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A Novel Coronary Bifurcation Stenting Technique: Double Kissing Nano-Culotte Stenting

CASE REPORT

INTRODUCTION

Percutaneous coronary intervention (PCI) of coronary bifurcation lesion (CBL) is challenging due to its complex anatomy resulting in difficulty in deciding on treatment procedure. Although there are advanced techniques and well-experienced operators, the optimal stenting strategy is still debated. The contemporary PCI techniques of CBL aim to achieve minimal stent protrusion to the main vessel and to minimize stent layers at the neocarina as well as the side branch (SB) ostium and proximal main vessel (PMV). In addition, it is necessary to avoid incomplete stent coverage at the SB ostium and stent malapposition. Traditional 2-stent strategies have been improved using minimal stent protrusion to the main vessel (MV) and double kissing (DK) balloon dilatation to reach optimal results. Although the DK crush has been the prominent treatment modality,[1] there are studies showing that the DK culotte stenting may have better results especially in terms of stent malapposition and metal layers at the neocarina.[2] In our case report, we demonstrate a novel minimal protruded DK nano-culotte stenting technique for the treatment of true CBL.

CASE REPORT

A 57-year-old male patient was admitted to our hospital with unstable angina pectoris. He had a history of PCI for the left circumflex artery (CXA) and the right coronary artery (RCA) 3 years ago. His electrocardiography showed normal sinus rhythm without any St-T wave abnormalities. Echocardiography showed an ejection fraction of 55%. Coronary angiography showed a Medina 1:1:1 true bifurcation lesion in the left anterior descending artery (LAD)-Diagonal SB. And also CXA and RCA were patent (Figure 1A). The PCI was performed for LAD-diagonal bifurcation lesion as a culprit vessel (Video 1). The left main coronary artery ostium was selectively cannulated with the extra backup guiding catheter. The guidewires (GW) were advanced into the LAD artery and the diagonal SB. Then, intravascular ultrasound (IVUS) was used to determine the plaque morphology and the vessel diameters as well as to decide the stent size. Predilatation was performed for both LAD and SB with a 2.0 × 20 mm semi-compliant coronary balloon. In this step, we prepared the SB stent outside of the catheter. First, the stent cover was removed with only the uncovering of the proximal strut. The stent balloon was inflated with low pressure (2-3 atmospheres) to allow partial opening of only the proximal strut of the stent. Then, the distal part of the LAD GW was crossed from the opened single cell and crimped back the proximal strut (Figure 1B). Finally, the prepared stent was advanced over the SB GW. After this preparation, the SB stent was advanced gently over the SB GW. The stent was stopped by the LAD GW at the ostium of the SB (Figure 1C). At this level, the SB stent (2.75 × 24 mm Sirolimus eluting coronary stent) was deployed with the nominal pressure. The stent was sized according to the diameter of the distal SB. Then, the stent balloon was pulled back slightly and inflated with high pressure (SB optimization) (Figure 1D). After the stent balloon was removed, IVUS was performed over the SB GW to demonstrate the single-opened stent strut into the LAD and full stent coverage of the

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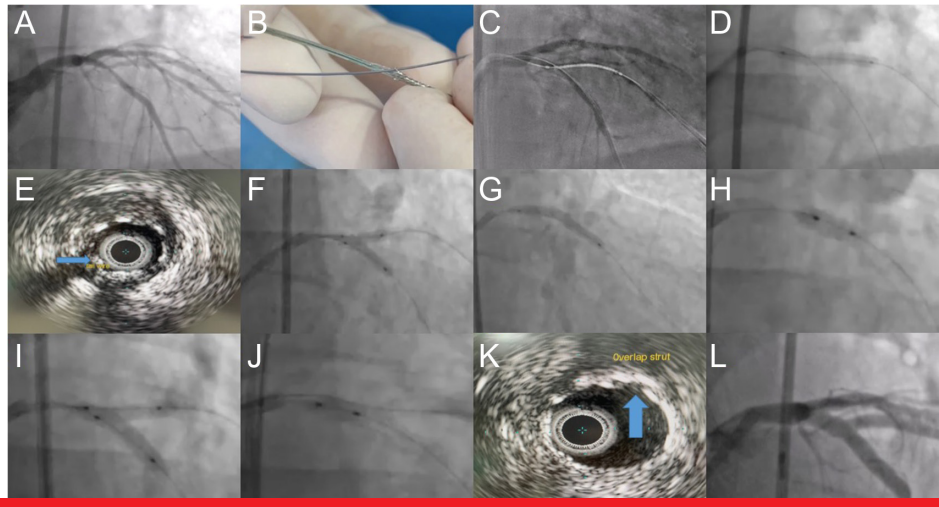

Figure 1. The procedural steps of the DK Nano-culotte stenting of the case. (A): Medina 1:1:1 true (LAD)-diagonal bifurcation lesion. (B): The distal part of the LAD guidewire was crossed from the opened single cell and crimped back the proximal strut. (C): Positioning of the diagonal stent. (D): Side branch optimization. (E): IVUS imaging of the LAD wire crossing from the opened last single cell of diagonal stent (arrowhead). (F): First kissing balloon dilatation. (G): LAD stent implantation. (H): First POT technique. (I): Second kissing balloon dilatation. (J): Final POT was performed. (K): IVUS imaging of the single overlapped struts (arrowhead). (L): Final angiographic imaging. DK, double kissing, IVUS, intravascular ultrasound, LAD, left anterior descending artery; POT, proximal optimization

SB ostium (Figure 1E). A 3.5 × 12 mm non-compliant coronary balloon (NCB) was advanced over the LAD GW while a 2.75 × 12 mm NCB was advanced over the SB GW (sized 1 : 1 according to the distal diameters). First, the SB balloon was inflated to avoid the distortion of the SB stent and then the LAD balloon was inflated to perform the first kissing balloon dilatation (KBD) (Figure 1F). Intravascular ultrasound was performed over both the LAD and SB GW to demonstrate the full expansion of the single strut. Non-compliant coronary balloons and SB GW were removed and the 3.5 × 31 mm Sirolimus eluting coronary stent was advanced through the single extended strut from the proximal to distal LAD. It was deployed with nominal pressure (Figure 1G). The stent was sized according to the diameter of the distal LAD and it was long enough to allow proximal optimization (POT). The stent balloon was removed and POT was performed with the 4 × 8 mm NCB (sized 1 : 1 to the proximal LAD) (Figure 1H). Rewiring to SB from the distal strut was performed with another GW and it was confirmed by the IVUS. Second KBD was performed with the 3.5 × 12 mm NCB (LAD) and 2.75 × 12 mm NCB (SB) (Figure 1I). Finally, re-POT was performed with the 4 × 8 mm NCB (Figure 1J). The procedure was terminated with the IVUS imaging to demonstrate the complete stent coverage at the SB ostium, optimal stent apposition into the proximal LAD and minimize stent layers at the SB ostium and neocarina (Figure 1K). The patient was discharged from the hospital without any complications on the day after the procedure. No major adverse cardiovascular event (MACE) was observed during the 6-month follow-up period after the PCI.

Procedural Steps of Double Kissing *Nano-Culotte Stenting*

1. The MV and SB are wired.
2. The SB stent, sized 1 : 1 according to distal SB, is prepared outside of the catheter. The stent cover is removed with only the uncovering of the proximal strut, and the stent balloon is inflated with low pressure (2-4 atmospheres). Only the proximal strut of the stent is partially opened and the balloon is deflated. The distal part of the MV GW is crossed from the opened single stent strut and crimped back the proximal strut manually.
3. The SB stent is advanced over the SB GW. The stent is stopped by the MV GW at the ostium of the SB (Figure 2A).
4. The SB stent is deployed (Figure 2B) and SB optimization is performed (Figure 2C).
5. The MV balloon is advanced over the MV GW and advanced through the single-opened SB stent strut (no rewiring is needed in this step) (Figure 2D).
6. First KBD is performed with balloons sized 1 : 1 according to the distal main vessel (DMV) and SB diameters (First, the SB balloon is inflated to avoid the distortion of the SB stent and then MV balloon is inflated) (Figure 2E and F). Then, balloons are deflated simultaneously.
7. The MV stent, sized 1 : 1 according to DMV, is deployed (Figure 2G and H).
8. Proximal optimization is performed with a balloon sized 1 : 1 according to PMV (Figure 2I).
9. After rewiring of the SB closed to the carina (distal strut), second KBD is performed with balloons sized 1 : 1 according to the distal MV and SB diameters (First, the MV balloon is inflated and then the SB balloon is inflated) (Figure 2J). Balloons are deflated simultaneously.
10. Final POT is performed (Figure 2K).

DISCUSSION

Coronary bifurcations account for approximately 15%-20% of all PCIs.[3] Although advanced techniques and novel devices are available, the incidence of MACE is still high especially driven by the SB stent restenosis.[4] Thus, the main treatment

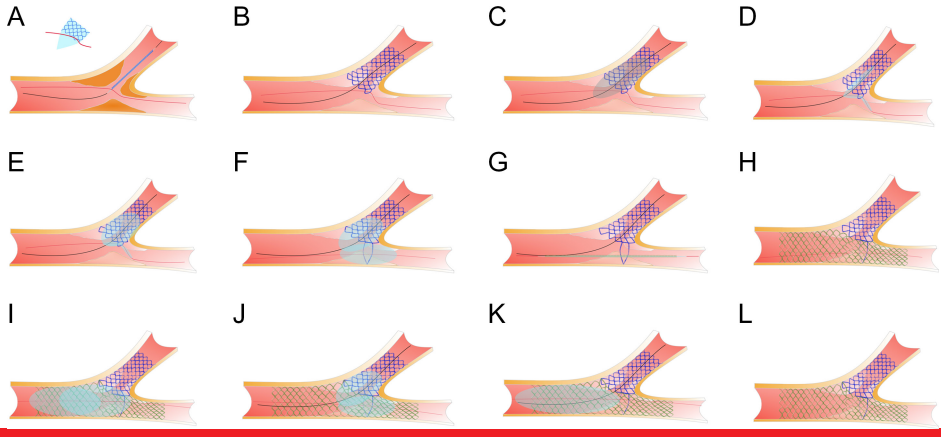

Figure 2. The procedural steps of the DK Nano-culotte stenting technique. (A): Positioning of the prepared SB stent with the Szabo technique. (B): Implantation of the SB stent. (C): Side branch optimization. (D): Positioning of the coronary balloons which are used for the kissing balloon dilatation. (E): The MV balloon is dilated first. (F) Then, the SB balloon is dilated to perform the first kissing balloon dilatation. (G): Positioning of the MV stent. (H): MV stent implantation. (I): POT. (J): Second kissing balloon dilatation. (K): Final POT. (L): Final view. DK, double kissing; MV, main vessel; POT, proximal optimization technique; SB, side branch.

goal of CBL is to decrease SB restenosis rate by the complete coverage of SB ostium, reduce stent malapposition, and minimize stent layer at the neocarina and SB ostium. While the provisional SB stenting is the optimal strategy for many non-complex CBL, 2-stent strategies continue to evolve in complex CBL. In the contemporary PCI era, double KBD and minimal stent protrusion from the SB ostium are the main targets of optimal 2-stent strategies. In previous trials, it was first performed in the DK crush stenting technique with minimal stent protrusion and double KBD.[1] The impact of the double KBD is to minimize distortion of stents and to reduce stent malapposition. Minimal stent protrusion results in reduction of multiple metal layers at the neocarina and SB ostium results in improve clinical outcomes. Upon showing that the DK crush stenting is a successful procedure, DK mini-culotte stenting is performed as the other 2-stent strategy in which DK and minimal protrusion are used. It was demonstrated that DK mini-culotte stenting was superior to DK crush stenting in terms of stent malapposition.[2] Thereupon, novel techniques began to make the procedure more optimal. The single-string stenting aimed to achieve minimal stent protrusion to the MV. It was demonstrated that the single-string stenting was feasible and favorable results were obtained in terms of stent overlap, malapposition rate, and residual obstruction in both the MV and SB.[5] In a study by Toth et al.[5] no MACE occurred during follow-up time of 6 × 4 months. In this technique, SB stent was deployed with minimal protrusion to the MV and then SB GW was slowly pulled back until it falls into the protruding cell, through which it was advanced into the distal MV. However, it is not easy to advance the wire through the single protruded cell and it may result in technical failure. Sandesara et al[6] also described a novel technique in which wire and balloon were loaded into the last single strut named single-cell DK culotte based on the flower-petal technique. However, in this technique, it may be difficult to advance the stent on which the balloon is loaded through the angulated vessels. With our newly described technique, we expect to overcome this problem. With this novel technique, we have also some advantages. Superimposition of multiple metal layers and stent malapposition are significantly reduced contrary to traditional 2-stent techniques. Overlap of stents is minimized only a single strut especially at the neocarina. Only one rewiring is needed to the SB after MV stent implantation. Additionally, if a dissection occurs during lesion preparation, it does not affect our strategy as there is no need to rewire until the final KBD. It has also some limitations. While a "napkin effect," where the SB single-protruded cell could not be expanded enough, may be a problem, it was demonstrated that large open cell designed stents may overcome this problem. In addition to this, more than 1 strut may be protruded if the bifurcation angle is very narrow. Contrary to this, both superior and inferior SB stent struts may be protruded in the presence of a very right bifurcation angle. Even in these cases, the overlap of metal layers is still minimal. Finally, beware of stent dislodgement and wire kinking due to tail wire technique.

CONCLUSION

The DK nano-culotte technique provides minimal strut protrusion and the least metal layer. It is aimed to decrease the presence of stent malapposition, incomplete coverage of the SB ostium, and SB restenosis. However, future trials are needed to demonstrate the impact of this technique on clinical outcomes.

Informed Consent: Written informed consent was obtained from the patient.

Declaration of Interests: The authors declare that they have no competing interest.

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Video 1: The double kissing nano-culotte stenting procedure of the case. Procedural steps of the double kissing nano-culotte stenting.

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