Clinical presentation and outcomes in type IV dual left anterior descending artery anomaly

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Abstract: Type IV dual left anterior descending artery (LAD) anomaly constitutes a rare subset of coronary anomalies in which the anterior and anterolateral wall of the left ventricle is supplied by a short LAD originating from the left coronary artery along with a long LAD that originates from the right sinus of Valsalva. Albeit rare, the angiographic presentation is challenging since the appearance of the short LAD is similar to a total occlusion beyond first few diagonal or septal branches. Here, we present a series of four cases with type IV dual LAD anomaly with different clinical and angiographic presentations.

Keywords: coronary angiography, coronary anomaly, coronary artery disease, acute coronary syndrome, atherosclerosis

Introduction

Congenital anomalies of coronary arteries include abnormalities in origin, course, or myocardial distribution and occur in 0.64 to 1.3% of patients undergoing coronary angiography [1]. Dual left anterior descending artery (LAD) is defined as the presence of two LAD arteries in the anterior interventricular sulcus (AIVS). Variants of the dual LAD pattern have been identified in 1% of all patients undergoing selective coronary angiography, who had otherwise normal hearts [2]. The rarest and perhaps the most challenging variant is dual LAD type 4, accounting 0.004% of all patients undergoing coronary angiography [3].

When confronted during a coronary angiography procedure, type IV dual LAD morphology presents several challenges to the operators. We present four cases of type IV dual LAD in the present report, diagnosed with conventional coronary angiography during evaluation for ischemic heart disease, and, subsequently, confirmed the course of long LAD using computed tomography (CT) angiography.

Materials and methods

For this case series, all coronary angiograms performed between 2000 and 2015 in the study institution were retrospectively reviewed using electronic medical records (EMRs). From these EMRs, a total of 111 patients diagnosed with a coronary anomaly were found, and digitally stored angiograms were reviewed by experienced invasive cardiologists. Clinical and angiographic data for 4 patients who had type IV dual LAD anomaly were retrieved from EMRs.
Case presentations

Case 1

A 68-year-old male was admitted to our outpatient clinic with typical angina that is present for four months. Echocardiographic examination revealed an ejection fraction of 45% and hypokinetic LV inferior segment. Coronary angiography was performed with femoral approach. Left coronary angiography showed a short LAD emerged from left main stem, which was terminated after giving first diagonal branch. During obtaining the right coronary angiogram, a second coronary artery arising from a separate ostium was visualized nonselectively, along with a spiral dissection flap in the right coronary artery (RCA) which was considered as a spontaneous dissection. Afterwards, the coronary ostia for the other artery was selectively engaged, revealing a second LAD, arising from the right aortic sinus, coursing towards the left side and reaching the proximal portion of interventricular groove, supplying blood to distal LAD territory. Remaining septal and diagonal branches arise from this long LAD. No percutaneous treatment was planned for the RCA, and lesions on short LAD and LCx were accepted as noncritical. Atherosclerotic plaques were not detected in long anomalous LAD. CT angiography confirmed these findings and revealed a prepulmonic course for long LAD artery. Remaining septal and diagonal branches arise from this long LAD. No percutaneous treatment was planned for the RCA, and lesions on short LAD and LCx were accepted as noncritical. Atherosclerotic plaques were not detected in long anomalous LAD. CT angiography confirmed these findings and revealed a prepulmonic course for long LAD artery. Remaining septal and diagonal branches arise from this long LAD. No percutaneous treatment was planned for the RCA, and lesions on short LAD and LCx were accepted as noncritical. Atherosclerotic plaques were not detected in long anomalous LAD. CT angiography confirmed these findings and revealed a prepulmonic course for long LAD artery. Remaining septal and diagonal branches arise from this long LAD. No percutaneous treatment was planned for the RCA, and lesions on short LAD and LCx were accepted as noncritical. Atherosclerotic plaques were not detected in long anomalous LAD. CT angiography confirmed these findings and revealed a prepulmonic course for long LAD artery.

Case 2

A 49-year-old man was admitted to emergency unit with shortness of breath that was present during rest. His blood pressure was 85/45, with fine crackles over lower lung segments. Transthoracic echocardiography showed akinetic anterior, anterolateral segments with an ejection fraction of 27%. To determine the etiology of LV failure, coronary angiography was performed. After engagement of left coronary artery ostium, selective contrast injections showed a short LAD terminating abruptly after giving first septal and diagonal branches. Both this short LAD and normal LCx had multiple atherosclerotic lesions, raising the possibility of a total occlusion in the mid LAD segment. However, a second coronary ostium besides RCA was engaged in right coronary sinus, revealing a long LAD supplying distal LAD territory and giving rise to remaining septal branches. This artery was free of atherosclerotic involvement, in contrast to other coronary arteries. The right coronary artery was totally occluded. A CT angio showed a prepulmonic course for long LAD artery. No further interventions were planned as extensive scarring was present in LV, as assessed with SPECT.

Case 3

A 78-year-old male patient with a diagnosis of acute inferior myocardial infarction subsequently underwent emergent coronary angiography, which revealed a total occlusion in RCA. The lesion was directly stented with a drug-eluting stent. Contrast injection to the right coronary artery visualized a second coronary artery in the right sinus of Valsalva, and selective engagement of this artery revealed a long LAD coursing towards the left AIVS and giving rise to distal LAD. Left coronary angiogram showed a normal left main trunk, branching to LAD and LCx arteries. This short LAD was totally occluded after bifurcation, and diffuse coronary lesions were detected on LCx and first obtuse margin. Similar to previous cases, long LAD aris-
from the right aortic sinus was free of lesions despite extensive atherosclerotic involvement in other arteries. No further treatment was considered, and the patient was free of ischemic symptoms at a control visit.

Case 4

A 63-year-old man was admitted to outpatient clinic with chest pain. Based on the abnormal treadmill test result, a coronary angiography was performed. Left coronary angiogram revealed a short LAD artery terminating in the midportion of the anterior interventricular sulcus after giving the second septal branch and an LCx artery. Right coronary angiogram showed a normal RCA and an anomalous long LAD originating from the same ostia with RCA coursing to the anterior interventricular sulcus and supplying the apex of the LV. There was minimal atherosclerotic involvement in RCA, and other vessels, including long and short LAD arteries being free of disease. This anomaly was considered to be a dual LAD coronary artery type IV, which was confirmed subsequently with CT angiography. The patient was discharged with general recommendations.

Discussion

The group of anomalies associated with the presence of double LAD running through AIVS is classified into four subtypes by Spindola-Franco and colleagues [2]. Type IV dual LAD is characterized by the presence of a short LAD terminating soon after giving a few septal and/or diagonal branches. The remaining LAD territory is supplied by a second “long” LAD merging from right sinus of Valsalva close to the ostium of the right coronary artery, coursing anterior to the pulmonary artery to reach the cranial part of AIVS. The type IV dual LAD anomaly was considered as a relatively benign anomaly. Therefore, the diagnosis is rather incidental during an invasive or CT angiogram.

In type IV dual LAD anomaly, the short LAD emerging from the left main stem terminates prematurely, giving impression of a total occlusion of the mid-LAD. In the presence of a mid- or distal occlusion of a normal LAD, it is not infrequent that a relatively well-developed conus branch of the RCA could supply the apical portion of the LV [4]. In an adult patient with coronary risk factors, the long and short LAD of the type IV dual LAD anomaly could be mistakenly taken for the combination of mid- to distal segment occlusion of the LAD along with a well-developed conal branch. In our series, all four cases had atherosclerotic coronary disease, and critical lesions were present in three of them, where it was quite easy to confuse type IV dual LAD anomaly with the aforementioned combination. However, the following features were suggestive for the presence of a type IV dual LAD anomaly: 1) the absence of a stump in LAD emerging from left main stem, 2) the initial transverse course of the long LAD in front of the pulmonary artery to reach the proximal part of AIVS, and 3) the presence of septal and diagonal branches emerging from the distal portion of long LAD, which should be absent in conal collaterals.

A summary for the cases presented in this report was given in Table I. There was extensive atherosclerotic involvement in short LAD, LCx, and RCA in the first three cases, and noncritical atherosclerotic involvement of RCA in the remaining fourth case. Peculiarly, there was no atherosclerotic involvement of the long LAD artery in all four of cases. This concept was noted in a previous case report by our study group, which was presented as Case no. 2 in the present series [5]. Data from previous case reports and small series, when available, confirm this observation. In a series of four patients with dual LAD undergoing CAGB surgery [6], one patient had type IV dual LAD anomaly while the long LAD emerged from left main stem in others (types I–III).
In the former patient with type IV dual LAD, the long LAD was not grafted as it was free of disease, while three other vessels received grafts. In another case report, Bali and associates reported a patient with type IV dual LAD along with an LCx emerging from RCA [7]. Both the dominant RCA and the short LCx had multiple atherosclerotic lesions, while the long LAD was free of disease. We have previously suggested that the lack of branching points, which were areas of turbulent flow and disturbed shear stress, in the initial part of long LAD artery could explain this phenomena [5]. Foci of altered shear stress were known to induce the rapid progression of atherosclerotic plaques [8]. Additionally, the long LAD has a prepulmonic course in type IV dual LAD, so the artery is not compressed externally, which may disturb the flow and cause atherosclerotic plaque development.

In conclusion, type IV dual LAD anomaly should be suspected in the presence of a LAD artery ending soon after giving a few septal or diagonal branches without a stump compatible with total occlusion. A careful inspection of the course of the long LAD and the presence of branches in the distal LAD should be adequate to differentiate the long LAD from the conal branch. Finally, there seems to be a tendency of long LAD to resist atherosclerosis, while the exact cause remains unknown and merits further research.

Highlights

- Although type IV dual LAD is a rare anomaly, it represents unique features, as well as challenging situations for the interventional cardiologists.
- To date, there are a few case reports about type IV dual LAD.
- In the limited literature, it is emphasized that short LAD which terminates prematurely can be misinterpreted as total occlusion of the mid-LAD. This misevaluation can lead to a series of unnecessary examinations and interventions.
- Our case series is the largest one in the literature with 4 cases of dual LAD type IV.
- In this report, as distinct from other reports, we highlighted the resistance of anomalous LAD to atherosclerosis and argued about the anatomical features of anomalous vessels that could explain this phenomenon.

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Table I  Clinical and angiographic properties of type IV dual left anterior descending artery cases

| Case no. | Presentation | Short LAD | Long LAD | Other features | Catheter for long LAD | CT angiography | Atherosclerotic involvement |
|----------|--------------|-----------|----------|----------------|------------------------|----------------|-----------------------------|
| Case 1   | Stable angina| Terminates after first D/S | Supplies the rest of LAD and D/S | None | JR | Prepulmonic course of long LAD | RCA |
| Case 2   | Acute heart failure | Terminates after first D/S | Supplies the rest of LAD and D/S | None | JR | Prepulmonic course of long LAD | RCA |
| Case 3   | Acute inferior STEMI | Terminates after first D/S | Supplies the rest of LAD and D/S | None | JR | Prepulmonic course of long LAD | RCA |
| Case 4   | Stable angina | Terminates after second D/S | Supplies remaining D/S, no dominant LAD body | Short Cx | JR | Prepulmonic course of long LAD | RCA (minimal) |

D – diagonal branches; JR – Judkins right catheter; LAD – left anterior descending artery; LCX – left circumflex artery; RCA – right coronary artery; S – septal branches
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