“Inter-lacing” of Stents: 13-Month Follow-up by Intravascular Ultrasound after Primary Simultaneous Kissing Stenting

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A fifty-four-year old man suffered from ST-segment elevation myocardial infarction of Killip class I over the anterior wall. The emergent coronary angiogram showed true bifurcation lesion of Duke type D over the mid-LAD and 2nd diagonal branch. The stenting strategy was made more difficult by discrepant diameters of the mid and distal LAD, which hampered culotte- or T-stenting technique. Simultaneous kissing stenting was successfully performed in the scenario of acute myocardial infarction.

Angiographic follow-up showed minimal in-stent restenosis of both stents. Interestingly, the IVUS disclosed that the “double-barrel” portion of the stents had become inter-laced, not in the expected pattern of “back-to-back”. The interesting picture could be explained by double-helix configuration of the double-barrel portion of the stents, and the innate inward driving-force originating from negative remodeling of the accommodating vessel.

Key Words: Kissing stent • IVUS • Coronary artery • Bifurcation

INTRODUCTION

Treating coronary artery disease with true bifurcational lesions always poses certain challenges to the interventional cardiologist. It is even more difficult when the proximal and distal segments of the bifurcation bear discrepant diameters. The occasion would jeopardize the conventional stenting techniques, such as with culotte- or T-stenting. Simultaneous kissing stenting is a good alternative, but the long-term result has been thought to be dismal. In addition, the regular follow-up of such stenting strategy by intra-vascular ultrasound (IVUS) is less reported. We report a case of simultaneous kissing stenting with two bare-metal stents in the scenario of acute myocardial infarction, and the interesting image of 13-month follow-up by IVUS.

CASE REPORT

A 54-year-old man, without known medical illness before, suffered from sudden onset of chest tightness and cold sweating at 10 pm. The pain radiated to his left shoulder and could not be relieved by rest. He came to our emergency room (ER), where ECG showed ST elevation over V2~V6, I, aVL and ST depression over II, III, aVF. Under the impression of ST-elevation myocardial infarction over the anterior wall, Killip I, he underwent emergent cardiac catheterization. At ER, loading dose of dual antiplatelet therapy (aspirin 300 mg and clopidogrel 300 mg), intravenous heparin and tirofiban were all applied at least 30 minutes before catheterization.

The coronary angiogram showed bifurcational lesion of Duke type D over the mid portion of the left anterior descending artery (LAD): mid-LAD 99%, orifice of 2nd
diagonal branch (D2) 95% stenosis. However, the discrepancy of diameters between the mid and distal LAD made culotte- or T-stenting difficult. (Figure 1a, bold arrows) Therefore, we tried “simultaneous kissing stenting” by beginning with an 8F Voda™ Left 3.5 guiding catheter. A Rinato™ guidewire was inserted to the distal LAD, while another Pilot 50™ wire was put into D2. A Maverick™ 3.0*20-mm balloon was used to dilate the D2 and mid LAD alternatively. Thereafter, a Multilink Zeta™ 3.5*23-mm stent was located over the mid LAD-D2, while another Multilink Zeta™ 3.5*28-mm stent was positioned over the mid to distal LAD. After placing the proximal marks of the two stents overlapping (Figure 1b), we simultaneously deployed the stents (12 atm for the D2 stent, 10 atm for the LAD stent) (Figure 1c). The procedure resulted in minimal residual stenosis and TIMI 3 flow in both vessels. The mid-LAD accommodating the two stents was intact, free from dissection (Figure 1d). The cardiac enzymes peaked in 4 hours (CK/MB: 880/119). The patient was discharged six days later and was regularly followed as an out patient.

He was suggested to receive follow-up coronary angiography and intravascular ultrasound (IVUS) 13 months later. The angiogram showed minimal in-stent restenosis (ISR) over both the LAD and D2 stents. The IVUS (Galaxy 2™, Boston Scientific) was performed in both LAD and D2 arteries. It revealed intact and appropriate coverage of neo-intima within the two stents. Interestingly, the IVUS showed pictures of “inter-lacing” over the double-barrel portion of the two stents (Figure 2, thin arrows) from both perspectives of LAD and D2. The “inter-lacing” was noticed at two discrete sites. The distal “inter-lacing” was over the “new artificial” carina (pull-back mark 8.3 mm), though sort of suspicious. The 2nd one was 5 mm proximally (pull-back mark 13.8 mm), showing more obvious “inter-lacing” (Figure 3). Both of the “inter-lacing” segments were 2 to 3 mm in length. As
there was no evidence of recurrent ischemia, the patient was suggested to keep optimal medical treatment for other risk factors.

**DISCUSSION**

Percutaneous coronary intervention to true bifurcation lesion (Duke type D) has been posing certain degree of challenge to interventional cardiologists. Several stenting techniques for true bifurcation lesions have been developed, including “culotte”, “modified T” and “crush”. However, it is more troublesome to deal with bifurcational lesion which bears discrepant sizes of the proximal and distal segments of the main vessel.

“Simultaneous kissing stenting (SKS)” deploys two appropriate stents over the main vessel and the side branch, with overlapping of the two stents in the proximal segment of the main vessel, constituting the “double-barrel”. A new artificial carina is created proximal to the original bifurcation. The SKS technique obviates the need for re-crossing the stent struts and prevents stent deformation. In addition, the coverage of the side branch ostium can be guaranteed. As compared with the standard technique for bifurcation lesions by stenting the main vessel with provisional stenting of the side branch, the SKS technique is associated with a trend toward fewer in-hospital major adverse cardiac events. It is also associated with greater procedural success of the side branch, with less post-procedural residual stenosis and with less procedural time, largely by obviating the need for re-crossing the stent and additional kissing balloon dilation. However, it has been thought that the double barrel portion of the SKS would have higher probability of long-term ISR, when comparing with other stenting technique. Dr. Sharma, who organized the so-far largest SKS randomized study, stated that SKS offered non-inferior result to other conventional stenting technique in treating bifurcational lesions. However, he also emphasized that the main limitation of his study was the lack of routine angiographic follow-up, and that all patients were followed clinically. A 30-patient-based 2-year angiographic follow-up study of SKS with sirolimus-eluting stents concluded that SKS was a feasible technique for bifurcational lesions and revealed a membranous diaphragm at the carina. However, there was no mention of further IVUS study in both articles.

In our case, the initial success of the SKS technique and revascularization were achieved in the stage of acute myocardial infarction. The patient was suggested to receive follow-up angiogram and IVUS in one year, based on the aforementioned high probability of in-stent restenosis of the double-barrel portion. Furthermore, the stents used were of bare-metal, not drug-eluting. The probability of ISR was thought to be even higher with double bare-metal stents. However, the follow-up angiogram showed minimal ISR, which was further proved by IVUS. It was more intriguing that the “double-barrel” portions of the two stents was not of the pattern of “back-to-back” in typical IVUS image. Instead, the “double-barrel” portions of the two stents seemed “inter-laced”.

According to Sharma’s study, the immediate IVUS study after SKS procedure showed “back-to-back” pattern of the “double-barrel” portions. The cross-section of the stents was a deformed circle, in the shape of a double-D, which was evidenced by the spanning segment between the artificial carina and “inter-laced” part in our patient (Figure 3). The new artificial carina formed by the two stents also showed similar double-D image. Technically speaking, there should be no room for the two stent-circles to be inter-laced immediately after the procedure of SKS. The simultaneously inflated balloons of the stent-catheters were against each other and allowed no space for interlacing. The respective stent was expected to be deformed like a “D” in cross-section, as the two stents were initially forced against each other. Interestingly, the “double-barrel” portions of the two stents in our patient retained intact circular shape and became “inter-laced” with each other 13 months later. Considering the design of the stent-strut, there seemed no way to make the two stents “inter-laced” ex vivo. The IVUS picture of “inter-lacing” could be possibly explained by the following two points. In the first place, the two stents were not back-to-back in parallel as double-barrel shotgun. Instead, they became swirled and tangled with each other during the process of high-pressure deployment. This phenomenon could be partially elucidated by the picture of stent deployment (Figure 1c), in which the balloons crossed each other as an “X”. Therefore, the “double-barrel” portions might gain the configuration of “double-helix”, resembling double-stranded DNA. This could partially explain why the two
stents were not fixed in their relative position in cross-section. As the linkages of the stent struts are not all around the circle in cross-section, the twisted configuration make “open-cell” possible and offers chances to dodge the linkage points, resulting in “inter-lacing”. It could also explain why the interlacing occurred in discrete sites with certain span, as the linkages of the struts are designed interrupted longitudinally. Secondly, the parent vessel should be large enough to accommodate the double barrels without compromising the stent configuration in the process of deployment. The innate inward-driving force originating from the negative remodeling of the accommodating vessel made the double barrels further tangled gradually. In the long run, the double-barrel portion of the two stents became “interlaced” at discrete sites, probably resulting from the aforementioned speculated mechanism.

In conclusion, simultaneous kissing stenting is a good alternative to treat bifurcation lesions, as it reduces procedural time, prevents stent strut deformation and guarantees complete coverage of the ostium of the branch. “Inter-lacing” of the stents could be the result of long-term stent-vessel interaction, which might be different from ex vivo expectation. It may need more exploration by long-term IVUS follow-up in cases of simultaneous kissing stenting to substantiate our hypothesis.

REFERENCES

採用雙槍式血管內支架置放之緊急血管成型術 — 13 個月後血管內超音波追蹤 —『相嵌的支架』

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一位 54 歲男性因為前壁急性 ST 節段上昇型心肌梗塞接受緊急血管成型術，但心肌梗塞相關之左前降枝呈現 Duke type D 之分叉型病灶，更頭痛的是中段左前降枝病灶前後段之血管內徑差異極大，其 Diagonal 2 又極為粗大，造成傳統分叉病灶支架置放方式如 culotte- or T-stenting, 無法順利執行。於此案例吾人成功的使用 simultaneous kissing stenting (雙槍式血管內支架置放)，順利的完成心肌梗塞血管的成型術。並於 13 個月後以血管內超音波追蹤，發現無明顯的支架內狹窄，並且兩支支架雙重主幹 (double-barrel) 的部分呈現完整兩個圓形截面而且有部分相嵌 (inter-lacing) 的情形，完全不同於傳統預想的『背靠背』的兩個圓形。

關鍵詞：雙槍式血管內支架置放、血管內超音波、冠狀動脉、分叉病灶。