A Case Report of Dual Left Anterior Descending Coronary Artery Anomaly with Crusade Catheter Intervention

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Dual left anterior descending coronary artery (LAD) is a rare congenital anomaly. We report a patient presenting with chest tightness, who was subsequently found to have this coronary anomaly via Multidetector computed tomography (MDCT). He underwent staged percutaneous coronary interventions (PCI) of the totally occluded long LAD and its diagonal branch (DB) successfully through the radial route. We conclude that anomalous coronary artery disease can be safely and successfully treated through the radial route after careful evaluation of origin and course of the anomalous vessels. CT coronary angiography is extremely useful in delineating the vessel course and particularly their relation to great arteries. Then, we present a technique that combines the reversed guidewire technique with a Crusade catheter, and we expect that this technique will increase the rate of access into the intended vessels, particularly with a difficult anatomy. We describe the details of this technique, its usefulness, why it works, and when to employ it in clinical practice through the following case report.

Key words: Dual left anterior descending coronary artery anomaly, Crusade catheter, Percutaneous coronary intervention, Computed tomographic coronary angiography

Introduction

Duplication of the left anterior descending coronary artery (LAD) is a rare anomaly (incidence 1%) first described by Spindola-Franco et al. in 1983[1]. It is characterized by a “short LAD” that terminates high in the anterior interventricular groove and a “long LAD” that has a proximal course outside the anterior interventricular groove and returns to the groove in its distal course. Types 1(as in this case) --3 are commonest and describe early bifurcation of the proximal LAD (LAD proper) into two vessels. Type 4 is extremely rare whereby a “long LAD” arises from the right coronary sinus or RCA with a “short LAD” arising from the left main stem. Awareness and recognition of dual LAD is important for diagnosis and therapeutic planning. Conventional coronary angiography (CAG) may sometimes misinterpret the “long LAD” as a large diagonal branch (DB) and the “short LAD” may be misinterpreted as a total occlusion of the mid portion of the LAD[2]. Accurate assessment of the coronary anatomy is crucial...
Multidetector computed tomography (MDCT) angiography is well suited to define coronary artery anomalies due to its multi-planar capability and is able to accurately characterize dual-LAD lesions[2]. Percutaneous coronary intervention (PCI) sometimes involves a challenge to negotiate acute-angle bifurcations even for the considerably skilled interventionalist, and significant angulations are a predictor of procedural failures and complications [3]. The Crusade catheter (Kaneka), a double-lumen multifunctional probing micro catheter, was designed with the express purpose of managing bifurcation lesions. A double-lumen is an effective structure for this purpose. The guidewire in the monorail lumen protruding from the end helps to stabilize the micro-catheter, while the guidewire in the over-the-wire lumen protruding from the side hole can be directed toward the ostium of the intended branch. Thus this device provides adjunctive support in getting catheter into the desired position[4]. The double-lumen additionally prevents entanglement of multiple guidewires. Here, we present a technique that combines the reversed guidewire technique with a Crusade catheter[5], and we expect that this technique will increase the rate of access into vessels, particularly with a difficult anatomy.

**Case report**

A 50-year-old man with a history of hypertension suffered from exertional dyspnea for one month. He underwent first coronary angiography (CAG) (Figure 1A) which revealed that dual left anterior descending artery (dual LAD, Type 1) with a long segment of chronic total occlusion at the distal end of the LAD proper, as middle portion of the long LAD and its DB which receiving abundant of collaterals from septal perforates (SP) of the short LAD. Left circumflex artery (LCX) showed multiple aneurysmal changes and multiple stenosis. Right coronary artery (RCA) originated as a continuation of the distal LCX. The patient subsequently underwent percutaneous transluminal coronary angioplasty (PTCA) with stent deployment for distal LCX-RCA successfully. The distal LAD proper – proximal long LAD had a thick, calcified deposit and blunted end. To access the long LAD/DB, a Filder FC then a Miracle 6 guidewire (Asahi Intecc) was used together with 1.25/10 mm RyujinTM Plus OTW (Terumo) in a conventional manner. The guidewire tip very difficultly penetrated the occluded long LAD, but unfortunately prolapsed into the unintended long LAD’s DB, no matter how many times we attempted to pass the wire through the origin of the intended long LAD. (Figure 1B)

To delineate the origin and course of the difficult coronary anatomy, he underwent the cardiac computed tomography angiogram (CTA) (Figure 2A) which revealed that the patient had type 1 dual LAD. The LAD proper gave rise a short LAD that terminated high in the midportion of the anterior interventricular groove, and the long LAD initially coursed parallel to the short LAD and then reentered into the anterior interventricular groove. The long LAD had some remnant in the occluded proximal segment then giving rise to mid-LAD and DB with acute angle and multiple stenosis in long LAD. The RCA originated from distal end of the LCX and a stent was deployed there well.

We performed CAG and staged PCI this time (Figure 1B-1F) owing to recurrent angina and
cardiac CTA (Figure 2A) revealed more accurate and detailed coronary anatomy. A 6 Fr EBU3.5 (Medtronic) guiding catheter was inserted from the right radial artery to the left main trunk. To access the LAD and DB bifurcation (Figure 1B), An Asahi Sion guidewire (Asahi Intecc) was used together with a Crusade catheter in a conventional manner. However, the guidewire tip immediately prolapsed into the unintended DB no matter how many times we attempted to pass the wire through the origin of the intended LAD (Figure 1B), and thus we had to abort the conventional antegrade approach. We used a reversed guidewire technique. A hairpin-bend was formed in a Fielder FC guidewire (Asahi Intecc) at a point 3 cm from the distal tip (Figure 1C) and inserted in the over-the-wire lumen. The Fielder FC wire was passed via the Crusade catheter into the DB beyond the bifurcation with the swan-neck shaped distal shaft protruding out of the side port (Figure 1D). Withdrawal of the wire toward the bifurcation with the Crusade catheter caused the Fielder FC wire tip to engage the ostium of the targeted LAD. When the wire was withdrawn further until the hairpin-bend reached the bifurcation point, the tip went deep into the LAD (Figure 1D). At this point, a gentle forward force with adequate rotation of the shaft enabled distal advancement of the tip. After the LAD was dilated using a balloon, a drug-eluting stent was deployed for the mid LAD. Two drug-eluting stents were placed to the span length of the distal LAD to middle LAD. All procedures were successfully completed without any complications (Figure 1F). The patient was discharged a few days later. He made an uneventful recovery effort tolerance at six months’ follow-up (Figure 2B).
Discussion

Malformation during the formation of cardiac sinusoids, coronary budding on aorto-pulmonary trunk and connection between the two systems may lead to development of coronary anomalies. Dual left anterior descending coronary artery is a rare coronary anomaly. Although variations in origin, course and distribution are rare in both right and left coronary arteries, they are fairly rarer in left coronary artery in comparison to the right coronary artery.

Variants of the dual LAD pattern have been identified in 1% of all patients undergoing selective coronary artery angiography with otherwise normal hearts. Spindola-Franco et al. provided an angiographic description of the important variants of dual LAD: dual LAD was defined as short LAD and long LAD that separate from the proximal LAD. Short LAD follows the anterior interventricular groove and terminated high near the apex. Long LAD originates from the early portion of LAD away from anterior interventricular groove and reaches the apex (Type 1-3).

In type 1 (as in this case) and type 2, a long LAD originates as a branch from the LAD proper, takes a course parallel to the short LAD in its proximal course on either the left ventricle (type 1) or the right ventricle (type 2) and returns to the anterior ventricular groove. Type 3 dual LAD is characterized by a middle intramyocardial course of the long LAD. In rare cases, long LAD originates from right coronary artery (Type 4).

With the widely use of coronary CT, it offered an alternative tool for detection of congenital coronary anomalies beyond coronary angiography.
Agarwal et al. reported two types of dual LAD (type 1 and type 4) by ECG-gated 64-MDCT coronary angiography\(^2\). In this case, it combined single coronary artery with dual LAD (Type 1). Interventional cardiologist may misunderstand this unusual coronary artery anomaly in angiographic finding. It is essential for interventional cardiologist or surgeon to recognize this rare coronary artery anomaly in coronary angiographic study or coronary CT for more accurate decision making. MDCT angiography is well suited to defining coronary artery anomalies due to its multi-planar capability and is able to accurately characterize dual LAD lesions.

Kawasaki et al. succeeded in treating an ostial LAD, which bifurcated at an acute angle from the LMT, using a bare wire. Adjunctive use of a double-lumen micro-catheter at the time of guidewire manipulation has some additional advantages as compared to the reversed guidewire technique alone\(^8\). First, the former helps the hairpin-bent shaft to pass into the unintended vessel beyond the bifurcation with less interference from the stenosis. Further, the guidewire gains better back-up support toward the intended branch, as the catheter minimizes the way of the shaft. Third, the present technique prevents entanglement of the wire shafts with one another. In the reversed guidewire technique, there are 3 wire shafts: a shaft distal to the hairpin-bend point of the wire for the intended vessel; a shaft proximal to the hairpin-bend point of the wire for the intended vessel; and a shaft required for the unintended vessel. Pulling the swan-neck shaped guidewire back to the bifurcation with torque to carry the tip to the targeted branch ostium in a crowded vessel is likely to induce shaft entanglement. Because a double-lumen micro-catheter accommodates 2 of the 3 shafts separately in each lumen and leaves only the shaft distal to the bent point outside the catheter, using this device can prevent entanglement. Lastly, using the double-lumen micro-catheter may decrease the risk of a swan-neck shaped wire getting stuck in a vessel, which is the greatest fear when utilizing the reversed bare guidewire operation.

This technique does have limitations. First, the reversed guidewire has inferior torque performance compared to the technique using the conventional antegrade wire. Second, the reversed guidewire has a higher potential of causing vessel dissection. As stated above, the highly trackable performance of plastic-jacket hydrophilic guidewires is a favorable feature for this technique. However, this feature itself may sometimes damage vessels. Furthermore, coronary perforation is also a risk, because the guidewire tends to slip forward into the distal end of the vessel regardless of intention during withdrawal of the microcatheter. Third, the swan-neck portion of the wire may present difficulty in traversing the critical coronary stenosis. Furthermore, when stenotic lesions lie not only proximal but also distal to the bifurcation, this irregularly shaped wire could be difficult to manipulate, even after the swan-neck part passes into the distal main vessel. Lastly, because the shaft of the Crusade microcatheter has a thickness of 2.9 Fr, the use of this catheter is limited to patients with greater vascular luminal caliber. This microcatheter may not be able to pass through lesions with nearly critical stenosis, particularly if accompanied by a thick layer of calcification. Predilation using a small balloon or rotational atherectomy may be required.
Conclusion

We conclude that anomalous coronaries can be safely and successfully treated through the radial route after careful evaluation of the origin, course and distribution of the anomalous coronary artery. CT coronary angiography is extremely useful in delineating the vessel course and particularly its relation to the other coronary arteries. Despite some limitations, the reversed guidewire technique with adjunctive use of a double-lumen microcatheter leaves less to chance and may be a reliable way to treat patients with acute-angle bifurcations of the coronary anatomy.

References

利用 Crusade 導管在雙套左前降支冠狀動脈
先天異常的介入性治療——一病例報告

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雙套左前降支冠狀動脈（dual LAD）是一種罕見的先天性異常。我們描述一位患者
主訴胸悶, 後來使用螺旋電腦斷層攝影術（MDCT）發現有此冠狀動脈先天異常。經由撓
動脈成功完成左前降支冠狀動脈（LAD）及其對角支（DB）嚴重分叉病灶的冠狀動脈介入
術（PCI）。只要經過事前審慎評估血管的起源、路徑異常，使用特殊的血管導線操作是可
以安全地和成功地穿越病灶。電腦斷層冠狀動脈血管造影術在事前評估血管的起源、路徑
異常極為有用。我們在這篇文章詳細描述這種技術，結合 Crusade 導管及逆行的導絲技術，
我們預料這項技術將會提高血管導線進入嚴重分叉病灶的可能性及實用性。

關鍵字：雙套左前降支冠狀動脈異常，冠狀動脈介入術，電腦斷層冠狀動脈血管造影術，
Crusade 導管

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