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### Extra-stent subintimal plaque modification; a novel technique to overcome resistant stent underexpansion

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## Cardiovascular Revascularization Medicine



## Extra-stent subintimal plaque modification; a novel technique to overcome resistant stent underexpansion

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Resistant stent underexpansion remains common in current interventional cardiology despite the use of intravascular imaging and lesion modification modalities. It can be very challenging to treat with the available tools. We present a novel technique to overcome resistant stent underexpansion after failure of the available methods.

A 56-year-old man had a recent percutaneous coronary intervention (PCI) to the right coronary artery (RCA) with underexpanded stents. He presents for PCI of the stent underexpansion and in-stent restenosis for medical refractory angina. He had failed previous attempts to expand the stents using high-pressure non-compliant (NC) balloon inflation; peripheral intravascular lithotripsy (IVL) (4.0 mm balloon, Shockwave, USA); laser atherectomy on contrast at 80 mJ/mm<sup>2</sup> and 80 Hz; and high-pressure Chocolate balloon (Medtronic, USA) (Fig. 1-A, Video 1). Intravascular ultrasound showed severely underexpanded stent with fibro-calcific plaque (Fig. 1-B).

We performed the second procedure using an 8-Fr. XB-RC guide catheter through right femoral access. Coronary IVL with a 4.0 × 12 mm balloon failed to expand the stent. Attempt to ablate the stent using peripheral orbital atherectomy 1.25 mm Solid Crown (CSI, USA) also failed (Fig. 1-B, Video 2). We decided to perform extrastent plaque modification (eSPM) (Fig. 2). We maintained wire access into the true lumen and placed a 4.0 mm NC balloon inside the stent. We used a Gaia Next III wire (Asahi Intecc, Japan) with an additional 4 mm shape to access the subintimal space (Fig. 1-C, Video 3). We exchanged to a Gladius Mongo wire (Asahi Intecc) over a Turnpike Spiral microcatheter (Teleflex, USA), that had a tiny umbrella shape and was knuckled in the plaque (Fig. 1-D, Video 4), over which we inflated 1.5 mm and 2.0 mm balloons followed by inflation of the intrastent 4.0 mm NC balloon (Fig. 1-E, Videos 5 and 6). Then we removed the extrastent wire and balloon and performed final balloon inflation with a final good expansion of the stent (Fig. 1-F, Video 7).

Our case demonstrates how eSPM can treat resistant underexpanded stents. The steps to perform it are as follows: 1) maintain wire

access into the true lumen with a 1:1 sized NC balloon in place as advancing the balloon after modification might be challenging, 2) access the subintima with a non-polymer jacketed tapered stiff wire (e.g., Gaia Next III wire) for only a few millimeters inside the plaque, then de-escalate to a stiff polymer-jacketed (PJ) wire that can be knuckled within the plaque. The knuckled wire would help modify the plaque and provide rail for advancing the smaller balloons, 3) inflate small balloons over the PJ wire followed by inflation of the NC balloon in the true lumen, and then simultaneously inflate both balloons, 4) remove the gear from the extra-stent area and perform final inflation of the NC balloon within the vessel.

The technique presented provides a bailout method for resistant stent underexpansion not responding to conventional and non-conventional methods including ablating the stent with atherectomy and IVL. Although IVL therapy provided a considerable advantage for the treatment of stent underexpansion, the pulse force generated might not always transmit through stents; and fibrotic non-calcified plaques do not usually respond to IVL [1]. This technique can be specifically helpful in patients with fibrotic or fibrocalcific plaques that would not readily respond to IVL. The disruption of the plaque with the knuckled wire and balloon inflations would help loosen the plaque and allow the stent to finally expand.

Although external crushing of the stent after reentry has been proposed, reentry into the true lumen can be challenging in calcified and fibrotic vessels with underexpanded stents. Moreover, external crushing adds another metal layer, which along with a bulky crushed stent, has unknown long-term outcomes. Our technique can be helpful as a last resort in resistant stent underexpansion.

Given the disruption of the extra-stent plaque area and difficulty in distinction between the plaque and the subadventitial space, our technique can be associated with a high-risk of perforation. The benefits of the technique should be weighed against the risk, especially in patients with higher risk of perforation including older patients and those with connective tissue disease. The described technique should be performed by operators who are familiar with chronic total occlusion percutaneous coronary intervention techniques such as “Scratch and Go,” and “wire knuckle” and who are ready to provide bailout treatment for vessel perforation. Further studying of the efficacy and safety of the technique is also warranted.

Abbreviations: PCI, percutaneous coronary intervention; CTO, Chronic total occlusion.

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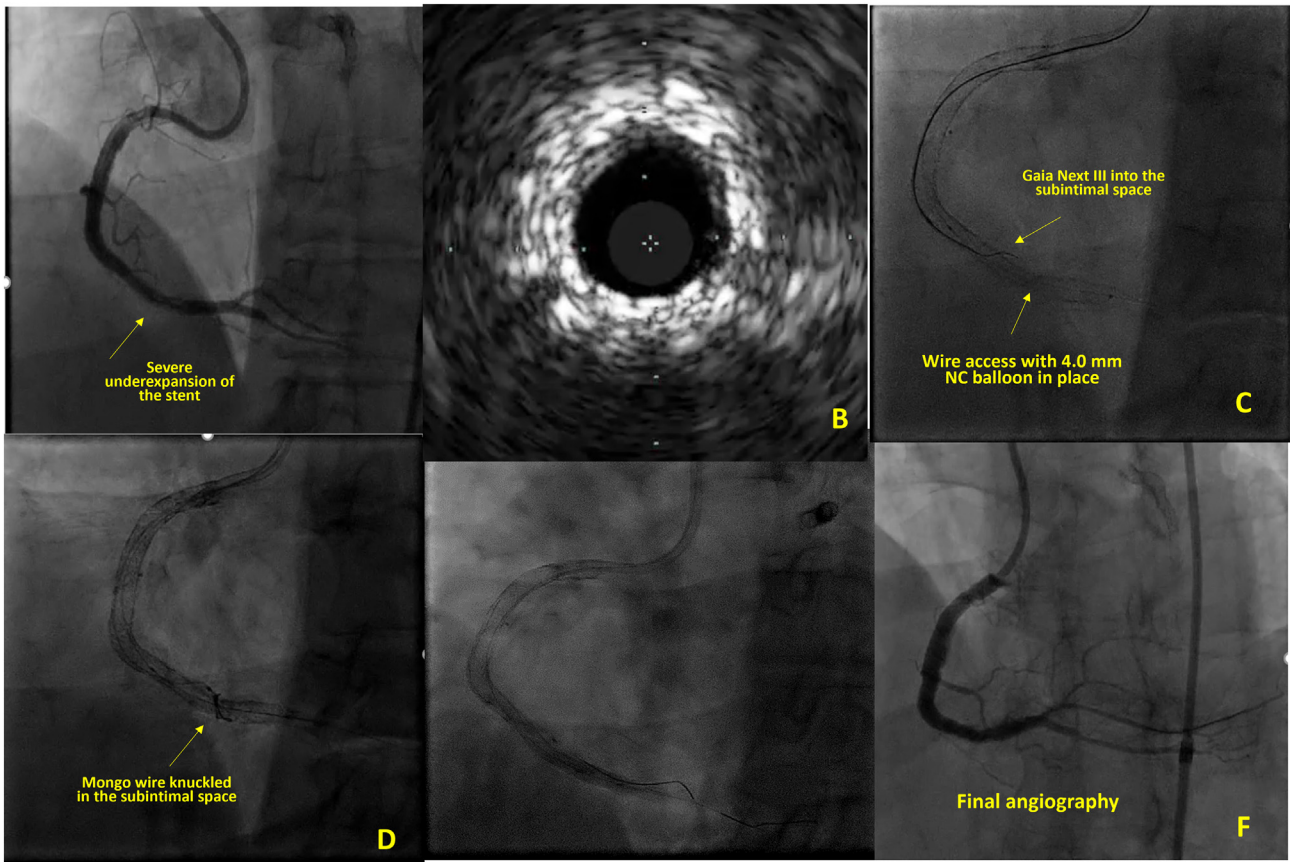
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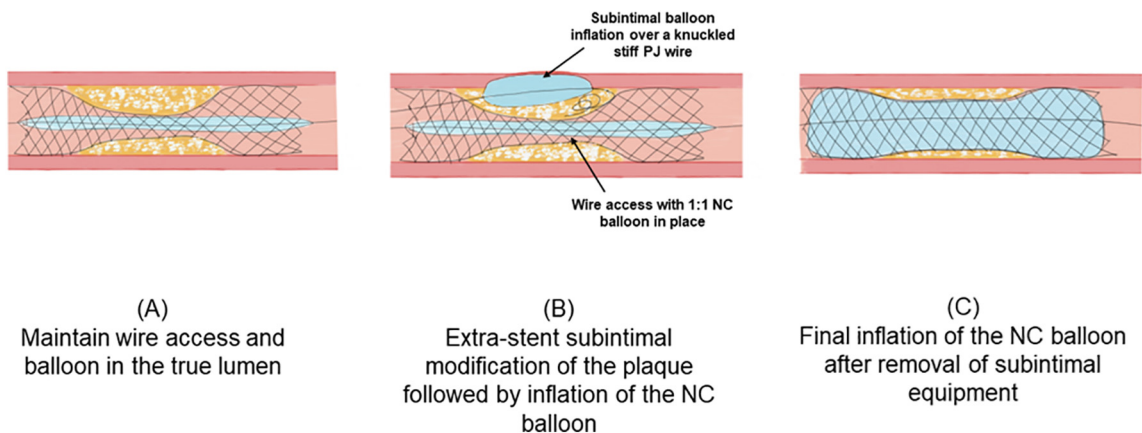
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**Fig. 1.** Treatment of resistant underexpanded stents in the right coronary artery  
Resistant underexpanded stent in the distal right coronary artery (RCA) (A); Peripheral orbital atherectomy failed to expand the stent (B); Extrastent subintimal plaque modification starts by gaining access into the subintimal space with a penetrative wire and a microcatheter (C); followed by knuckling of a stiff polymer-jacketed wire (D), and inflation of small balloons to modify the plaque then inflation of the 1:1 mm non-compliant balloon (NC) within the true lumen followed by simultaneous balloon inflations (E); with good final angiographic result (F).  
NC: non-compliant; PJ: polymer-jacketed; NC: non-compliant.

**Extra-stent subintimal plaque modification in resistant stent underexpansion**



**Fig. 2.** Illustration of the extrastent subintimal plaque modification technique  
PJ: polymer-jacketed; NC: non-compliant.

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