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Title: The shortcomings of The Medina compared to the Movahed coronary bifurcation classification led to stagnation in coronary bifurcation research. Time for a change in using the more comprehensive but at the same time simpler Movahed coronary bifurcation classification.

Short title: The Medina vs Movahed Bifurcation Classification

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Special report:

Older Coronary bifurcation classification not in clinical use:

Coronary artery intervention in the setting of coronary bifurcation is associated with less success and increased risk for stent thrombosis, myocardial infarction, and restenosis. In order to reduce complications and increase success rate, a comprehensive classification that is on one hand simple but on the other hand can describe a given bifurcation lesion if needed in detail is very important for clinical and research use involving coronary bifurcation lesions to guide bifurcation research and use of specific technique.

There are many coronary bifurcation lesions classifications that have been published to improve clinical understanding of bifurcation lesions. Initially, 4 classifications were described before the era of drug-eluting stents. They have similarities and are very difficult to remember. Furthermore, it was not clinically useful as true bifurcation lesions were separated into many unnecessary subgroups groups without describing other important features such as bifurcation angles in their classification. Different types were separated using numbers or the alphabet without any association between the given name and anatomical description seen in the bifurcation lesion. (1,2)

For example, the Sanborn classification, Sanborn's Type I and Type III lesions describes two lesions separating two different lesions without clinical relevancy. Similar to Sanborn, Safian separating type I A and IIIA and Lefevre 1 type 1 and type 4 lesions are not relevant and difficult to remember. Furthermore, they do not describe proximal segment or angulation very important for choosing different two stents' techniques. As

there is no connection between the given name and lesion types, they are very difficult to memorize. These are the main reasons why these classifications have not been utilized in clinical practice.

The shortcoming of the Medina classification leading to stagnation of research involving coronary bifurcation lesions:

In the last decade, the use of the Medina classification (3) has gained popularity in the interventional community despite the fact that the Medina classification separates true bifurcation lesions into 3 unnecessary subgroups: proximal segment of main branch, side branch ostia, and distal segment of the main branch. Any disease of each segment involvement will be given suffix 1 otherwise suffix 0 is assigned starting from left to right. For example, lesion 1,1,0 means that the proximal segment, and side branch ostia are diseased, but the distal part of the main branch is free of disease (Figure 1). This classification appears to be easily memoizable but completely fails to include many important features of given bifurcation lesions such as angulation, the size of the healthy proximal segment, disease burden, length, location, length of the lesion, etc. Furthermore, separating true bifurcation lesions into three unnecessary subgroups makes this classification useless.

The Movahed coronary bifurcation simplifies bifurcation lesions and at the same time offers optional suffixes for a more detailed description of a given bifurcation lesion if needed:

In order to overcome the limitations and shortcomings of all the above-described classifications, the Movahed bifurcation classification was introduced eliminating the redundancy of separating true bifurcation lesions in unnecessary subgroups and at the same time introducing additional suffixes that can be added as needed to describe any important details needed for a given bifurcation lesion regarding choosing best interventional technique and also to make comparative bifurcation lesion studies by describing the kind of lesions were studied. Furthermore, it is very easy to memorize (Figures 1, 2 3). (4,5) This classification is based on a system that is composed of a single prefix to which up to unlimited different suffixes can be added if desired. (The description of this classification starts with the prefix B (for Bifurcation lesion) to which other suffixes can be added for a final description of a given bifurcation lesion. The nomenclature for true bifurcation lesions has only one description called B2 (B for bifurcation 2 meaning both bifurcation ostia have disease. Separating true bifurcation lesions from others is very important without dividing true bifurcation to unnecessary subgroups. It is proven that the risk of side branch occlusion is much higher in true bifurcation lesions regardless of where the lesions in a given bifurcation occur making separation useless.

Furthermore, if only the main branch has disease, it will be called B1m (B for bifurcation, 1m meaning only one branch main branch has disease) or 1s (meaning only 1 branch involving the side branch has disease). These summarize all bifurcation lesions into simple three categories called B2, B1m, and B1s lesions.

The importance of summarizing true bifurcation lesions in one group and separating it from non-true bifurcation lesions:

The importance of true bifurcation (B2) lesions in comparison to other non-true bifurcation lesions has been documented numerous times. In the first randomized trial comparing the NIR stent to the Palmaz-Schatz stents, true bifurcation lesions (B2 lesions) were found to be associated with a much higher occurrence of myocardial infarction in comparison to lesions that have no side branch (B1m) involvement (40% for B2 lesions vs. only 4.7% if side branch was not involved B1m lesion). (6) B2 lesions have the highest angiographic predictor for side branch occlusion in 65% of lesions vs. 4% in lesions without side branch disease.

The importance of the bifurcation angle is described as V or in the Movahed bifurcation classification regarding clinical outcome:

Another important feature of a given bifurcation lesion for the clinical outcome is the bifurcation angle. By adding any optional suffixes such as for example bifurcation angle (V or T), this classification has limitless options in describing a given bifurcation if needed for research, coding, or clinical. The suffix V describes shallow angles less than 70 degrees (like a V) and the suffix T describes a steep angle of more than 70 degrees (like a T). For example, a B2T lesion is a simple description of a true bifurcation lesion

(meaning both branches have involvement of both bifurcation branch ostia (2 for both ostia) with a steep angulation (T for steep angulation) of branches.

Angulation of bifurcation branches that are ignored in other classifications is very important regarding outcome. Steep angulation makes side branch access more difficult after main branch stenting and therefore, it is significantly associated with worse outcomes. Dzavik et al. documented this fact. (7] found a significant increase in long-term mortality in highly angulated lesions that were treated with crush stent technique. Furthermore, steep angulation is at high risk for abrupt vessel closure or side branch occlusion. 8 Therefore, it is very important that bifurcation classifications incorporate this important feature into classification as it is done in Movahed's classification.

Important to describe the proximal healthy segment of a given bifurcation lesion in the case of planning to use the kissing stent technique:

Another important feature of a given bifurcation lesion is a description of the proximal segment in the case a kissing stent technique is desired. This part is completely ignored in clinical trials comparing different bifurcation interventional techniques. For the kissing stent technique to be utilized, the proximal healthy segment to deploy the stent has to be at least as large as $2/3$ of the sum of the diameter of both distal branch vessels in order to accommodate two stents. (9) In The Movahed classification has an optional suffix called L that can be added to describe the proximal segment if it is at least $2/3$ of the sum of distal branches making kissing stent technique feasible in these lesions (L for Large

proximal segment), whereas if the proximal segment is small (less than 2/3 of the sum of the diameters of both branches) it is assigned the suffix of S (S for Small proximal segment) meaning that Bs lesions are not suitable for the kissing stent technique.

Importance of having limitless optional suffixes if needed to describe a given bifurcation lesion for clinical or research purposes if needed:

The Movahed bifurcation classification has limitless optional suffixes that can be added if needed. For example, bifurcation lesions involving LM could add additional suffix LM to B2 true bifurcation lesions or CA for severe calcification or TR for thrombus-containing lesions, etc. if needed to describe more detail of a given bifurcation lesion for research or clinical purposes. In extreme cases for better communication if needed, an interventionalist could describe a true heavily calcified bifurcation lesion containing significant thrombus with steep angulation as a B2TTR lesion, or if a detailed description is not needed just use B2 for a true bifurcation lesion. A summary of currently available classifications can be seen in Figure 1. A detailed structural explanation of Movahed's classification can be seen in Figure 2. A comparison to the Medina classification can be seen in Figure 3. Suggestions for interventional techniques based and some important anatomical features of a given bifurcation lesion can be seen in Figure 4.

Conclusion:

In the era of drug-eluting stents, coronary artery bifurcation interventions are performed in higher numbers.. It is important to have a clinically relevant classification of coronary bifurcation lesions without useless subgroup division of a true bifurcation lesion.

Furthermore, it should be easy to remember but on the other hand, should have optional suffixes that can be used if needed for better communication accuracy and description of specific bifurcation lesions studied. The Medina classification has severe shortcomings regarding the above-described issues whereas The Movahed bifurcation classification removes the shortcoming of the Medina classification by making it simpler but more comprehensive with limitless suffixes that can be used if needed. It should be time to abandon the Medina classification in favor of the Movahed bifurcation classification (10) in order to proceed with a more accurate design of interventional trials and techniques based on specific bifurcation lesion and resolve current stagnation in coronary bifurcation research that is related to the use of the Medina bifurcation classification.

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Figure1: Summary of currently known coronary bifurcation classifications with permission from Expert Rev Cardiovasc Ther ².

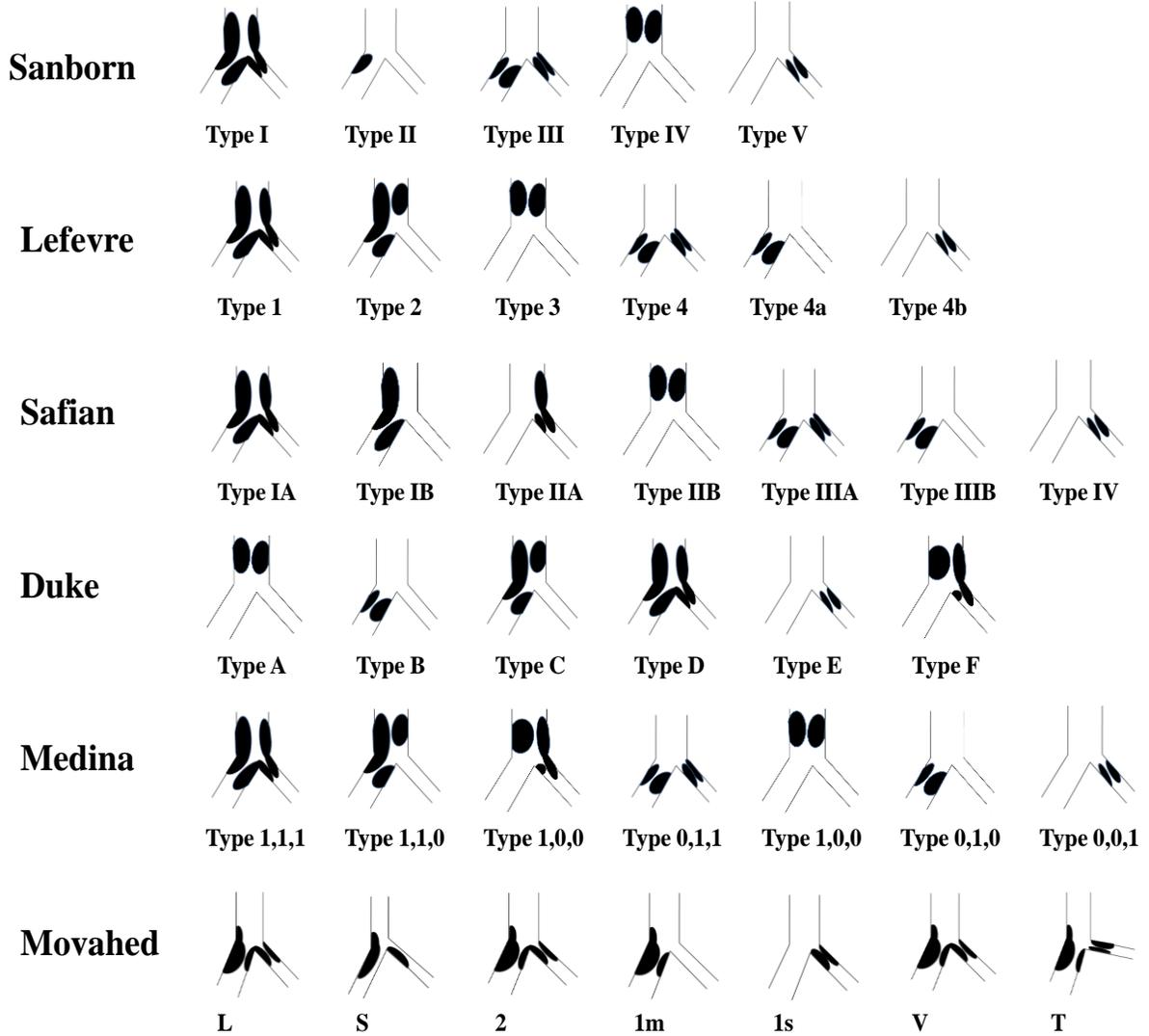
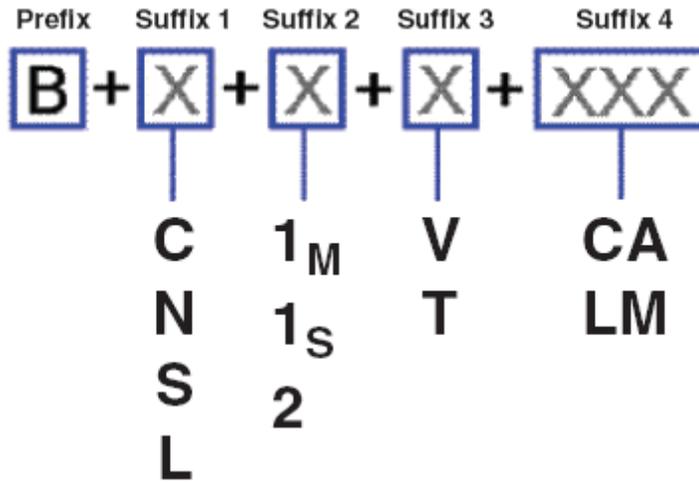


Figure 2: Detail structural description of the Movahed's coronary bifurcation classification (reprint with permission from The Journal of Invasive Cardiology ⁴)



- Suffix 1: C = Close to bifurcation
 N = Non-significant sidebranch
 S = Small proximal segment
 L = Large proximal segment
- Suffix 2: 1_M = Only main branch ostium diseased
 1_S = Only sidebranch ostium diseased
 2 = Both main and sidebranch ostia diseased
- Suffix 3: V = Angle between branch vessels less than 70 degrees
 T = Angle between branch vessels more than 70 degrees
- Suffix 4: CA = Calcified
 LM = Left main involved in bifurcation

Figure 3: Comparison between the Medina and the Movahed bifurcation classification revealing simpler and clinically more relevant Movahed classification summarizing all true bifurcation lesion into a simple one category called B2 lesion. (reprint with permission of Anatolian Journal of Cardiology ⁵)

Movahed	Medina
B2	1.1.1, 1.0.1, 0.1.1
B1m	1.1.0, 1.0.0., 0.1.0
B1s	0.0.1

Figure 4: Examples of relevant interventional techniques depending on the type of bifurcation lesion. (see figure 2 for abbreviations. Reprint with permission from Expert Review in Cardiovascular Therapy ²)

