crucial for assessing the clinical significance of this anomaly and guiding optimal management strategies. In addition to detecting anatomical variations, CCTA also allows non-invasive evaluation of coronary atherosclerotic plaques, including identification of calcified plaques and the degree of luminal stenosis. Early detection of non-obstructive plaques has important prognostic value because it can reflect subclinical atherosclerotic processes that may progress to more severe coronary artery disease (Maggialetti et al., 2023).

The left anterior descending artery (LAD) originates from the proximal RCA conus branch, and coronary CT can demonstrate its course in the three-dimensional space between the aortic root and the right ventricular outflow tract. This is also noteworthy because its course in the aortic root and pulmonary artery root can cause myocardial ischemia and even sudden death (Akech et al., 2025; Yarlagadda et al., 2020).

Based on the results of coronary angiography and CCTA, the patient was diagnosed with a double LAD variant. The patient's symptoms are mainly due to the absence of several blood vessels between the two LADs, leading to a sparse vascular distribution. Symptoms may appear after strenuous exercise or because the L-LAD runs between the aorta and the pulmonary artery, leading to chest tightness after activity.

Conclusion

This case demonstrates a rare dual left anterior descending artery (LAD) variant (Type VI), characterized by a short LAD originating from the left coronary artery and a long LAD arising from the proximal right coronary artery (RCA). Accurate identification of this coronary anomaly is critical to avoid misdiagnosis as LAD occlusion and to inform appropriate interventional or surgical management. Coronary computed tomography angiography (CTA) is essential for the precise delineation of anomalous coronary anatomy and for preventing unnecessary interventions.

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