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CASE REPORT

Recognition and Management of Incomplete Stent Expansion Facilitated by StentBoost and Guideliner Tools

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ABSTRACT

Suboptimal or incomplete coronary stent expansion is associated with increased restenosis rate and target vessel revascularization. Stent visualisation with plain fluoroscopy has become challenging due to reduction of stent strut thickness. Inability of stent or balloon delivery is a frequent cause of procedural failures in percutaneous coronary interventions. This case report highlights the role of a novel stent enhancing technique, StentBoost, in recognition and management of incomplete stent expansion and of the Guideliner catheter, which is an essential assist device in complex and challenging coronary interventions, especially via the radial access.

INTRODUCTION

Adequate stent deployment has an important effect on immediate and long-term results after percutaneous coronary interventions (PCI). Suboptimal or incomplete stent expansion is associated with increased restenosis and target vessel revascularization (TVR) rates and might also predispose to stent thrombosis.[1-3]

Stent deployment is usually performed under plain fluoroscopy, using device markers for guidance, a practice that does not eliminate the risk of stent underexpansion,[4] especially when no post-dilatation is done. The StentBoost technique (*Philips Medical Systems*) constitutes a new x-ray image enhancing technique, which provides improved stent visualization by eliminating motion artefacts.[5]

Inability of stent or balloon delivery is a frequent cause of procedural failures in coronary interventions. Different techniques to facilitate guiding catheter support and device delivery have been described (buddy wires, anchoring balloons, rotational atherectomy, etc.). The Guideliner catheter (Vascular Solutions, Inc.) is a monorail guiding catheter extension that facilitates stent delivery and is approved for providing extra support and coaxial catheter guide engagement.[6] In this case report we intend to highlight the role of the aforementioned technique and device, and therefore suggest their potential applicability.

Abbreviations
CT = computed tomography
ISR = in-stent restenosis
IVUS = intravascular ultrasound
LAD = left anterior descending (coronary artery)
OCT = optical coherence tomography
PCI = percutaneous coronary revascularization
TVR = target vessel revascularization

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CASE REPORT

An 80-year-old male, with a past medical history of hypertension, diabetes mellitus, dyslipidemia, ongoing tobacco abuse and coronary artery disease with prior PCI in the left anterior descending (LAD) coronary artery 5 years earlier due to unstable angina, presented with significant exertional dyspnea. Due to his symptoms and history of previous PCI, it was decided to proceed to coronary angiography. Coronary angiography was performed via a right radial artery access. It revealed a patent left main coronary artery, a heavily calcified LAD with 60-70% stenosis in the proximal segment, a 90% stenosis inside the old stent consistent with in-stent restenosis (ISR) due to intimal hyperplasia, followed by subtotal occlusion in the distal segment (Fig. 1). The left circumflex coronary artery was free of significant stenoses. The first diagonal branch had a 60-70% ostial stenosis. The right coronary artery was significantly calcified and had 60-70% stenosis in the proximal portion.

The decision was made to perform PCI at the significant ISR 90% lesion of the mid-LAD. The left main was engaged with a 6 French XB 3.5 (Cordis, Vistabrite, USA) guiding catheter. A hi-torque PILOT 50 guidewire 0.014 inch (Abbott Vascular, USA) was advanced into the distal LAD. A non-compliant Sprinter NC RX balloon 2.5x12 mm (Medtronic, USA) failed to advance through the lesion, due to insufficient back-up support of the guiding catheter, and vessel's calcification and tortuosity. Subsequently, the "mother and child" technique was used, with the Guideliner catheter (Vascular Solutions, Inc.) advanced into the LAD just proximal to the stenosis. The catheter provided greater support and facilitated the advancement of the balloon to the lesion.

With the balloon markers located within the lesion, the stent enhancing technique "StentBoost" was used. Visualization of the stent revealed that this lesion was not due to ISR but due to insufficient expansion of the previously implanted stent, which was not apparent on plain cine-angiography (Fig. 2). The lesion was dilated with use of the 2.5x12 mm non-compliant balloon followed by further inflation of a 3.25x12 mm non-compliant balloon NC Sprinter RX (Medtronic, USA) (Fig. 3, 4) with excellent angiographic result (Fig. 5, 6). The angiographic result was verified by the StentBoost technique, which revealed a complete stent expansion after plain balloon angioplasty (Fig. 7). One year later the angiographic review of the patient's vessel showed no restenosis of this lesion.

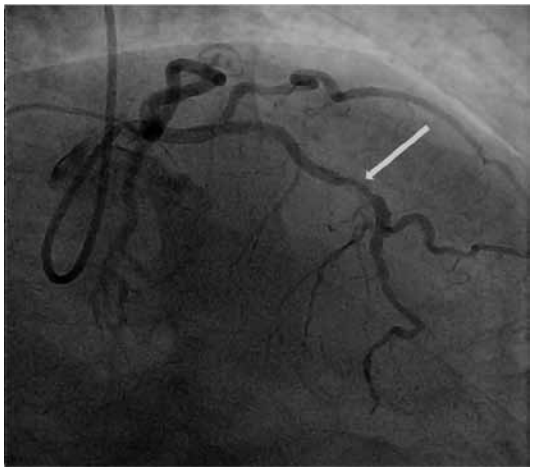

FIGURE 1. The left anterior descending (LAD) coronary artery with 90% stenosis inside the stent (white arrow) that resembled in-stent restenosis (ISR), as it was apparent in coronary angiography.

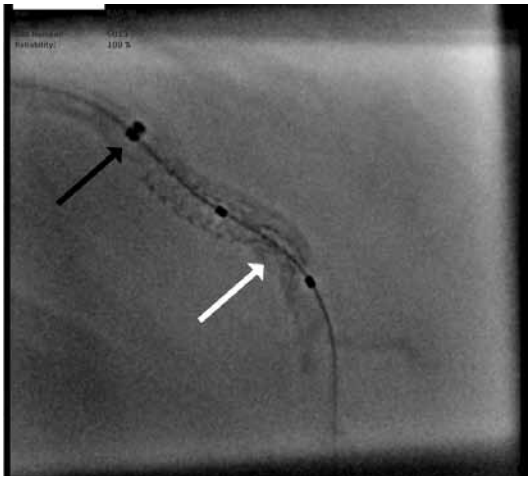

FIGURE 2. Incomplete stent expansion and severe calcification surrounding the stent (white arrow) as it was visualized by the stent enhancing technique, StentBoost .The black arrow indicates the Guideliner catheter (StentBoost image).

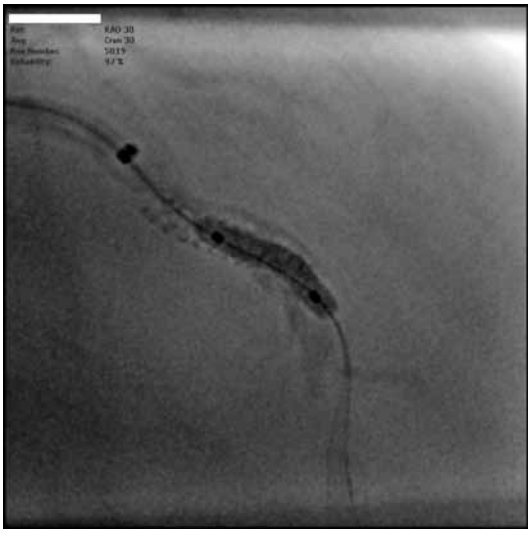

FIGURE 3. Angioplasty of the lesion with non-compliant balloons. (StentBoost image).

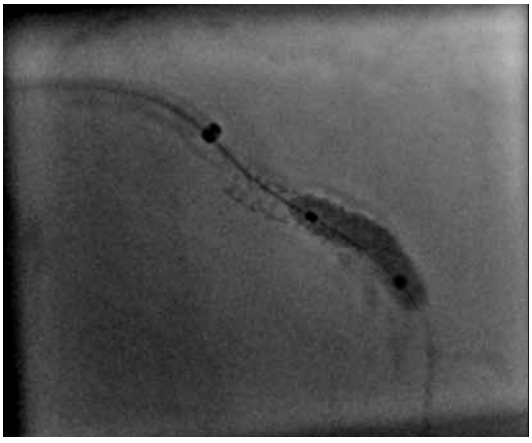

FIGURE 4. Angioplasty of the lesion with non-compliant balloons (StentBoost image).

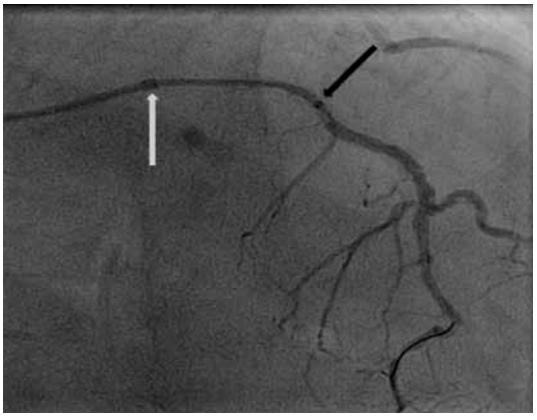

FIGURE 5. The "mother and child" technique with use of the Guideliner catheter (black arrow) provided great back-up support for performance of angioplasty from right radial access. The white arrow indicates the guiding catheter.

FIGURE 6. Excellent angiographic result was achieved after plain balloon angioplasty.

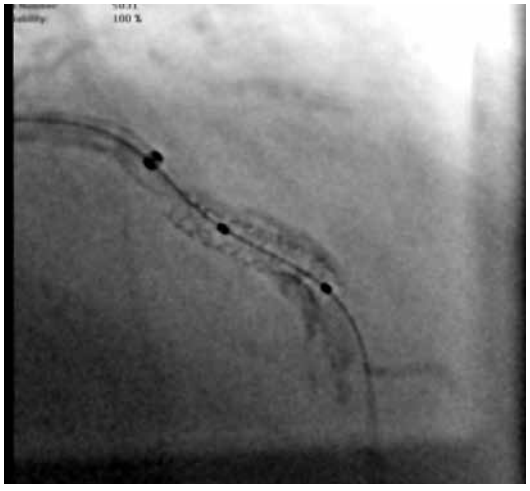

FIGURE 7. Complete stent expansion established by stent enhancing technique StentBoost.

DISCUSSION

In the new stent era, adequate stent deployment and optimal stent expansion are the cornerstones of successful PCI and reduction of target lesion revascularization due to restenosis and acute stent thrombosis. Stent visualisation with plain fluoroscopy has become challenging due to reduction of stent strut thickness and has its shortcomings. The StentBoost technique (*Philips Medical Systems*) aids us to overcome these disadvantages by enhancing stent visualisation. It requires detectable radiopaque markers inside the stent located on a balloon. Single standard cine acquisition of 2 seconds at 30 frames per second, with no contrast media injection is enough to enhance the stent. The StentBoost technique enhances the image by integrating series of non-contrast images from a single run by balloon marker motion compensation. StentBoost Substract is another mode of this technique which is automatically generated from cine acquisition at 15 frames per second, consisting of 2 seconds without contrast agent injection followed by 2 seconds with contrast injection at a rate of 3 ml/sec with total amount 6 ml of contrast agent. The enhanced subtracted image shows improved contrast of the stent and indicates the relation between the location of the stent and the vessel wall. The visualization dynamically fades in and out, between the stent image and the vessel image, in order to show the relationship between the two.[7]

As demonstrated in our case report, the StentBoost technique can reveal significant details about the structure and the

deployment of the stent. Nevertheless, the diagnosis of stent underexpansion was made only after the advancement of the balloon into the stent. Subsequently, the treatment strategy was altered since the final diagnosis was inadequate stent deployment that needed high-pressure dilatation rather than ISR that would have invoked the use of a different treatment, such as drug eluting balloon or stent-in-stent implantation. Especially in this case, the diagnosis was almost impossible to make with standard cine acquisition imaging, due to severe calcification surrounding the stent. Perhaps imaging with use of intravascular ultrasound (IVUS) or optical coherence tomography (OCT), if the dedicated catheters could be advanced inside the lesion, or coronary CT angiography could have revealed the exact nature of the lesion but only after underexpansion had been suspected.

Except of the aforementioned applications, this StentBoost technique can serve as an essential tool in challenging cases, like bifurcation lesions where it shows accurately the relationship between both stents and facilitates the recrossing of the guidewire into the side-branch through the optimal stent strut of the main branch, or in diffuse long lesions where more than one stent are implanted and accurate stent overlap is mandatory. Additionally, it provides valuable information about the morphology of the stent and therefore of restenosis cause (stent fracture, deformation, underexpansion).

Optimal ostial engagement and great back-up support of guiding catheters are required for challenging PCI procedures.[8] Despite the improvements on crossing profile of the newer coronary devices, in about 5% of cases stent delivery is unsuccessful and is one of the main causes of procedural failure.[9] The "5 in 6", "mother and child" technique with use of the Guideliner catheter (*Vascular Solutions, Inc.*) involves a rapid exchange guiding catheter extension that facilitates stent and balloon delivery and is approved for providing extra support and coaxial guide engagement.[6] The GuideLiner's highly flexible rapid exchange section allows interventional cardiologist to use standard length guidewires, balloons or stents through an existing hemostatic valve without the need to disconnect from the mother guide. The device is compatible with standard guiding catheters and results in an internal diameter approximately 1French size smaller than the guiding catheter. When the radial access as in our case is preferred, the angle of entry from the radial approach into the aortic sinus renders sometimes coaxial guide placement difficult. In our case the Guideliner catheter facilitated the successful coaxial placement of the guiding catheter and by "deep-throating" into the LAD, offered excellent back-up support for the delivery of non-compliant balloons through the tortuous and heavily calcified artery. If a new stent was deemed necessary, its insertion could have been greatly facilitated by this technique.

Despite the soft tip of the catheter, it should be mentioned that the risk of dissection with deep intubation into a coronary vessel is not negligible, with reported rates of 0.5%-1%,[6] particularly in the presence of proximal segment disease or an anomalous origin of the vessel. Inability of advancement and possible damage especially of high profile stents due to wire wrap around the metal collar of catheter, is another limitation of this device which should be kept in mind. Rare potential complications from Guideliner's use are also air embolism, vessel's thrombosis and arterial spasm.

CONCLUSION

Novel techniques and devices have permitted PCI operators to constantly face more complicated and challenging cases. StentBoost is a novel stent enhancing technique which provides enhancement of the image and better stent visualisation than cine-angiography. In the present case it identified incomplete stent expansion as a cause of an angiographic image mimicking ISR and verified adequate stent deployment after angioplasty, without significant amount of extra contrast or radiation.

The Guideliner catheter is an easy to use guiding catheter extension that greatly facilitates backup support, optimal ostial engagement and device delivery, possible in complex procedures especially via the radial access with 6 French guiding catheters, which otherwise might have failed. Both StentBoost technique and Guideliner catheter are safe, simple, cost-effective and can be applied in daily clinical practice.

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