

## EDITORIAL COMMENT

# Drug-Eluting Stents

## Careful Deployment Required\*

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The question of adequate deployment or optimal expansion of coronary stents has been with us since the very beginning. On the one hand, it is well documented that stent underexpansion, or malapposition, both for bare-metal stents as well as drug-eluting stents (DES), is related to adverse events including stent thrombosis and stent restenosis (1–3). Yet, on the other hand, overexpansion of a stent is not without its problems, such as compromise of jailed side branches, strut fracture, and distal and proximal dissections jeopardizing large branches. So although most interventionists deploy a stent at high pressure, or post-dilate a stent with high pressure balloons at least once, there likely is a quite natural hesitation not to overexpand the stent in doing this. Moreover with DES, there may also be a complacency that has grown up to “let the drugs do their work.” That is, just get the stent struts into contact with the arterial wall in the expectation that neointimal hyperplasia will be inhibited, and the antiplatelet therapies will prevent any stent thrombosis. Taking the time to expand a coronary stent to its completely adequate and optimized size, using extra angiographic injections or intravascular ultrasound (IVUS) to assess and reassess the results several times over, perhaps has come to be seen as an unnecessarily time-consuming and possibly dangerous practice.

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Proponents of IVUS have long suggested its routine use in stent procedures to check for adequate deployment. To its great credit, IVUS has yielded many critical insights into mechanisms of arterial wall injury and healing responses, as well as stent-vessel wall interactions (4). Generally speaking, when post-deployment IVUS is performed after stenting, it leads to more frequent post-deployment dilations using more higher-pressure balloons. This is 1 way to help achieve ade-

quate stent expansion and avoid underexpansion. Yet proponents of angiography-only for stent deployment point out the increased procedure time and extra costs associated with routine IVUS use, along with the multiplicity of definitions, its unavailability in many institutions, and the lack of randomized trial data showing any clinical benefit (5).

In this issue of *JACC: Cardiovascular Interventions*, Liu et al. (6), from the Cardiovascular Research Foundation at Columbia University, have added a small but important additional piece to a very complicated puzzle. They identified from their extensive database 3 groups of patients: a group of 20 patients with definite DES thrombosis, a group of 50 risk-factor-balanced patients with DES restenosis but no thrombosis, and another group of 50 risk-factor-balanced patients with neither of these outcomes. Of note, the time interval from DES implantation until stent thrombosis was a median of 9 days in that group, so these were mostly early stent thrombosis cases, although it was a skewed distribution and some thrombosis events did occur later. The median follow-up intervals for the other 2 groups (restenosis and event-free) were both a little over 8 months, which is sufficient. The main finding was that there was a gradation in adequacy of DES expansion as assessed using IVUS. The group with the least adequate stent expansion (most underexpansion) was the DES thrombosis group. At the other extreme, the group with the most adequate DES expansion (least underexpansion) was the group with no events. The DES restenosis group occupied a middle position in terms of expansion adequacy. The analysis also suggested that there was a gradation in diffuseness of DES expansion across the 3 groups, with more diffuse underexpansion found in the thrombosis group.

The final finding that is of note here was that the proximal segments of the stents were more underexpanded than the distal segments. This might suggest that the natural tendency is to “size” the stent to the distal arterial dimensions alone and pay less attention to the more proximal arterial dimensions. Thus the initial stent deployment and any post-dilations that are done are aimed to ensure that adequate stent expansion is achieved at the distal edges, perhaps leaving the proximal stent segments underexpanded in relation to the vessel wall. Given the commonplace fears of arterial dissections due to overexpansion in the distal segments, this unilateral focus of attention would not be unexpected.

What can 120 coronary stent cases teach us? The current paper by Liu et al. (6) serves as a reminder that proper stent deployment techniques are forever necessary. Good clinical results depend not only upon the drugs we use, whether the antiproliferatives on the DES or the antiplatelet agents taken orally, but also depend on taking the necessary time to do the procedure carefully. Inadequate deployment is responsible for at least some of the adverse clinical events of thrombosis and restenosis that continue to haunt us. Adequate stent expansion throughout the entire stent length

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must be the goal. All of this might mean a greater use of IVUS to check for optimal stent expansion. The devotees of IVUS will continue to champion this approach, and for those who prefer IVUS but have been constrained by outside forces, the justification for IVUS has never been greater. For those who prefer angiography, it might mean spending additional minutes studying the post-deployment angiogram carefully, or perhaps obtaining 1 or 2 additional angiographic views and studying them in equally great detail. It likewise seems reasonable to pay more attention to the adequacy of stent expansion in the proximal stent segments. There are pre-clinical and early clinical data suggesting that a more prolonged stent delivery inflation time (60 s) can help achieve optimal DES expansion (7,8). This needs to be confirmed in larger series but is a newer approach. Only by taking the necessary time and paying close attention to detail will we be able to reduce the contribution that inadequate DES expansion makes to these insidious phenomena.

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