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Definition and classification of bifurcation lesions and treatments

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Introduction

Coronary bifurcation lesions are regarded as complex and their treatment is still the subject of substantial debate. Dedicated studies, data collection and outcome assessment are complicated by the existence of significant discrepancies between the various definitions, as well as the multiplicity of descriptions and classifications of lesions, partially described treatment techniques under several names and inaccurate analysis and measurement methods.

The purpose of the present article is to provide a new terminology for coronary bifurcations resulting from discussions held and consensus statements issued by the European Bifurcation Club (EBC)[1].

Definition of a bifurcation stenosis

The various definitions[2] of coronary bifurcation stenosis currently available are obviously based on the presence of a main vessel and a side branch (SB). These definitions do not take into account the distance between the main vessel stenosis and the ostium of the side branch. However, given that there is no lesion-free area between the main branch minimal luminal diameter (MLD) and the side branch ostium, stent implantation in the main branch, especially with drug-eluting stents, cannot be carried out without involving the SB.

Successive definitions of bifurcation lesions have been based on the side branch diameter, either arbitrarily or in relation to potential treatment strategies, and also on the diameter of the smallest available balloon or stent.

Definition of a significant side branch according to the volume of vascularised myocardium, which is not easy to assess, is in fact the same problem, given the linear relation between vessel diameter and myocardial mass[3].

Defining the importance of a SB according to the potential consequences of its occlusion includes also factors such as left ventricular ejection fraction, myocardial viability or localisation of ischaemia.

The definition proposed by the EBC takes into account the characteristics of each individual patient: a bifurcation stenosis is a coronary artery narrowing occurring adjacent to, and/or involving, the origin of a significant side branch. A significant SB is a branch that you don't want to lose in the global context of a particular patient (symptoms, location of ischaemia, branch responsible for symptoms or ischaemia, viability, collateralising vessel, left ventricular function...)"[4].

The linear relation between diameter and myocardial mass which applies to all coronary arteries, as well as the relation between myocardial necrosis and elevation of myocardial markers in the blood, may generate a new definition based on the clinical consequences of side branch occlusion for each individual patient.

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Lesion classification

In medicine, classifications are often used to describe pathologies, anatomies and techniques in order to simplify complex issues. Why classify bifurcation lesions? Because definitions involve several anatomical characteristics which vary according to the position of the lesion(s) in one or more of the three segments of the bifurcation: proximal main (PM), distal main (DM), or side branch (SB).

The objective is to associate each type of bifurcation with a prognosis, a technical difficulty or an optimal type of treatment, although this should not be regarded as systematically relevant.

In addition to the localisation of lesions, the classification criteria may lie in the presence and significance of calcifications, lesion length, and the angles between the vessel segments.

The position of lesions in the three segments of the vessel has generated several classifications using letters and Roman numerals[2,5-8]. Not all of these definitions are exhaustive. In addition all of them require a memorisation effort. The various lesion types are sometimes grouped into "true" bifurcation lesions (stenosis in the proximal and/or distal segment of the main vessel and in the SB) or "pseudo" bifurcation lesions in cases where the side branch is involved but only the main vessel is diseased.

The only classification which indicates the position of lesions and does not require memorisation is the Medina[9] (Figure 1) classification validated by the EBC. It is comprised of three numbers and two commas. The number before the first comma represents the PM, the number between the two commas is the DM, and the number after the second comma represents the SB. "1" accounts for the presence and "0" for the absence of a >50% lesion. Most of the time, this classification is performed by means of simple visual analysis. It should, however, be confirmed by quantitative angiography performed with dedicated software taking into account the laws of coronary ramification[10,11]. As with any other classification, Medina's classification does not provide a complete description of lesions. Indeed, no differentiation is made between a normal segment (lesion-free segment) and a <50% lesion, or between two lesions in the PM and DM and a single continuous lesion in the main vessel. The presence of calcifications is not identified by this classification, though they may influence the outcome of the treatment strategy. Accurate visualisation of calcifications depends on the quality of the X-ray equipment and quantification remains subjective. Angles may have an impact on the outcome of certain therapeutic techniques[12,13]. They can only be reliably measured using 3D angiography. In addition, including these continuous values in a classification implies that cut-off values must be selected. This also applies to lesion length, especially for the SB, which may influence the selection and the outcome of the treatment strategy. Measurement by a dedicated QCA of lesion length and vessel angles may be combined with the Medina classification confirmed by quantitative angiography.

Movahed[8,14,15] proposed a clinically relevant, simple and complete classification which allows a relationship to be built up intuitively between the aspect of a lesion and a potential treatment strategy. However, this classification is difficult to memorise and has not been supported by any randomised study.

Indeed, there is currently no available description of prognostic values associated with the various Medina lesion types identified[16]. Moreover, except for the DK-Crush trial, all studies and meta-analyses have demonstrated the equivalence or even the superiority of the provisional SB stenting strategy compared with systematic dual stenting in most lesion types (except for 0,0,1)[17-27].

The results of certain studies even suggest that the Medina classification could be reduced to two lesion types: either 1,1,1 or non 1,1,1[28,29]. Any classification is primarily a working tool for the analysis of series and for randomised controlled trials. Medina's is the simplest and the most reliable classification.

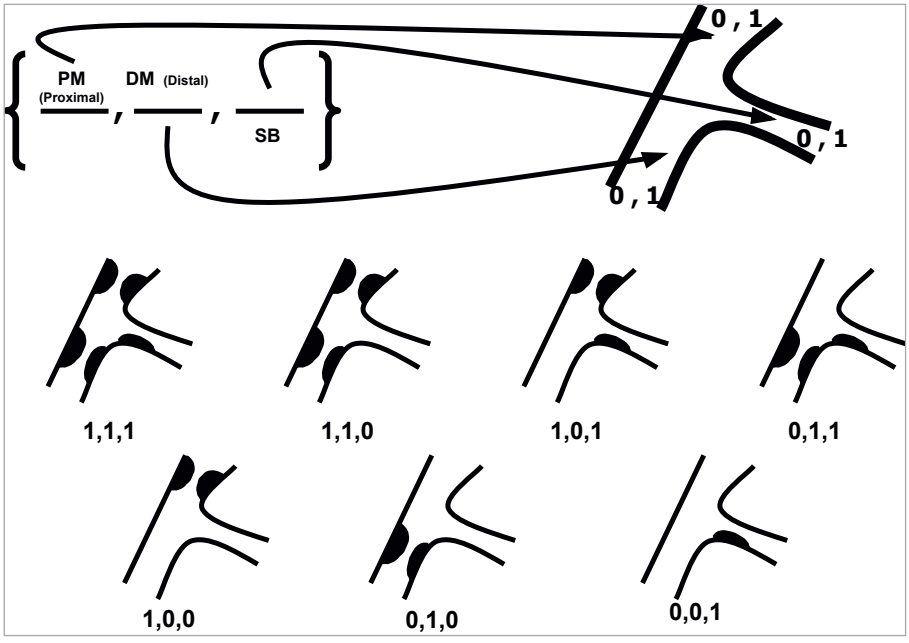

Figure 1. Medina classification.

In view of certain limitations associated with angiographic assessment, a Medina "IVUS index" has been proposed. This would be based on the localisation of plaque rather than significant lesions, although IVUS findings may not automatically influence treatment outcome. A Medina "FFR index" has also been considered, though this is not feasible as FFR can only be used to analyse two vessels and not three segments.

Denomination of a bifurcation lesion

In order to define a bifurcation lesion according to the Medina classification as well as the treatment strategy implemented, the main distal segment and the side branch must be accurately identified.

It may be useful to note that diagonals are almost always side branches. It is, however, more difficult to determine which marginal is the main branch and this difficulty also applies to the PDA and PLA.

According to the coronary ramification laws, the largest and/or the longest vessel is the main vessel.

It is preferable to avoid technical criteria such as difficult access to a small branch for identifying the main distal segment as this may complicate the classification and definition of treatments.

The EBC has proposed the identification of bifurcations following the same method as the Medina classification, for instance: LAD1, LAD2, Dg1 or LM, LAD1, Circ1, Ramus, etc.

Definition and classification of treatments

Technical treatment strategies of coronary bifurcation lesions are also amenable to classifications which facilitate their description in addition to pinpointing their common advantages and drawbacks.

Several indexes of technical strategies[2,7,8] have already been reported. The main limitations are the lack of accuracy and completeness[7,8], and memorisation issues[8]. Indexing techniques according to the number of stents implanted in a bifurcation are insufficiently accurate and may lead to confusion between techniques with completely different outcomes, especially when bare metal stents are used[29].

Final stent positioning in a bifurcation may serve to classify treatment techniques, though this does not take into account the order in which the stents are implanted, as in the case of the Culotte strategy where the operator may choose to start stent implantation in the main branch or in the side branch with really different technical difficulties.

The MADS classification proposed by the EBC takes into account

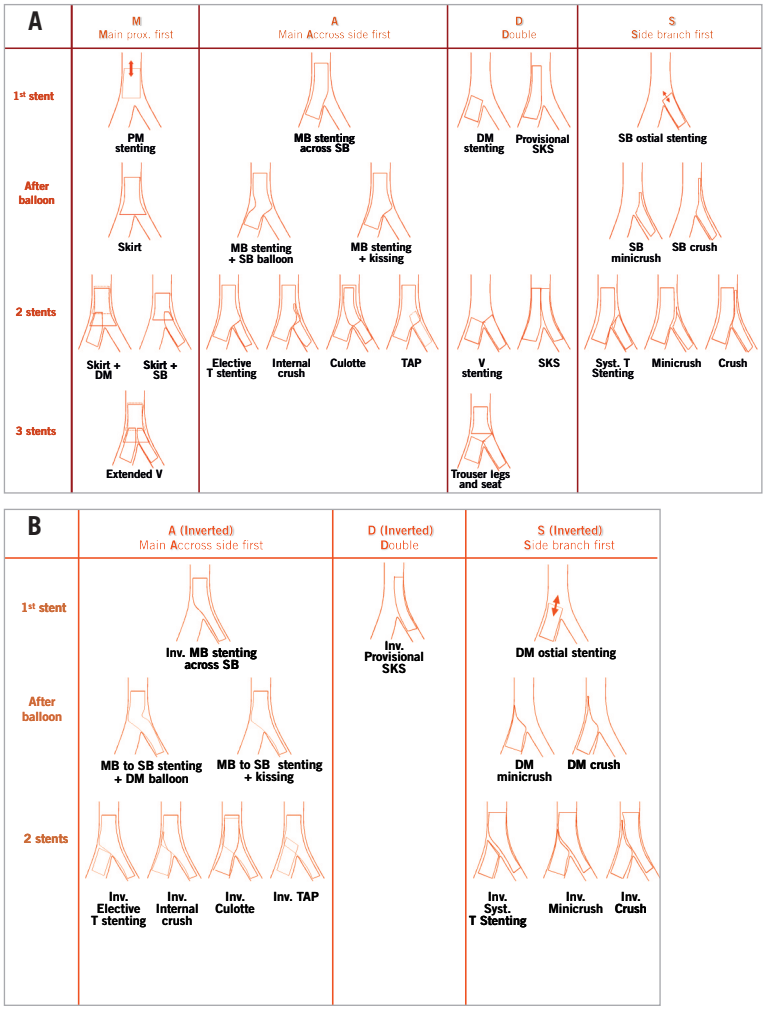

Figure 2. A) MADS classification: straight techniques; B) MADS classification: inverted techniques.

both issues, namely, final stent positioning and order of implantation. This classification describes the strategy implemented by the operator (placement of the first stent) and potential implantation of additional stents according to the operator mind, the results and the difficulties encountered. This is an open and exhaustive classification.

The four classes (Figure 2a) are identified by letters: M (main) indicates that the first stent is placed in the proximal main segment; A (across) that the stent is deployed in the main vessel through the SB, D (double) means that implantation of a single or two simultaneous stents is carried out in two separate lumens without necessity to cross any strut ; in Class S treatment strategy, the first stent is deployed in the SB with or without protrusion in the MB. In each treatment category, the initial strategy may be completed by implantation of one or two additional stents. All these techniques have been reported on or published and have been assigned a name chosen from a list of various denominations (suggested by authors).

The inversion of distal branches defines the “inverted techniques” for example the stenting of the main proximal segment towards the SB through the main distal segment (inverted provisional T) (Figure 2b).

Some operators may not find in this classification the exact description of “their” technique with wires and balloons such as, for example, the various types of “Crush technique” (conventional, balloon-crush) with or without final kissing balloon, DK-Crush...

An e-CRF including these various manoeuvres should result in a more exhaustive classification which would facilitate the tasks of an angiographic core lab.

Conclusion

Instruments have been developed to define, describe, classify and measure coronary bifurcation lesions and their treatment strategies. The objective is the use of a common terminology in order to compare the lesions and their outcome, as well as potential therapeutic solutions. So far, the randomised trials in which this terminology has been used have been limited to generic comparisons between simple and complex techniques and only in a few instances to head to head comparisons between well-defined complex techniques.

There is currently no indication that any individual lesion type included in the very simple Medina classification may be associated with a technique or an optimal treatment device in the future.

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