

Anchor balloons assisted deep intubation of 5F catheters for uncrossable lesions

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Abstract

A number of treatment strategies for complex coronary lesions have been utilized in varying clinical settings over the last decade. However, cardiologists still encounter some difficult scenarios such as variant coronary artery origins, severely calcified and highly tortuous lesions. We report four cases in which the stents failed to cross lesions using the conventional percutaneous coronary intervention techniques, but all the target lesions were successfully stented finally using a new combined technique of anchor balloon assisted deep intubation of 5F "child-in-mother" catheter.

Key words: Anchor balloon, child-in-mother catheter, percutaneous coronary intervention

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Introduction

Over the last decade, a number of treatment strategies for complex coronary lesions have been utilized in varying clinical settings.^[1-3] However, interventional cardiologists still address difficult scenarios in everyday clinical practice, such as variant coronary artery origins and severely calcified and highly tortuous lesions. With the application of parallel wire,^[4] anchor balloon,^[5] and "child-in-mother" catheter,^[6-8] some difficult lesions can be successfully stented. However, there are still other lesions that cannot be crossed, even with the aforementioned techniques. Here, we report four cases in

which the stents failed to cross lesions using conventional percutaneous coronary intervention (PCI) techniques, but all target lesions were successfully stented using a new combined technique.

Case Reports

Case 1

The first case was a 74-year-old female who was admitted to the hospital because of severe exertional chest pain. One-year prior to her admission, the patient had undergone computed tomography angiography, which had revealed multi-vessel disease with severe calcification [Figure 1a]. After being admitted, the patient underwent coronary angiography, which revealed a highly calcified subtotal occlusion in the middle right coronary artery (RCA) [Figure 1b], 30–40% stenosis in the proximal left anterior descending artery (LAD), 40% stenosis in

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the middle left circumflex artery (LCX) and 90% stenosis in the middle obtuse marginal artery (OM). PCI was performed after informed consent was obtained. A 6F short-tip amplatz (SAL) 1.0 guiding catheter (Medtronic, Minneapolis, MN, USA) was used to engage the RCA through the right femoral access, and a fielder XT guide wire (Asahi Intecc co, LTD, Aichi, Nagoya, Japan) was successfully manipulated to cross the highly calcified lesion under the support of a 135 corsair micro-catheter (Asahi Intecc co, LTD),^[9] after which corsair was spun to cross the lesion and run - through guide wire (Terumo Corporation, Tokyo, Japan) was used to replace the Fielder XT guidewire. Then, predilation was performed using a 1.5 mm × 15 mm maverick balloon (Boston Scientific, Natick, MA, USA) and a 2.0 mm × 15 mm Apex balloon (Boston Scientific, Natick, MA, USA). However, a 2.5 mm × 24 mm Partner stent (Lepu Medical, Beijing, China) could not cross the lesion. Accordingly, another 3.0 mm × 15 mm Apex balloon was used to re-dilate the lesion, but the stent still became stuck at the proximal and middle RCA. Attempts using either the buddy wire or anchor balloon technique failed [Figure 1c], and the stent was damaged during these procedures [Figure 1d and h]. Then, a 5F Heartrail™-ST01 “child-in-mother” catheter (Terumo Corporation, Tokyo, Japan) was utilized and inserted at the proximal RCA to increase the backup support of the SAL guiding catheter; however, a new 2.5 mm × 24 mm Partner stent also failed to cross the lesion. Finally, we performed a combined technique by delivering a 2.5 mm × 8 mm Maverick balloon to the distal RCA and anchored the entire system with 8 atmospheric pressure. The 5F “child” catheter could then be deeply inserted until it touched the target lesion [Figure 1e]. After withdrawing the balloon, the 2.5 mm × 24 mm partner stent was successfully delivered to the lesion through the “child” catheter [Figure 1f] and deployed after withdrawing the 5F catheter, with a good final result and TIMI III

flow [Figure 1g]. Another stent was implanted in OM 4 days later, and the patient was discharged 1-day after the second procedure without any complications.

Case 2

The second case involved an 82-year-old male who was admitted to the hospital for a planned PCI. The patient had rejected coronary artery bypass grafting and received two PCIs within the past year for RCA and LCX total occlusions. This time, a planned PCI was arranged for the LAD lesions. CAG showed 40% stenosis in the distal left main coronary artery (LM), 90% stenosis in the proximal LAD, 80% stenosis in the middle LAD, and 80% stenosis in the proximal first diagonal (D1) [Figure 2a]; the RCA and LCX remained open without any stent restenosis. PCI was accessed through the right radial artery. A 6F BL guiding catheter (Terumo Corporation, Tokyo, Japan) was chosen to engage the LAD. A run - through guide wire was delivered to the LAD, and another run - through guide wire was delivered to D1. The proximal D1 lesion was dilated using a 2.0 mm × 20 mm Apex balloon and another 2.5 mm × 20 mm Sprinter balloon (Medtronic, Minneapolis, MN, USA), after which a 2.5 mm × 16 mm Taxus stent (Boston Scientific, Natick, MA, USA) was successfully implanted [Figure 2b and c]. Then, the proximal and middle LAD lesions were predilated separately using a 2.5 mm × 20 mm Sprinter balloon. However, after predilation, a 2.75 mm × 23 mm Taxus stent failed to cross the proximal LAD lesion. The stent also failed to cross the lesion after either another predilation with a 3.0 mm × 15 mm Sprinter balloon or through use of the buddy wire, anchor balloon or “child-in-mother” catheter [Figure 2d-f]. Finally, the combined technique of the “child-in-mother” catheter and anchor balloon was performed [Figure 2g], and a 3.5 × 15 Azule (Orbus Neich Medical, B.V, AN Hoevelaken, The Netherlands)

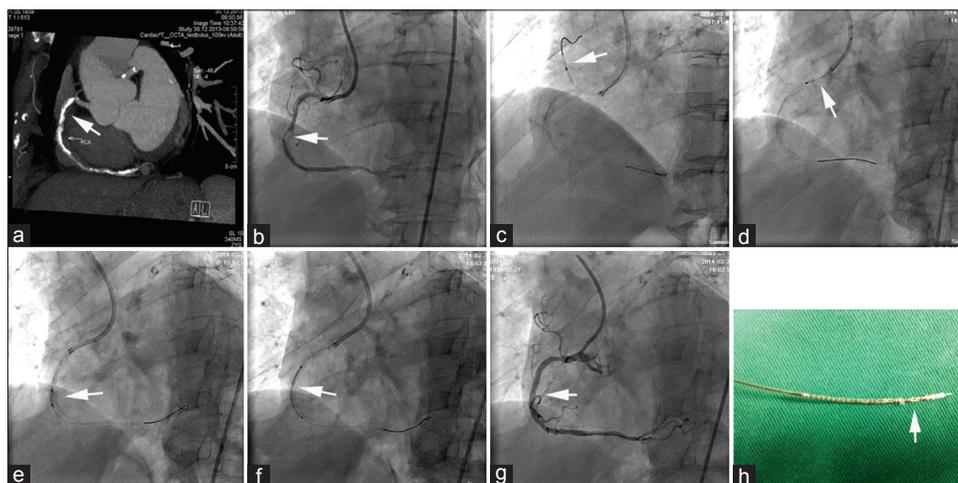


Figure 1: (a) Severe calcification visible by computed tomography angiography. (b) A highly calcified subtotal occlusion in the middle right coronary artery. (c) An anchor balloon. (d) The damaged stent. (e) A deep-seated 5F “child-in-mother” catheter assisted by a 2.5 mm × 8 mm anchor balloon. (f) A stent delivered to the middle right coronary artery through the “child” catheter. (g) The final result, TIMI III flow. (h) The damaged stent

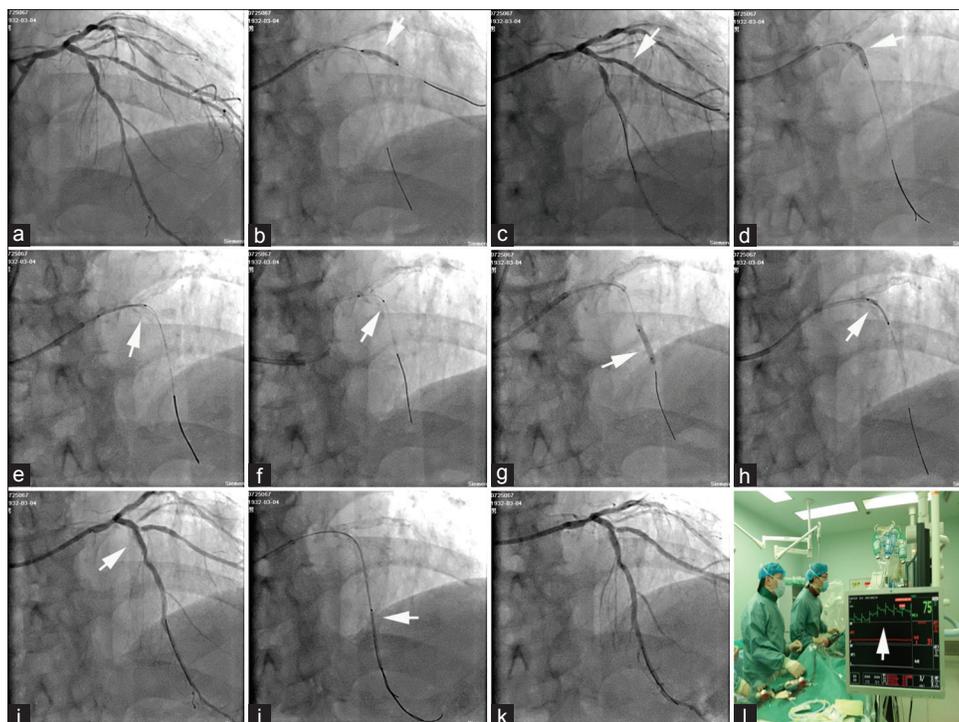


Figure 2: (a) Baseline angiography. (b) A 2.5 mm × 16 mm Taxus stent deployed in D1. (c) Post stenting angiography of D1. (d) Left anterior descending artery predilatation. (e) A 3.0 mm × 15 mm balloon was stuck in the proximal left anterior descending artery. (f) A 3.0 mm × 15 mm balloon was stuck in the proximal left anterior descending artery. (g) A deep-seated 5F “child-in-mother” catheter assisted by a 2.5 mm × 20 mm anchor balloon. (h) A 3.5 × 15 Azule stent delivered to the proximal left anterior descending artery. (i) Post stenting angiography of the proximal left anterior descending artery. (j) A 2.75 mm × 23 mm Taxus stent delivered to the middle left anterior descending artery. (k) Final result. (l) The ST segment elevated while the 5F catheter was inserted into the proximal left anterior descending artery

stent was successfully implanted in the proximal LAD under the support of a deeper seated 5F “child” catheter [Figure 2h and i], after which a 2.75 mm × 23 mm Taxus stent was finally implanted in the middle LAD under the support of two buddy wires [Figure 2j]. The final angiogram showed a good result (TIMI III flow) without complication [Figure 2k].

Case 3

The third case was a 67-year-old male who was admitted to the hospital for exertional chest pain. The CAG was accessed through the right radial artery, which showed 90% stenosis in the proximal LAD, normal LCX, and 90% stenosis in the distal RCA. In addition, the RCA originated from the left coronary sinus. PCI was suggested for RCA and LAD, and an Amplatz left-1 guide catheter (Cordis Corporation, Miami Lakes, FL, USA) was used to engage the RCA ostium, but it demonstrated bad coaxality [Figure 3a]. A run-through guide wire was successfully placed, and the target lesion was predilated with 1.5 mm × 15 mm and 2.0 mm × 20 mm Apex balloons. However, because of the malformation of the RCA and bad coaxality of the guiding catheter, the target lesion was poorly visualized, and it was impossible to precisely locate the stent even after placing a buddy wire. Then, the aforementioned combined technique was adopted. Using a 2.0 mm × 20 mm Apex balloon as the anchor balloon, a 5F “child” catheter was deeply inserted

near the target lesion of the RCA [Figure 3b], after which two Taxus stents (3.0 mm × 32 mm; 3.0 mm × 24 mm) were precisely located and successfully deployed [Figure 3c-e]. The final angiogram showed a good result, (TIMI III flow) without complication [Figure 3f]. Then, a 3.5 mm × 24 mm Partner stent was successfully implanted in the LAD using the normal technique.

Case 4

The fourth patient was a 64-year-old male who was admitted to a local hospital because of exertional chest pain lasting for 2 years. Six months prior to admission, the patient had received a PCI in the hospital, but a stent failed to cross a lesion in the LCX due to tortuosity of the vessel and calcification of the target lesion. After admission, CAG was performed via the right radial artery, which showed 80% stenosis in the highly torturous middle LCX and 70% stenosis in the distal LCX [Figure 4a]. An EBU 3.5 guiding catheter (Medtronic, Minneapolis, MN, USA) was chosen to engage the LM ostium. A BMW guide wire (Abbott Vascular, California, USA) and a run-through guidewire were successively delivered to the distal LCX, after which both LCX lesions were predilated with a 2.0 mm × 15 mm Maverick balloon. However, a 2.75 mm × 18 mm Excel stent (JW Medical Systems, Shandong, China) could not cross the middle LCX [Figure 4b]. Then, a 5F child-in-mother catheter was inserted into the middle LCX

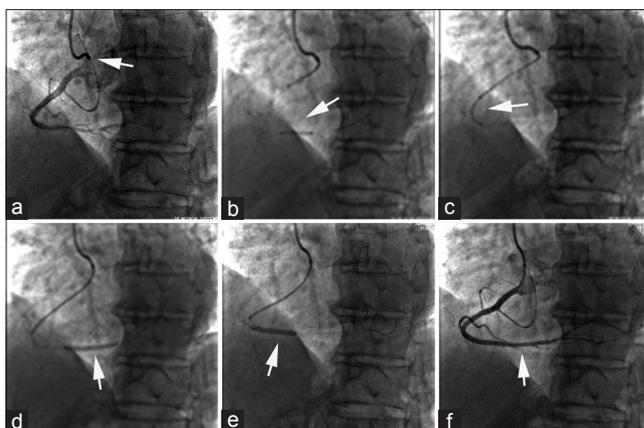


Figure 3: (a) Baseline angiography showing the right coronary artery originated from the left coronary sinus and 90% stenosis in the distal right coronary artery. (b) A deep-seated 5F “child-in-mother” catheter assisted by a 2.0 mm × 20 mm anchor balloon. (c) A 3.0 mm × 32 mm Taxus stent delivered to the distal right coronary artery. (d) A deployed stent. (e) Another deployed stent (3.0 mm × 24 mm Taxus). (f) Final result, TIMI III flow

lesion with the assistance of a 2.0 mm × 15 mm anchor balloon [Figure 4c]. Finally, two 2.75 mm × 18 mm Excel stents were successfully delivered to the distal and middle LCX, respectively [Figure 4d and e]. Although a postdilation balloon could not cross the torturous middle LCX, the final angiogram showed a good result (TIMI III flow) without complication [Figure 4f].

Discussion

The calcification and tortuosity of the coronary arteries often increase the resistance of the entire intervention system, and operators may fail to deliver the stent to the target lesion, which can result in damage or dislodging of the stent. Lesions with both chronic total occlusions (CTO) and bifurcation lesions may double the difficulty of implanting stent and decrease the PCI success after CTO recanalization.^[10] In addition, bad coaxiality of the guiding catheter and target vessels due to the variant origin of the coronary artery could also dramatically affect the backup support of the guiding catheter, as well as the quality of the angiography, and even prevent stent delivery or location.

Regarding the aforementioned situations, predilation with a noncompliant balloon, a buddy wire, and anchor balloon techniques are usually adopted, but these methods are not always effective. In addition, because PCI procedures are currently and predominantly accessed from the radial artery in most catheter labs and the 6F guiding catheters are generally adopted, the catheter volumes may be limited with the anchor balloon technique, and the two wires often intertwine, causing stent damage; dislodging may even occur, as in the first case. Moreover, the anchor balloon technique may damage the anchored branch.

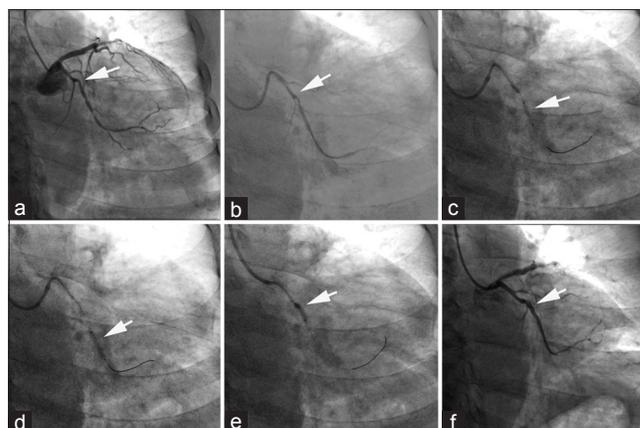


Figure 4: (a) Baseline angiography showing 80% stenosis in a highly torturous middle left circumflex and 70% stenosis in the distal left circumflex. (b) An Excel stent became stuck in the middle left circumflex lesion. (c) A deep-seated 5F “child-in-mother” catheter assisted by a 2.0 mm × 15 mm anchor balloon. (d) A 2.75 mm × 18 mm Excel stent delivered to the distal left circumflex lesion. (e) Another 2.75 mm × 18 mm Excel stent delivered to the middle left circumflex lesion. (f) Final result, TIMI III flow

The 5F “child-in-mother” catheter would be another choice in this setting, but the 5F “child” catheter can generally only be inserted into the proximal coronary artery under the support of a single 6F “mother” catheter, while encountering calcification, tortuosity, or anatomic variation, and consequently, not allow sufficient backup support for stent delivery. Rotational atherectomy would be indicated if the balloon cannot cross or dilate a calcified lesion; however, in the four cases described, all lesions could be crossed by a 2.5 mm or 3 mm diameter balloon, and all lesions could be dilated, although the stent could not cross the lesion.

In the four patients described all different techniques (except for rotational atherectomy) were attempted, but none of them was successful. Moreover, a stent was damaged while performing the anchor balloon technique in the first case. However, all target lesions were successfully stented after using the combined technique. Specifically, we first deeply inserted a 5F “child-in-mother” catheter to close the target lesion, with the assistance of an anchor balloon in the distal segment of the target vessel (generally at the lesion segment) using the pushmi-pullyu method. Then, the anchor balloon was withdrawn, and the stent was delivered through the 5F “child” catheter to the target lesion, after which the “child” catheter was pulled back, and the stent was deployed.

This technique demonstrated the following benefits. First, only one guidewire was needed inside the 5F “child-in-mother” catheter; thus, there was enough space for the stent to be smoothly delivered to the target lesion. Second, the stent could be introduced completely to the target lesion under the protection of the “child” catheter without directly

touching the calcified or tortuous vessel wall, thus, avoiding damage to or dislodging of the stent.

The GuideLiner has been reported to have similar efficacy to the “child-in-mother” catheter; however, the following shortcomings of the GuideLiner have also been observed: (1) The GuideLiner cannot be advanced >15 cm beyond the tip of the guide catheter because the metal collar of the GuideLiner can become hooked when it is pulled back;^[11] (2) because large/bulky stents can become damaged while entering the collar of the GuideLiner, low profile stents are recommended for the GuideLiner and stents >4 mm in diameter are avoided;^[8] and (3) the rod of the GuideLiner can become intertwined with the GuideLiner, thus, the stent can sometimes become stuck during delivery. In comparison, these shortcomings of the guide liner can be avoided by deeper intubation of a 5F “child-in-mother” catheter in combination with an anchor balloon. Our study has proved that the new combined technique could be very useful in patients with highly calcified, tortuous lesions, as well as those with variants in the coronary origin.

Several limitations of this new technique should be noted. (1) The deeply inserted catheter may increase the risk of ischemia when the culprit vessel is extremely small or with severe proximal lesions. In the second case, the ST segment was elevated while the 5F “child-in-mother” catheter was inserted in the proximal LAD [Figure 2]. However, we quickly delivered the stent and pulled back the “child” catheter, and there was no complication. (2) Although there was no vessel dissection from deeper insertion of the “child” catheter in the four reported cases, operators should gently manipulate the “child” catheter while it is deeply inserted into the coronary artery to avoid damaging the vessel wall which could even result in aortic dissection.^[12] Besides, the contrast injection should be gently performed. (3) The balloon should be placed at the lesion segment while anchoring the entire system to avoid damaging the normal segment of the coronary artery. In the second patient case, the anchor balloon caused a dissection within the middle LAD lesion, which was planned to be covered by a stent. However, if the anchor balloon was not anchored at the lesion site, more stents would be needed in case a dissection in a normal segment occurs. (4) When a target lesion is located in the distal part of the coronary artery, a stent with a relatively longer delivery system should be chosen because the 5F “child-in-mother” catheter extends the delivery system. In the third case, we first tried to deliver a 3.5 mm × 24 mm Partner stent, but the 1350 mm-stent delivery system of the stent was too short to reach the distal RCA lesion. Therefore, two Taxus stents with a delivery system length of 1440 mm were implanted.

Conclusion

Deeper intubation of a 5F “child-in-mother” catheter, assisted by an anchor balloon, is safe and exhibits a high success rate for uncrossable lesions with high calcification, tortuosity, or variant coronary origins.

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Conflicts of interest

There are no conflicts of interest.

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