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Functional PCI in bifurcation lesions

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Introduction

In the contemporary practice of percutaneous coronary interventions (PCI), bifurcation lesions account for approximately 20-30% of all coronary lesion subsets[1]. Bifurcation PCI remains one of the most challenging procedures with respect to procedural complexity and relatively high rates of early and long-term adverse cardiac events, as compared to non-bifurcation PCI. Although there have been marked advancements in stents, devices, techniques, and adjunctive drug therapies, the optimal management of bifurcation lesions is still the subject of considerable debate. Despite great interest in this complex lesion subset and a fast growing body of scientific evidence, over the past decade, the management of bifurcation disease has been focused mainly on technical aspects[2,3]. However, given that adjunctive imaging and functional tools are widely applicable in contemporary practice, an integrated approach combining functional aspects and technical aspects might be helpful to guide treating physicians in their decision making on PCI strategies and procedural optimisation, which are ultimately linked to improvement of the outcomes of patients with such complex lesions. Herein, we highlight the most debated issues and propose our recommendations for a simple and integrated approach while emphasising the functional aspects of bifurcation PCI.

Why bifurcation treatment should be considered as a matter of concept rather than technique

The clinical relevance of a bifurcation lesion is generally based on the anatomic and functional significance of the side branch (SB) and the potential myocardial complications associated with SB occlusion during bifurcation PCI. However, in routine clinical practice, the relevance of the SB has most often been arbitrarily defined on the basis of the subjective judgement of the interventional cardiologist; by coronary angiography, several anatomic factors (i.e., size and length of the main branch [MB] and SB, severity of stenosis, bifurcation angles, calcification, or disease pattern) might be assessed. Beyond such simple angiographic characteristics, more detailed characterisation of atherosclerotic plaque burden involving the bifurcation zone and the functional significance of the lesions can be important for any strategy planning of bifurcation PCI. Put simply, conventional Medina

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classification for bifurcation lesions can be refined using intravascular ultrasound (IVUS) imaging or fractional flow reserve (FFR) measurement, which lead to a conceptual rather than a technical approach for optimal bifurcation treatment.

Why a functional approach is needed in bifurcation PCI

In the last decade, many clinical studies involving non-randomised and randomised trials have compared the use of a simple versus a complex stenting technique in non-left main (LM) or LM bifurcations. The majority of these studies have shown no advantage in implanting two stents regardless of the lesion location or bifurcation type. Based on this evidence, a simple strategy with provisional SB stenting has now become the preferred strategy in the majority of bifurcation techniques. With such a concept, the provisional SB stenting strategy, if feasible, should be considered the standard approach for bifurcation treatment. When should we treat SB occlusion by a provisional approach? From a practical viewpoint, after crossover stenting of the MB, SB salvage (i.e., provisional balloon or stenting) is usually considered: (1) when there is impaired SB flow (Thrombolysis In Myocardial Infarction flow grade <3); (2) when there is a major SB dissection; or (3) when SB narrowing is regarded as functionally significant leading to significant residual ischaemia. If angiographic narrowing of the SB occurred after MB stenting, how do we assess the functional significance of SB narrowing? Decision making for SB treatment can be guided by functional FFR assessment. A previous study suggested that angiographic and IVUS parameters had poor diagnostic accuracy in predicting the functional significance of SB narrowing, in which the relations between angiographic/IVUS parameters and FFR were different between main vessel (MV) and SB lesions[4]. Despite a high incidence of SB narrowing after provisional bifurcation stenting, ostial SB stenosis after MB stenting in most cases was non-significant by FFR[5,6]. In addition, the presence or absence of final kissing balloon inflation did not substantially improve serial FFR values of the SB immediately after and at follow-up of the procedures[7]. Therefore, if FFR assessment is technically feasible for the SB, such a functional tool might be used to support the choice of a further treatment strategy for SB narrowing after provisional stenting and, as a result, it might reduce SB intervention without increasing subsequent revascularisation along with retaining functional integrity.

In case of a sufficiently large SB with anatomic and functional relevance, a two-stent technique could be initially considered. There are no data showing a significant difference in clinically relevant outcomes according to different two-stent techniques; only a small difference was observed for soft clinical endpoints (i.e., late loss, branch restenosis, or repeat revascularisation)[2,3]. Therefore, any two-stent technique (i.e., T/modified-T/TAP, crush/mini-crush/DKCRUSH, or culotte) can be used and selected according to the size of the MB or SB, bifurcation angle, plaque distribution or location and, importantly, operator experience and expertise.

Why an imaging approach is needed in bifurcation PCI

The LM is a unique bifurcation lesion subset that requires careful clinical and technical consideration: (1) the LM involves more than 70% of the overall myocardium, (2) SB occlusion of an LM bifurcation (left circumflex artery [LCX]) is clinically not acceptable, and (3) the LM, MB, and SB are relatively large vessels compared to other bifurcation lesions. For distal LM bifurcation lesions with intact or diminutive SB, the practical application of FFR for a SB circumflex artery after provisional stenting is similar in approach to non-LM bifurcation treatment. If the LCX is severely diseased at baseline, an initial two-stent approach might be preferred. Intravascular imaging should be mandatory for LM stenting, especially for a distal LM bifurcation lesion. Recently, the results of two large comparative trials (EXCEL and NOBLE) of left main PCI versus bypass surgery have been released[8,9]. Despite disparate conclusions, both studies draw attention to procedural techniques in left main PCI; IVUS utilisation exceeded 70% in both studies. Considering the benefits of IVUS to define disease distribution, inform stent sizing and technique and enhance appropriate stent sizing and expansion, the role of IVUS in reducing left main restenosis and stent thrombosis-related complications may be clinically meaningful. Therefore, at the minimum, IVUS should be performed at the completion of the procedure to assess stent apposition and deployment. For complex stenting of a distal LM bifurcation, the IVUS-measured minimum stent area that best predicts angiographic in-stent restenosis on a segmental basis is 5.0 mm^2 for the LCX ostium, 6.3 mm^2 for the LAD ostium, 7.2 mm^2 for the polygon of confluence (POC), and 8.2 mm^2 for the proximal LMCA above the POC (namely, criteria 5-6-7-8 for distal LM complex stenting)[10]. With these criteria, IVUS optimisation during LMCA stenting procedures may improve clinical outcomes.

Conclusion

In conclusion, for bifurcation PCI treatment, both strategies (provisional stenting or any planned two-stent technique), according to the SB significance and the size of jeopardised myocardium, might be equally feasible in the contemporary DES era. In cases of a provisional strategy for bifurcation lesions, non-significant SB narrowing after MV stenting might rarely show positive FFR (approximately 10-20%), and therefore FFR guidance is helpful in decision making for SB treatment. In true distal LM bifurcation lesions in which a two-stent strategy is planned, IVUS-guided optimisation is crucial and affects early and long-term clinical outcomes. Although there is no common rule for bifurcation treatment, the integrated use of functional and imaging tools (i.e., FFR or IVUS) will make bifurcation treatment a matter of concept rather than technique, which will tailor individualised decision making of the optimal treatment strategy for such complex coronary lesions.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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