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Stenting of left main bifurcation lesion using modified double-kissing culotte technique

Implante de stent em lesão de bifurcação do tronco da coronária esquerda usando técnica *double-kissing culotte* modificada

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ABSTRACT – Left main coronary artery bifurcation represents one of the most challenging settings for the interventional cardiologists. The conventional stents are designed and shaped to restore tubular geometry, while the left main coronary artery bifurcation is far more complex with different diameters and non-tubular cross-sections. In relevant patients, two stent strategy is preferred over provisional T-stenting. The double-kissing crush has been the preferred double stent technique. We present a case in which the double-kissing approach was used in left main coronary artery bifurcation stenting with the culotte technique, which resulted in good angiographic outcome and no malapposition. Patient was stable even at 4 months follow-up.

Keywords: Coronary artery disease; Stents; Percutaneous coronary intervention

RESUMO – A bifurcação do tronco da coronária esquerda representa um dos locais mais desafiadores para os cardiologistas intervencionistas. Os stents são projetados e modelados para restaurar a geometria tubular, ao passo que a bifurcação do tronco da coronária esquerda é bem mais complexa, com diâmetros diferentes e secções transversais não tubulares. Em pacientes complexos, a estratégia de implante de dois stents é preferida à estratégia de stent provisional. O *double-kissing crush* é a técnica de duplo stent preferida. Apresentamos um caso em que a abordagem *double-kissing* foi usada no implante de stent na bifurcação do tronco da coronária esquerda com a técnica *culotte*, que resultou em bom resultado angiográfico e sem malaposição. O paciente manteve-se estável mesmo com 4 meses de acompanhamento.

Descritores: Doença da artéria coronariana; Stents; Intervenção coronária percutânea

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INTRODUCTION

In percutaneous coronary intervention (PCI) for bifurcation lesion, single stenting of main branch (MB) is preferred approach, and stenting of side branch (SB) is only recommended in some cases.¹ Double stenting of both the MB and SB is currently recommended in 5% to 36% of bifurcation procedures.^{2,3} Various techniques have been developed for this purpose and are now used in daily routine. Among these techniques, we mention T and protrusion (TAP) stenting, culotte stenting, mini-crush, double-kissing crush.

A recent modification in these techniques is the use of double-kissing balloon; in this technique optimization of the SB result with additional kissing balloon dilation before stenting the MB is done, and then two balloons are inflated simultaneously, such that the shifting of plaque into the SB can be prevented. Here we present a case of left main coronary artery (LMCA) bifurcation lesion that was managed successfully using double-kissing culotte technique.

CASE REPORT

An 80-year-old male presented to Cardiology Department with angina on exertion (class III) and dyspnea on exertion (class III). His electrocardiogram (ECG) showed

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nonspecific ST-segment and T waves changes in anterior leads. Echocardiography showed severe left ventricular (LV) systolic dysfunction, with an ejection fraction of 30%. Patient's risk of bleeding was 2 according to HAS-BLED. He had a previous history of hypertension, non-insulin dependent diabetes mellitus and dyslipidemia. He was on antianginal drugs, antiplatelet drugs, anti-hypertensives and oral hypoglycemic drugs.

The patient's routine blood investigations were done. Troponin I was negative. Creatine phosphokinase-MB was in the normal range. He was taken up for coronary angiography (CAG), which revealed LMCA disease with triple vessel disease, left main bifurcation lesion (Medina 1-1-1). His SYNTAX score was equipoised (23). Heart team considerations were taken. The patient was offered coronary artery bypass graft surgery but he was unwilling for surgery and was taken for PCI.

In angiography, a long diffuse lesion was observed in ostial to mid-left anterior descending (LAD) artery and ostial to mid-left circumflex (LCx). Because of the diffuse nature of disease in both vessels, a two-stent strategy was adopted from the very beginning. Patient was advised

to undergo intracoronary imaging but due to financial constraints they decided against it. A total of 7,000 units of intravenous (IV) heparin were administered and PCI was initiated via femoral approach. The LMCA was engaged with a 7F extra-back up (EBU) 3.75 guide (Medtronic, Minneapolis, Minnesota, United States). The LMCA was severely calcified with the extension of the calcification into the proximal LAD and LCx (Figures 1A and 1B).

Both the LAD and LCx lesions were primarily wired with a rotational atherectomy guidewire (Boston Scientific Corporation, Marlborough, Massachusetts, United States). The rotational atherectomy of LMCA-LCx and LMCA-LAD was performed using 1.5mm burr sequentially at 160,000rpm (Figures 1C and 1D). The Finecross® MG microcatheter (Terumo Interventional Systems; New Jersey, USA) was advanced over the LAD wire, which was exchanged for a workhorse wire (BMW). At this point, the LCx lesion was also crossed using 0.014 workhorse coronary wire. Then, sequential dilatation of LAD was done with a 3x15mm non-compliant (NC) balloon (Accuforce®, Terumo), from distal LAD to proximal LAD (Figures 1E to 1G).

Figure 1. Coronary angiogram showing (A and B) distal left main disease with triple vessel disease; (C and D) rotational atherectomy done to left circumflex and left anterior descending artery; (E to G) sequential pre-dilatation of left anterior descending artery from distal to proximal; coronary angiogram showing (A) stent deployed in distal left anterior descending; (B to D) positioning, deployment and proximal optimization of left circumflex stent.

A 3x38mm drug-eluting stent (DES) (cobalt-chromium everolimus eluting stent, XIENCE Xpedition; Abbott Vascular, Santa Clara, California) was implanted from mid to distal segment of LAD at 16atm (Figure 1H). The stent was post dilated with 3.5x 13mm NC balloon (Mozec™ NC, Meril). Both LAD and LCx lesions were predilated with 3X15mm NC balloon (Mozec™ NC) sequentially to achieve full angiographic expansion. Another 4x38mm DES (cobalt-chromium everolimus eluting stent, XIENCE Xpedition) was implanted from the LMCA to LCx. The stent in LCx was post-dilated with 4x13mm NC balloon (AccuForce, Terumo). Proximal optimization (POT) was performed using 5x10mm NC balloon (AccuForce) at 18atm (Figures 1I to 1K).

The LAD wire was made to recross the distal strut of the implanted stent in LCX. The lesion was crossed with a 1.5x8mm NC balloon (AccuForce) and struts dilated (Figure 2A). First kissing balloon inflation was performed using 3x12mm and 3.5x12mm NC balloon (Mozec™ NC) in LAD and LCx, respectively (Figure 2B). Then a 3x15mm DES (Cobalt-chromium everolimus eluting stent, XIENCE

Xpedition) was implanted from LMCA to LAD with a 3mm overlap (Figures 2C and 2D). Second POT was performed using 5x10mm NC balloon (AccuForce), at 18atm. Left circumflex stent was recrossed and LAD was dilated at high pressures, at 16atm with 3.5mm NC balloon (Figures 2E to 2I). A second kissing balloon inflation was performed using 3.5mmx10mm and 4x10mm NC balloons in LAD and LCX, respectively, at 10atm (Figure 2J and 3A). Final POT was performed using 5x8mm NC balloon (AccuForce), at 18atm. Final CAG and stent boost revealed good final result, with good apposition and wide-open carina (Figures 3C to 3G).

Patient was discharged in stable condition after 2 days of hospitalization. Patient was started on dual anti-platelet therapy including aspirin and ticagrelor, for 6 months, and, thereafter, only aspirin was continued. Four months later, patient was clinically stable with no symptoms. At a 16-month follow-up, patient underwent hip-fracture surgery under general anesthesia, which went uneventful. At that time, a dobutamine stress echo was unremarkable and did not induce ischemia.

Figure 2. Coronary angiogram showing (A) left circumflex strut dilated with a small balloon; (B) first kissing balloon inflation; (C) positioning of left anterior descending artery stent across left circumflex stent; (D) deployment of stent in left anterior descending; (E) proximal optimization to left circumflex done; (F) recrossing of left circumflex stent; (G) post dilatation of left circumflex stent; (H and I); post dilatation of left anterior descending artery; (J) second kissing balloon inflation done.

Figure 3. Coronary angiogram showing (A) second kissing balloon inflation; (B) dilatation of left circumflex strut; (C) final proximal optimization; (D) stent boost; (E to G) final angiogram.

DISCUSSION

The patients with unprotected LMCA disease are at high risk because of a large amount of jeopardized myocardium.⁴ In recent EXCEL trial, the patients with left main bifurcation lesion were mostly treated with provisional stenting strategy.⁵ It is still not very clear if alternative approaches could confer superior outcomes. In previously conducted randomized clinical trials, using double-kissing crush as the preferred two-stent technique resulted in lower rates of target lesion revascularization (TLR), stent thrombosis and composite major adverse cardiac events (MACE), compared to provisional stenting strategy and culotte stenting in distal left main bifurcation lesions.^{6,7}

In contrast to the conventional crush technique, the peculiarity of double-kissing culotte is the performance of an additional kissing balloon dilation of the SB prior to MB stenting. The merit of this is that MB stenting does not cause relevant deformation towards the SB, and in the SB stent itself. Therefore, after MB stenting, the access to the SB is more predictable and straightforward for the final kissing balloon dilation. If we apply the same principle to culotte technique and do double-kissing twice, as we have done in this case, the prognosis would be better.⁷

In the Bifurcations Bad Krozingen (BBK) II trial, culotte stenting is more efficacious than TAP stenting in preventing restenosis. This is demonstrated by a significantly lower binary restenosis rate at the bifurcation lesion after culotte stenting, as compared to that after TAP stenting. These angiographic differences between the aforementioned stenting techniques translated into a 50% lower rate of TLR. Thus, the result in the SB was the main driver of the primary and secondary endpoints of the study. This may

be attributed to culotte stenting, which achieves an optimal and complete coverage of the SB ostium. In contrast, TAP stenting can result in the gap, protrusion into the MB or stent distortion within the SB. It might be speculated that the smoother transition of the stented area from the MB into the SB using the culotte technique might result in less irritation of the vessel wall at the SB thus resulting in lower neointima formation.⁸ The culotte stenting and classic crush stenting was first compared in the NORDIC RCT. This trial showed a significantly reduced in-stent restenosis with culotte stenting.^{9,10}

Unanswered technical bifurcation questions may lead to testing of devices on the bench. The testing is in compliance with the Food and Drug Administration recommendations, and the ISO publications, ISO 25539-2.¹¹ Bench test data suggest that double-kissing approach facilitates the culotte technique. However, the clinical validity and relevance remain untested in a larger in-vivo population.⁷

Our case entails a modified culotte stenting technique by performing a double-kissing approach, i.e., by optimizing the SB result with additional kissing balloon dilation before stenting the MB. This innovative technique might maintain shape of bifurcation anatomy by minimizing distortion of the SB ostial stent. This technique is likely to provide the largest amount of laminar flow both in the MB and the SB, and might result in fewer TLR and stent thrombosis compared even to double-kissing crush technique. In our case, this technique resulted in good apposition, good result and good carina, as visualized in stent boost and angiographic images. The bench study has confirmed that post-procedural anatomy after double-kissing culotte procedure can be ideally close to the native anatomic structure.⁷

In our patient, we found very good angiographic and clinical result by applying this principle. In this case report, we modified the culotte technique by adding an additional step of double-kissing. This minor change of kissing twice has resulted in better apposition of SB stent, as shown by benchmark study by Toth et al.⁷ A larger data with a greater sample of patients using this technique, is required to test the validity of findings in real-world patients. This case report suggests that modified double-kissing culotte is feasible, and it might translate into better short term or long-term results, but its relevance remains to be confirmed in a larger population in randomized controlled trials.

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None.

CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: RM; data collection: RM, AS, DD, SS and BM; data interpretation: BM, AS and SS; text writing: RM, BM, AS and SS; approval of the final version to be published: RM and DD.

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