EDITORIAL COMMENT

Drug-Eluting Stent Implantation

Technique Matters, More Than Ever*

Bernard De Bruyne, MD, PhD, Emanuele Barbato, MD, PhD
Aalst, Belgium

In 1995, Colombo et al. (1) demonstrated, with intravascular ultrasound (IVUS), that stent implantation could be safely performed without anticoagulation, provided the stent was thoroughly apposed against—actually impacted in—the arterial wall. The media-to-media principle has since then been considered a prerequisite of good stenting and has been extended into the concept “the bigger the better.” Nevertheless, several studies indicated that, on the basis of IVUS, malapposition and/or underdeployment was present in approximately 20% after implantation of bare-metal stents (BMS). In addition, malapposition emerged as the main underlying mechanism of restenosis and stent thrombosis. Paradoxically, a decade later, in the era of drug-eluting stents (DES), it seems that this rate of underexpansion and malapposition further increased. It seems as if interventionalists, falsely reassured by the potent antiproliferative properties of DES, had neglected the lessons brought by IVUS in the BMS era and counted on the drug to ascertain stent patency and favorable clinical outcome. Therefore, the present reminder by Romagnoli et al. (2) in this issue of JACC: Cardiovascular Interventions is very timely. It is a plea for IVUS-guided post-stent dilation with noncompliant balloons.

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Reasons for Stent Malposition/Underexpansion

Romagnoli et al. (2) review and discuss the possible determinants of suboptimal stent deployment. The factors that are easiest to quantify relate to the relative physical properties of the atherosclerotic vessel wall and of the balloon catheters. Yet, the most frequent reason for malapposition/underexpansion is highly operator-dependent, namely undersizing of the stent. The choice of a too-small stent often relates to a tentative approach of the arterial segment to be treated. The impression often prevails that with the choice of an undersized stent, one stays on the safe side. This is a shortsighted view, compounded by the lack of regular IVUS documentation of the post-stent result. How often is the difference between the views from the inside (IVUS) and from the outside (angiography) surprising? Undersizing is further favored by direct stenting. Tight stenoses preclude marked increase in flow. This, in turn, translates into the absence of endothelial stimulation by high shear stress, ultimately leading to negative remodeling of the proximal and distal part of the arteries (3). In addition, the distal part of the artery might be underpressurized and, therefore, not subject to normal distension forces. Even after administration of nitrates, these arteries maintain a relatively small caliber. Finally, in the case of critical stenoses, reduced antegrade flow and competitive collateral flow lead to poor angiographic visualization of the distal part of the vessel. The ignorance of these basic physiological principles produces a gross underestimation of the original vessel dimensions and might contribute to undersizing of the stent. Pre-dilation, by reestablishing near-normal coronary hemodynamic status, avoids many of these pitfalls. Pre-procedural IVUS and quantitative coronary angiography will be of little help in appreciating these dynamic phenomena without prior pre-dilation.

Noncompliant Balloons for Post-Dilation: Rationale and Results

Romagnoli et al. (2) rightly point out the advantages of using noncompliant balloons rather than overstretching (semi-)compliant balloons to post-dilate the stented segment. As compared with compliant balloons, noncompliant balloons not only have a flat relationship between the changes in applied pressure and the changes in observed volume (ΔV/ΔP, the definition of compliance) but, most importantly, also tolerate 50%-larger inflation pressures. These combined properties allow greater forces to be applied at the often highly noncompliant stenotic segment without taking the risk of overstretching other parts of the diseased segment (4). In contrast to compliant balloons, the diameter of noncompliant balloons is predictable and (almost) constant over their whole length, even at very high pressures. In the interventionalist’s toolkit, noncompliant balloons represent high-precision tools as compared with their compliant counterpart. Even though the clinical benefit of stent post-dilation with noncompliant versus compliant balloons has never been specifically confirmed, Romagnoli et al. (2) gather convincing indirect arguments...
supporting not only the notion that stents, including DES, should be adequately sized and post-dilated, but also that this post-dilation is safer and more efficacious when performed with noncompliant balloons. With DES, probably even more than with BMS, careful attention to implantation technique is of paramount importance (5).

**Clinical Usefulness of IVUS After Stent Implantation**

There is no doubt that IVUS has greatly contributed to our understanding of the coronary atherosclerotic process. Aspects such as the discrepancy between angiographic and ultrasonic imaging, diffuseness of the disease, remodeling of the vessel wall, and composition of the stenotic segments, among others, have been highlighted by IVUS. In addition, the mechanisms leading to restenosis and stent thrombosis have largely been unraveled by IVUS. Yet, a diagnostic tool can be considered clinically useful in individual patients if: 1) its result triggers a change in the individual decision-making process; and 2) this change, in turn, contributes to a better clinical outcome for the patient. Intravascular ultrasound definitely fulfills the first requirement but has never been able to convincingly demonstrate the second. The aim of the AVIO (Angiography Versus IVUS Optimisation) study alluded to by Romagnoli et al. (2) is precisely to compare the long-term clinical outcome of an angiography-guided with that of an IVUS-guided strategy for DES implantation. This study will use novel and more stringent criteria to define optimal stent implantation.

Awaiting these results, let’s not forget the lesson of IVUS: a rigorous implantation technique is paramount, also in the DES era.

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**REFERENCES**