EDITORIAL COMMENT

Long Lesions, Long Stents and the Long Process of Stent Optimization*

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“It is vain to do with more what can be done with less.”
—William of Occam

In the past few years, we have witnessed a dramatic proliferation in the use of stents as a treatment for symptomatic coronary artery disease. Stents now account for over 60% of catheter-based coronary interventions in the U.S. In 1998, 500,000 patients were treated with stents (1). Several factors have contributed to this explosive increase: the reassuring early results achieved with stenting, leading to a reduction in the number of emergency bypass operations and obviating the need for surgical standby (2,3); the decrease in the incidence of stent thrombosis and bleeding complications after the procedure with the administration of antiplatelet therapy (4,5) after the emergence of the key role of platelets in this complication (6); and the demonstrated advantage of stenting over plain percutaneous transluminal coronary angioplasty (PTCA) in terms of restenosis and restenosis-driven events for an increasing number of indications (7,8). Despite overwhelming enthusiasm, coronary stent placement is still an immature technology (9). The report of Kobayashi et al. (10) in this issue indicates that the gauging process of stent placement is far from complete. Before declaring the plain balloon dead and ready to bury (11) or before calling the balloon back (3) to dethrone the stent, we need to learn much more about how to improve the outcome of patients undergoing stent implantation, and the study of Kobayashi et al. (10) helps to achieve this goal.

Choosing the right stent deployment strategy. The stent deployment strategy used by Kobayashi et al. (10) was based on high pressure balloon inflation (~17 atm on average); intravascular ultrasound (IVUS) guidance was used in half of the cases. High pressure balloon inflation was proposed by the same investigators (18), embraced by the large interventional cardiology community and ultimately highly recommended by the American College of Cardiology Expert Consensus Document on Coronary Artery Stents (19). By the end of their study (10), we are informed that the overall restenosis rate in the 743 lesions angiographically reinvestigated at six months was 32%. Because high pressure inflation was the only strategy used in this study, the data provided do not allow identification of its contribution to the overall result. In fact, from the beginning, the high pressure inflation technique was so attractive that it was adopted without hesitation, even though there was no strong evidence to support its use. Only recently, in a randomized trial of patients receiving balloon-expandable stents of multicellular design, it was found that balloon inflation with a pressure comparable to that used in the study of Kobayashi et al. (10) was not associated with any appreciable benefit, as compared with pressures in the range of 8 to 13 atm (20). The issue of optimal stent deployment becomes even more complicated considering that despite the attractive background and a multitude of investigations during this decade, the advantages of the IVUS guidance remain to be proved (19).

Choosing how much to stent. The variability in stent length of the models available up to a few years ago was very limited; the 15-mm size was most common. Placement of a single stent of this length was associated with a reduction in restenosis in STRESS (STent REStenosis Study), which only included lesions <15 mm (8). The situation is completely different now. Lesions fulfilling the BENESTENT...
(BELgian NEtherlands STENT) (7) and STRESS criteria (8) represent only a small portion of those currently treated. Interventionalists are increasingly willing to treat longer and diffuse narrowings as well as lesions at tandem. Manufacturers are offering stents with different lengths that enable matching the stent with lesion length and vessel anatomy. For long lesions, the operator has the choice of deploying multiple short stents or a single long stent. The immediate results with stenting are impressive. However, longer lesions and multiple stents are usually associated with a higher risk of restenosis. During the stent placement procedure in long coronary lesions, we are all faced with the dilemma: Should we cover only part of the lesion or the entire lesion with stent(s)? Should we use a single long stent or multiple short stents? The study of Kobayashi et al. (10) contributes significantly in resolving this dilemma.

Long lesions have been associated with an increased risk of restenosis after PTCA. Hirshfeld et al. (21) found a restenosis rate of 48.5% after plain angioplasty in lesions >7 mm in length. Even a higher restenosis rate of 58.3% emerged from the study of Bourassa et al. (22) after conventional PTCA of lesions >10 mm in length. Similarly, several studies have shown an increased likelihood of restenosis after coronary stent placement in long lesions (23,24). However, the issue of the independent role of lesion length in the outcome after stenting is more complex than after PTCA alone. Longer lesions usually need a longer segment to be covered by the stent. This may require the placement of more than one stent. Both greater stented length and a higher number of implanted stents may increase the risk of restenosis and mask the direct relation between lesion length and lumen renarrowing after stenting.

Kobayashi et al. (10) assessed the specific role of lesion length, stented segment length and number of stents in the outcome of 725 patients after coronary stent placement in 1,090 lesions with a special focus on restenosis. Angiographic follow up at six months was performed in 71% of the patients. The lesions were subdivided into three groups according to the length of the stented segment, with about half of the cases belonging to the group with a stented segment length ≤20 mm and the other half almost equally distributed between the other two groups with a stented segment length of 21 to 35 mm and >35 mm. A collateral finding of the study is that the in-hospital outcome of the group with the longest stented segment was characterized by a four- to sixfold increase in the risk of stent thrombosis and in the need for bypass surgery. Fortunately, the overall incidence of these events in this study group was low, and the authors also found that the increased risk was confined to those patients with threatened or abrupt vessel closure before stenting, thus mitigating possible concerns that the greater extent of stenting might have been responsible.

At follow-up, the incidence of restenosis (diameter stenosis ≥50%) was 23.9% in the group with short stented segments, 34.6% in the group with intermediate stented length and 47.2% in the group with long stented segments. An interesting result emerged from various stratified analyses. The authors showed that the association between stented segment length and restenosis was also present when the analysis was restricted to patients who received a single stent, to patients without coil stents and to patients without total or subtotal occlusions or acute or threatened vessel closure. It is interesting to note that even under IVUS guidance there was a continuous increase of the incidence of restenosis with the increase in stented segment length. Several other clinical, angiographic and procedural characteristics were also different among the groups with different stented lengths. This prompted the authors to perform a multivariate analysis with the objective of identifying the independent predictors of restenosis. Only three factors emerged to be independently correlated with angiographic restenosis at follow-up: A greater stented segment length and a smaller vessel size were the most potent risk factors of restenosis, followed far behind by a greater residual stenosis immediately after stenting. Of note, long lesions did not constitute a risk factor for restenosis, nor did multiple stenting. These data suggest, therefore, that the length of the stented segment has a substantial influence on restenosis and that this effect cannot be minimized by the use of a single long stent instead of multiple shorter stents.

Major effort has been spent to reduce the role of a multitude of risk factors in human medicine, but replacing a genuine with an iatrogenic risk factor is not what we are expected to do. If the unsalutary relation between stented segment length and restenosis is an inalienable feature of every stenting procedure, stent skeptics would feel encouraged and would more emphatically question the basic usefulness of stenting. The best answer in this regard is obviously found in past and future randomized trials. The careful analysis of Kobayashi et al. (10), along with other reports on this subject, also provides us with sufficient information on the circumstances in which this risk factor metamorphosis occurs and the ways to prevent it. For the entire group of patients included in the study (10), a mean stented length of 27.5 mm corresponded to an average lesion length of 12.6 mm. The discrepancy between stented and angiographic lesion length recognized by the authors and illustrated in Figure 2 of the report was not evenly distributed among the three study groups. Although there was, on average, only 5.5 mm of stenting in “excess” in the short stenting group, this excess amounts to 38.5 mm in the long stenting group. This nonuniform discrepancy could not be sufficiently explained by differences in the indications for stenting. We are not provided with data on the potential existence and extent of postangioplasty dissections. The authors indicate, however, that the discrepancy may be due to the frequent use of IVUS, which is able to discern diseased portions even in segments shown angiographically to be free of lesions.

In another recent study performed in 2,736 patients with an 83% six-month angiographic follow-up rate, in whom an average lesion length of 11.1 mm was covered with a mean
stent length of 17.8 mm, lesion length and not stented segment length was independently correlated with restenosis (25). Multiple stenting and stent overlap were among the other independent risk factors. This study concluded that when there was good matching of the extent of stenting with lesion length, lesion length continued to have an important negative effect on restenosis, and that this effect can be reduced by avoiding multiple and overlapping stents. The aforementioned results are in favor of a single long stent strategy for long lesions and warrant, in turn, specifically designed studies in the future.

The lesson that Kobayashi et al. (10) has imparted is that the interventionalists should be prepared to sometimes resist the temptation to use stents on the basis of excellent immediate results, only. We should handle this device with care. We should not forget that we are called to palliate the patient’s symptoms by treating significant stenoses, and we should recognize the frequently ephemeral nature of coronary tree reconstruction. The fight against atherosclerosis requires a different, biologic arsenal. A minimal residual stenosis should be the goal at the diseased site responsible for the patient’s ischemia and not everywhere that wall abnormalities and insignificant stenoses can be visualized angiographically. “Spot” stenting proposed by De Gregorio et al. (26) and lesion-matched single long stenting are strategies that should be further tested in patients with long lesions. The utility of stent placement in long coronary lesions has not yet been documented. The study of Kobayashi et al. (10) and other studies on this subject are important for establishing the best stent strategy to pursue for these lesions before launching the necessary randomized trials of stent versus PTCA. Otherwise, we run the risk of comparing a mature PTCA with a still untuned stent technique. Until then, the best we can do is to follow the recommendation given in the concluding sentence of the study: “when stenting is performed, the shortest possible stent length should be utilized,” and we should not allow Occam’s razor to become rusty.

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REFERENCES