Letter to the Editor

What is The Next Step When a Non-Compliant Balloon Does Not Pass through a Freshly Deployed Stent?

In coronary intervention practice, optimal stent deployment in terms of adequate expansion and complete apposition is of paramount importance to obtain favorable immediate and long-term results. Even with the introduction of stent delivery systems based on a semi-compliant balloon allowing stent deployment at higher pressures (≥ 14 atm), adjunctive post dilation with a non-compliant (NC) balloon at very high pressures (≥ 20 atm) is still necessary to optimize the result in a vast majority of cases. After the introduction of drug-eluting stents, this issue has been highlighted in order to reduce restenosis and prevent the devastating event of stent thrombosis.[1]

Nevertheless, advancing the NC balloon across the proximal edge or body of a freshly deployed stent might prove challenging in some situations. NC balloons have a higher profile than do regular balloons, but some other mechanisms are responsible for snagging NC balloons in a coronary artery segment that is widely open after stent implantation. One mechanism is that in some instances (long stenting or bifurcation stenting), we size the stent according to the distal reference lumen diameter and aim to optimize the result in the proximal part using a bigger NC balloon. In this situation, the NC balloon may get stuck to the proximal edge of the stent, which is already mal-apposed. This is especially true when the coronary artery has some tortuosity proximal to the stent site, which forces the tip of the balloon to point toward the edge rather than toward the center of the stent due to the wire bias created by the vessel tortuosity. Another issue is the friction between the balloon and the stent struts itself particularly when the stent has been deployed after a tortuosity or in a curved coronary artery in which the wire bias phenomenon develops as well.

Numerous techniques have been described to help overcome difficult device delivery (mainly stent delivery) across the coronary arteries. These techniques are implemented to overcome the difficult delivery of NC balloons across the stents as well. They include the buddy wire technique,[2] buddy balloon technique,[3] balloon deflection technique,[4] having the patient take a deep breath during the balloon delivery,[5] dottering technique, rotating the balloon catheter while advancing it, inflating the balloon with 1-2 atm, and changing the wire position to a different direction.[6] In the buddy wire technique, a second wire of the extra support and/or hydrophilic type is advanced along the first one through the stent in order to straighten the proximal tortuous coronary segment as well as providing more support for balloon tracking.[2, 6] In the buddy balloon technique, a regular balloon is advanced beyond the stent in the distal artery over a second wire; the shaft of this balloon can straighten the coronary artery more effectively than can a second wire alone. Furthermore, the operator can inflate this balloon to entrap the first wire in the distal coronary segment. By pulling the first entrapped wire, the operator can advance the NC balloon across the stent thanks to the reduced bias of this taut wire.[3, 6] In the balloon deflection technique, a second regular balloon is advanced up to the proximal edge of the stent, which occupies the potential mal-apposed space and causes the NC balloon to deflect from the edge of the stent; thereby allowing it to cross. This deflector balloon can also be inflated with 1-2 atm in order to provide a stronger platform.[4, 6] In the deep inspiration technique, the patient is requested to take a deep breath during the balloon delivery. During this maneuver, the diaphragm and heart are displaced into a more vertical position, which causes the coronary tree to somewhat straighten and reduces the vessel tortuosity, particularly in the proximal parts leading to reduced wire bias.[5] In the dottering technique, the NC balloon is dottered gently by forward and backward movements near the proximal edge of the stent. These forward and backward movements bounce the indwelling wire up and down, reducing the wire bias and opening a window of opportunity to advance the balloon successfully. It is worthy of note, however, that this technique only works in vessels of enough diameters, which allow the bouncing of the wire. The other proposed technique is to rotate the balloon catheter while advancing it, which might allow the balloon to enter the stent through the rotational energy produced. This maneuver could potentially lesson the wire bias transiently. Inflation of the balloon with 1-2 atm can also centralize the wire at the stent lumen and facilitate the balloon crossing. Finally, changing the wire direction by steering it to a side branch out of the main vessel after exiting the stent might also reduce the wire bias and help to advance the balloon.[6]

As was mentioned, the main mechanism for a majority of these techniques is that they tend to lessen the wire bias, which directs the balloon away from the stent struts and facilitates the balloon delivery. Another option is the use of the Hi-Torque Wiggle Wire™ (Abbott Vascular, Santa Clara, CA, USA) with its unique feature of 60 mm of sinusoidal shaping, which starts 60 mm from the distal tip. It may help

to reduce friction by altering the angle of contact between the balloon and the body of the stent. However, the Wiggle Wire™ should usually be introduced distally in the coronary artery by exchanging via a micro catheter or an over-the-wire balloon because the sinusoidal portion of the wire reduces its steerability.[7] The other proposed method is the use of Rotaglide™ (Boston Scientific, Natick, MA, USA) solution for application on the balloon surface; this lubricant is originally used in rotational atherectomy procedures to reduce the catheter friction.[8] Furthermore, using very short NC balloons may also be helpful in this respect. Although the deep seating of the guiding catheter for additional back-up support could be considered for this purpose,[6, 9] the operator should bear that in mind that a forceful delivery may lead to the stent edge deformation or dislodgement or catheter-induced coronary dissection if this maneuver is successful at all. In brief, one or a combination of the aforementioned techniques could be helpful to overcome the difficult balloon delivery by straightening the coronary artery segment proximal to the stent site and/or the stented segment itself, which directs the NC balloon away from the stent struts or some other mechanisms, altogether culminating in reduced friction forces. These strategies are time-consuming and increase the costs, and may potentially complicate the procedure or eventually fail.

NC balloons not only have a higher profile but also are much less flexible than are regular balloons because of their different material (polyethylene terephthalate versus polyolefin copolymer, respectively). But what matters in this scenario is not the profile of the balloon because the artery is already widely open after stent implantation. In our experience, the pivotal mechanism which impedes the balloon from passing through the stent is the rigidity of the NC balloon. This rigidity adds to the wire bias and causes the tip of the balloon to become snared at the proximal edge or within the stent struts. We propose a simple trick with no added cost which almost always overcomes this issue: just inflate the balloon with a few atmospheres outside the stent (e.g., out of the body, in the guiding catheter, or in the coronary artery itself, proximal to the stent site) and deflate it. It will be passed easily in its re-wrap form. The essential mechanism is that the NC balloon is more flexible in its re-wrap form, which makes it more trackable. Furthermore, some folding in the balloon surface is created (wings), which alters the angle and the area of contact between the balloon and the stent struts in a manner which lowers the friction forces. What is noticeable is that the winged balloon, albeit with a higher profile, passes much more easily through the stent because it is more flexible and has less friction with the stent struts.

In our experience, we have succeeded in passing the balloon easily using only this method in cases where some of the other techniques have failed, except for one patient. In this patient, we aimed to post dilate the right coronary artery with a full metal jacket and we were forced to implement this method along with the buddy wire technique so as to be able to pass through the second curve of the artery.

In conclusion, we propose that this simple and safe technique be employed as the first choice in this scenario and that the other techniques be used only in patients for whom this technique cannot work on its own.

References

1. Romagnoli E, Sangiorgi GM, Cosgrave J, Guillet E, Colombo A. Drug-eluting stenting: the case for post-dilation. JACC CardiovascInterv 2008;1:22-31.
2. Jafary FH. When one won't do it, use two-double "buddy" wiring to facilitate stent advancement across a highly calcified artery. Catheter CardiovascInterv 2006;67:721-723.
3. Li SS, Cheng CW. Coronary angioplasty on an impassable calcified stenosis using a buddy balloon technique. Catheter CardiovascInterv 2004;62:35-37.
4. Abernethy WB, 3rd, Choo JK, Oesterle SN, Jang IK. Balloon deflection technique: a method to facilitate entry of a balloon catheter into a deployed stent. Catheter CardiovascInterv 2000;51:312-313.
5. Attaran RR, Butman S, Movahed MR. Going around the bend: deep inspiration facilitates difficult stent delivery in the native coronary arteries. Tex Heart Inst J 2011;38:270-274.
6. Nguyen TN, Hung PH, Huy DD, Khuong HK, Bakraceski N. Stenting. In: Nguyen TN, Colombo A, Hu D, Grines CL, Saito S, eds. Practical Handbook of Advanced Interventional Cardiology: Tips and Tricks. Cambridge, MA: Blackwell Scientific Publications; 2008. p. 96-117.
7. Simons AJ, Caputo RP, Gaimbartolomei A. Successful placement of a stent in a previously treated un-stentable vessel segment, made possible by the ACS Hi-Torque Wiggle Wire: a case report. J Invasive Cardiol 2004;16:28.
8. Chan AW, Ramee SR, Collins T, Quintana H, White CJ. Rotaglide-facilitated stent delivery: mission accomplished. Catheter CardiovascInterv 2003;59:477-481.
9. Bartorelli AL, Lavarra F, Trabattoni D, Fabbiocchi F, Loaldi A, Galli S, Montorsi P. Successful stent delivery with deep seating of 6 French guiding catheters in difficult coronary anatomy. Catheter CardiovascInterv 1999;48:279-284.

Arash Gholoobi,
Assistant Professor of Cardiology,
Atherosclerosis Prevention Research Center,
Imam Reza Hospital,
EbneSina Ave.,
Mashhad,
Iran.
9137913316.
Tel: +98 511 8544504.
Fax: +98 511 8544504.
E-mail: gholoobia@mums.ac.ir.