Bifurcation Classification Schemes: Impact of Lesion Morphology on Development of a Treatment Strategy

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A number of bifurcation lesion classification schemes exist in which capital letters or Roman numerals categorize various types of bifurcation lesions. Unfortunately, these classification schemes are confusing and difficult to remember because of the lack of association between the numbers or letters and various anatomic abnormalities of bifurcation lesions. Recently, the Medina classification was proposed as a simpler, easier-to-remember scheme that labels bifurcation lesions by plaque involvement in 3 anatomic segments (proximal main segment, distal segment of main branch, and side branch). However, this classification also has limitations because it doesn't include important descriptive features of bifurcation lesions that could be important in determining optimum stent treatment strategy. The Movahed classification overcomes these limitations by including bifurcation angle and proximal vessel size in its scheme. The impact of these various classification schemes on stent treatment strategies and more recent clinical trial results is discussed.

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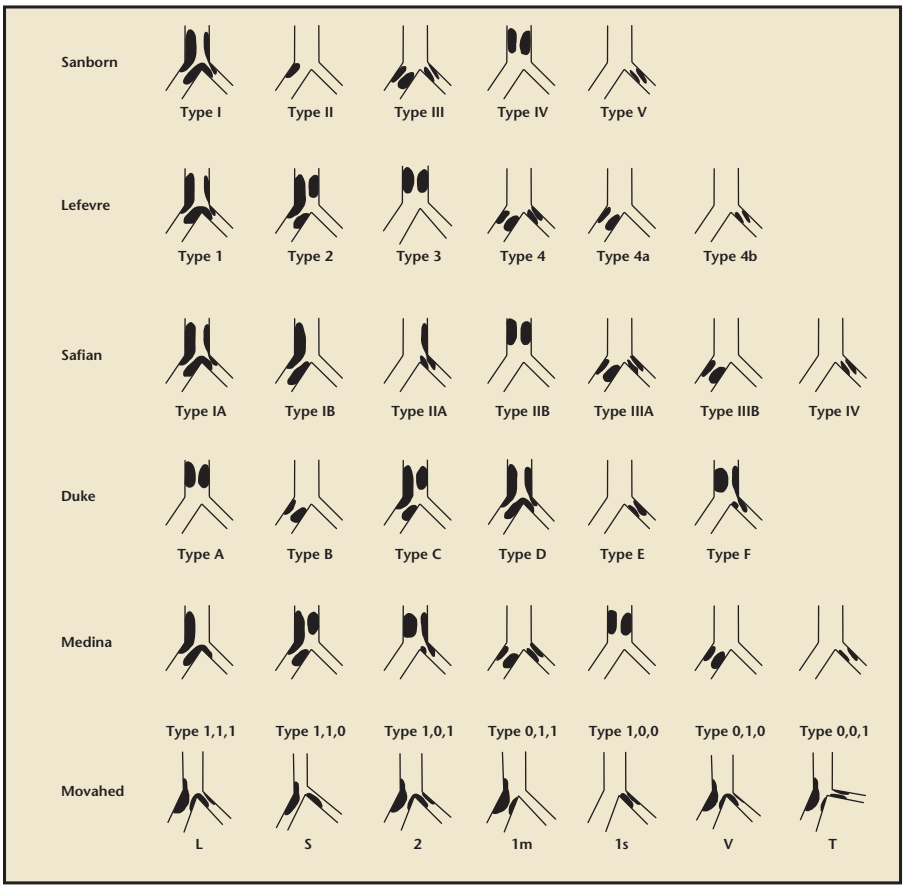
Despite advances in stent technology, including drug-eluting stents (DES), coronary artery bifurcation lesions continue to remain a significant challenge for percutaneous coronary interventions (PCI). As compared with the excellent results of DES treatment of nonbifurcation lesions, there continue to be both increased risk of immediate procedure-related complications (eg, side branch [SB] occlusion and biomarker elevation indicative of myocardial infarction) and lower long-term successful outcomes (eg, higher restenosis and stent thrombosis rates) in bifurcation lesions treated with DES.[1-4] Although

a number of different interventional techniques have been proposed for treatment of bifurcation lesions (crush, culotte, kissing stent, one-stent, stent with balloon, and T-stent techniques), utilization of a clinically useful bifurcation lesion scheme could help determine which stent strategy would provide the best procedural and long-term outcomes for different bifurcation lesion types.

Bifurcation Lesion Classification Schemes

Currently, 6 major bifurcation lesion schemes have been published in the literature (Figure 1).[5-9] In the first 4 classification schemes, capital letters or Roman numerals are used to categorize various bifurcation lesion types. Unfortunately, these classifications are not clinically relevant and are confusing and difficult to remember because of their lack of association between the numbers or letters and various anatomic abnormalities of bifurcation lesions. For these reasons, the Medina classification[8] was proposed in 2006 as a scheme that is simpler and easier to remember because it classifies bifurcation lesions by the presence or absence of disease in the proximal segment of the main branch (MB), distal segment of the MB, and the SB side branch. Any involvement in each segment is assigned suffix 1, otherwise suffix 0 is assigned from left to right. For example, lesion 1,0,1 means that the proximal segment and distal part of the main branch has disease but the side branch ostia are free of disease.

Figure 1. *Summary of currently published major coronary bifurcation classifications. Reproduced with permission from Movahed MR.*[9]



Because of its simplicity, the European Bifurcation Group recently recommended that this scheme be used for the classification of bifurcation lesions.[10]

As Movahed[9] has pointed out, however, the Medina classification does have limitations; it doesn't include the important description of proximal vessel size and bifurcation angle in its scheme. These descriptors are important in choosing different stent techniques.[11] In this new scheme, a series of suffixes were created to describe the size of the proximal main vessel (MV) segment (S or L for small or large), disease in the main (M), side (S), or both vessels, and lesion angulation (V for $< 70°$ and T for $> 70°$) (Figure 2). Including additional descriptors of the bifurcation lesions over and above the Medina classification may aid in comparing and choosing which stent technique is best for each individual bifurcation lesion type.

Examples of Different Stent Strategies in Different Bifurcation Lesions

It has already been reported that different bifurcation lesions may be treated better with different stent techniques (Figure 3). For example, Dzavik and colleagues[12] have reported that the crush technique was associated with higher major cardiac events in highly angulated bifurcation lesions as compared with shallow-angled bifurcation lesions (22.7% vs 6.2%; $P = .007$). Steep angulation has also been shown to be a risk factor for SB occlusion.[13] Thus, highly angulated lesions may be better treated with an alternative stent strategy such as the culotte or T-stent technique as compared with the crush technique (Figure 4).

The Medina classification scheme also doesn't describe the size of the proximal MV. This characteristic may be important when considering

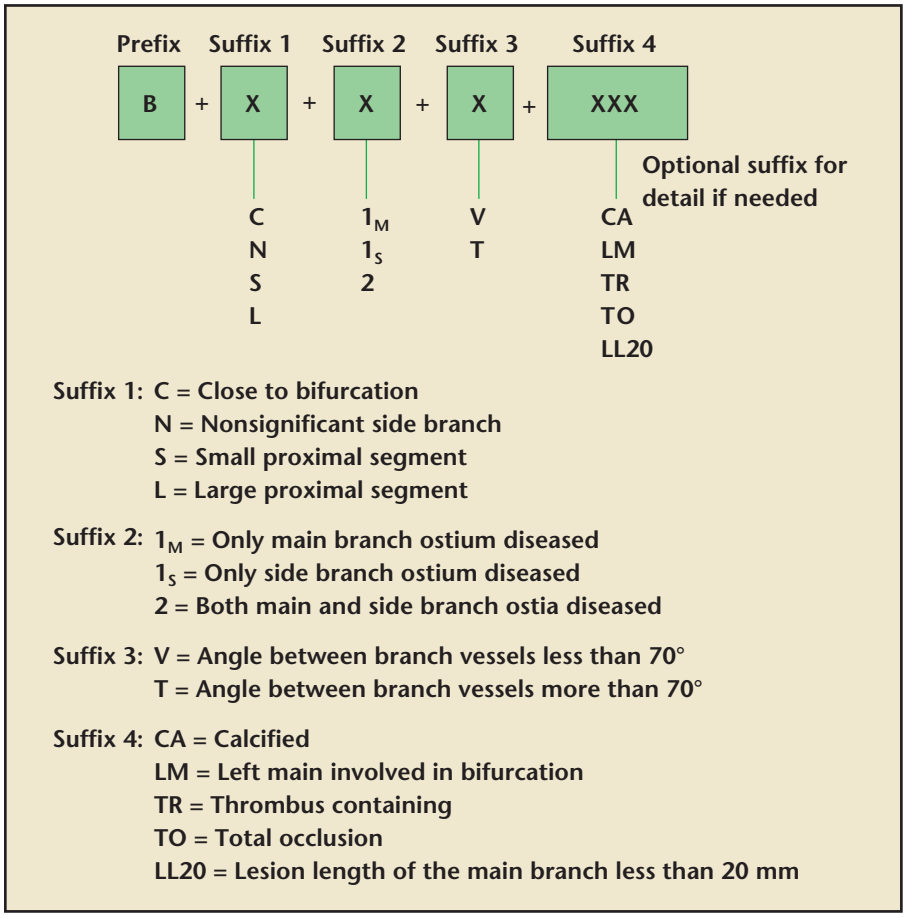


Figure 2. *Detailed structural description of the Movahed coronary bifurcation classification with modification of the fourth suffix. Reproduced with permission from Movahed MR, Stinis CT.*[11]

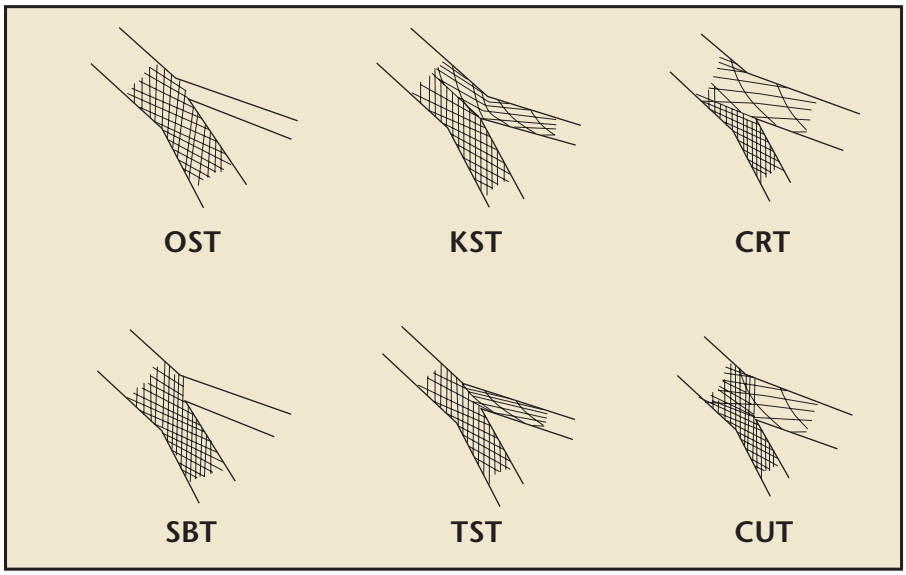


Figure 3. *Schematic description of interventional bifurcation techniques. CRT, crush stent technique; CUT, culotte stent technique; KST, kissing stent technique; OST, 1-stent technique; SBT, stent with balloon technique; TST, T stent technique. Reproduced with permission from Movahed MR.*[9]

the kissing stent technique.[14] If the proximal MV is too small, use of the kissing stent technique with 2 stents in the proximal MB may not be feasible. Only if the size of the proximal vessel is greater than two-thirds of the sum of the 2 SBs is it recommended that the kissing stent technique be used (Figure 5).

Randomized Comparisons of Different Stent Techniques for Bifurcation Lesions

Several randomized studies have addressed different stent strategies for the treatment of bifurcation lesions. In the Sirius bifurcation study with sirolimus-eluting stents, a 6.3% risk of stent thrombosis in patients that were stented in both the MB and SB raised concerns about this stent strategy when compared with provisional stenting of the SB.[1] However, in another study in which patients were randomized to simple versus complex stent strategies, there was no difference in restenosis rates or clinical outcomes with stenting of the MB and balloon dilation of the SB versus additional stenting of the SB.[15] More recently, a series of randomized studies were reported from the Nordic PCI Study Group in which investigators examined different stent strategies for bifurcation lesions. In the Nordic I Study, the strategy of stenting the MV and the SB was compared with stenting the MV with optional stenting of the SB with sirolimus-eluting stents.[16] Although there was no difference in the primary endpoint of major adverse clinical events at 6 months between the 2 stenting techniques, there were significantly longer procedure and fluoroscopy times, higher contrast volumes, and a higher rate of procedure-related increases in biomarkers of myocardial injury in the MV plus SB stenting group as compared with the simple stenting strategy. In the second Nordic Stent

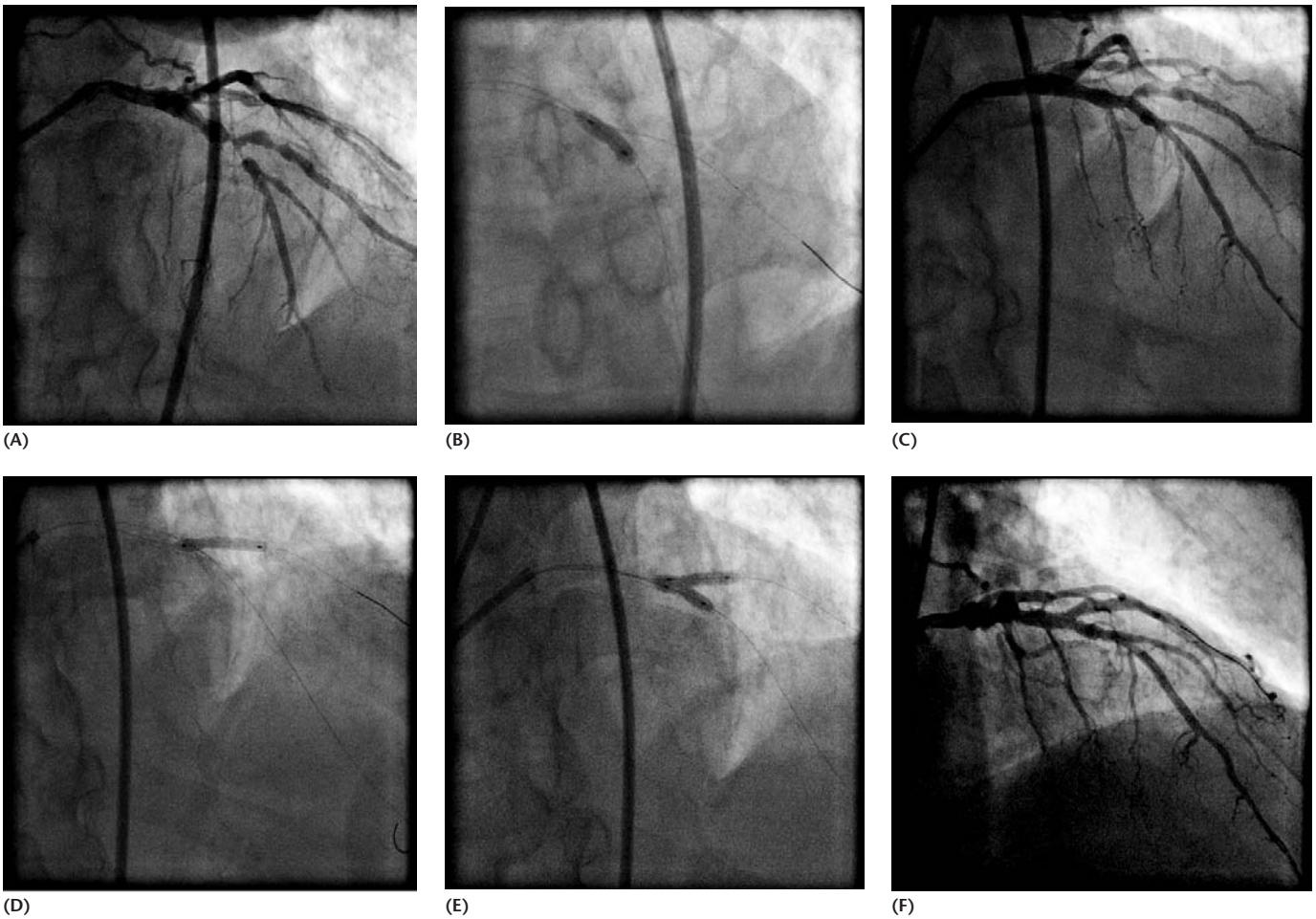


Figure 4. (A) *Example of a Medina 1,1,1 or Movahed B2V left anterior descending artery (LAD)-diagonal bifurcation lesion.* **(B)** *Placement of a Promus® 3.5 × 12 mm stent in the main vessel followed by post dilation with a Quantum™ 3.5 × 12 mm balloon through an 8F guide.* **(C)** *Plaque shift in diagonal.* **(D)** *Placement of a Promus 3.0 × 12 mm stent in the diagonal after predilation with 2.0 × 12 balloon using the culotte technique.* **(E)** *Final kissing balloon dilation of both branches with Quantum 3.5 × 12 and 3.5 × 15 balloons.* **(F)** *Final angiographic result. The Promus stent and Quantum balloon catheter are manufactured by Boston Scientific Corp. (Natick, MA).*

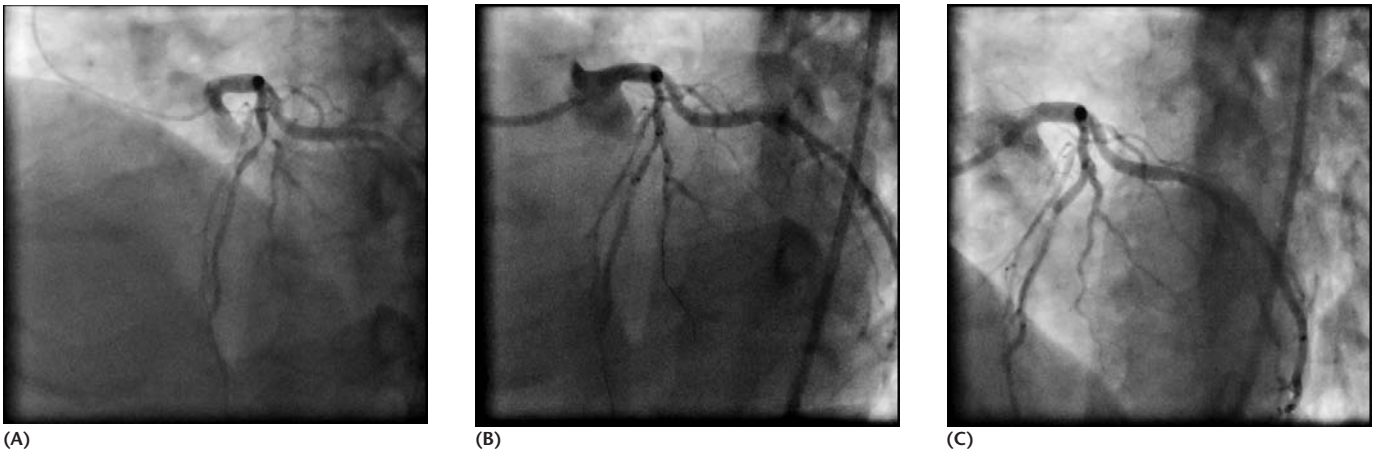


Figure 5. (A) *Example of a Medina 1,1,1 or Movahed BL2V left anterior descending artery (LAD)-diagonal bifurcation lesion.* **(B)** *Placement of Promus® 3.0 × 15 stent in the LAD and 2.5 × 12 Promus stent in the diagonal through an 8F guide after predilation.* **(C)** *Final angiographic result. The Promus stent is manufactured by Boston Scientific Corp. (Natick, MA).*

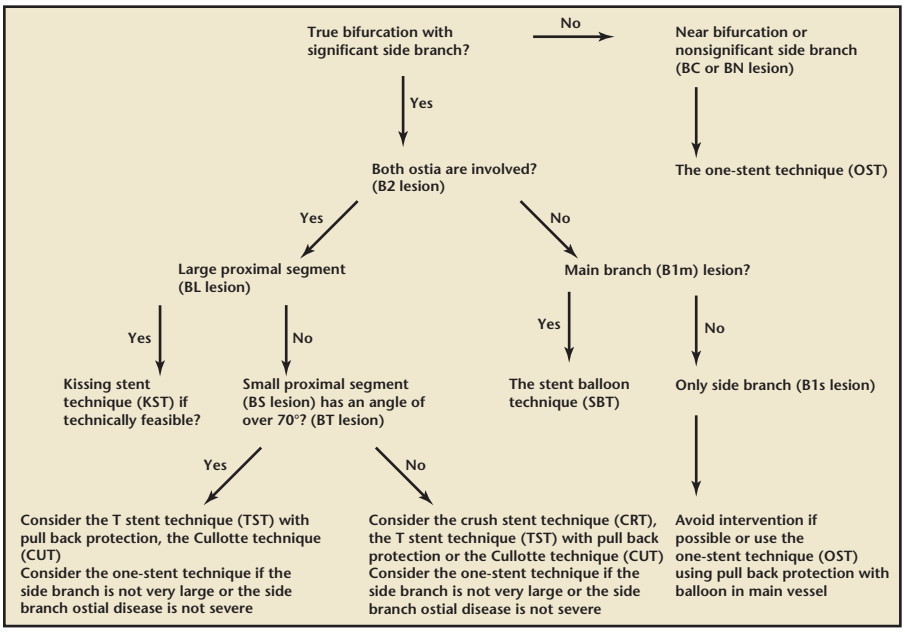


Figure 6. *An algorithmic approach for the treatment of coronary bifurcation lesions based on the lesion type. Reproduced with permission from Movahed MR.*[9]

Technique Study in which both the MV and the SB needed stent coverage, the crush and the culotte techniques were compared in a randomized trial with clinical and angiographic endpoints. Although both techniques were associated with similar clinical and angiographic results, there was a trend toward less procedure-related increase in biomarkers of myocardial injury and significantly reduced in-stent restenosis following culotte stenting.[17] An algorithm for approaching coronary artery bifurcation lesions based on bifurcation landscape is suggested in Figure 6.

Conclusions

Treatment of bifurcation lesions continues to represent a significant challenge in interventional cardiology despite the development of DES and the use of multiple stent strategies. As different bifurcation lesions may be better treated with different stent strategies, a clinically relevant bifurcation lesion classification scheme is necessary to compare and optimize our treatment of bifurcation lesions. The Medina classification is currently the most widely accepted scheme. Additional lesion descriptors such as lesion angulation (V or T) would be helpful for the development of bifurcation lesion treatment strategies in the future. ■

Dr. Sandborn has no real or apparent conflicts of interest to report.

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Main Points

- Despite advances in stent technology, coronary artery bifurcation lesions continue to remain a significant challenge for percutaneous coronary interventions.
- Currently, 6 major bifurcation lesion schemes have been published in the literature. Unfortunately, these classifications are not clinically relevant and are confusing. As a result, the Medina classification was proposed as a scheme that is simpler and easier to remember because it classifies bifurcation lesions by the presence or absence of disease in the proximal segment of the main branch (MB), distal segment of the MB, and the side branch.
- Although a number of different interventional techniques exist for treatment of bifurcation lesions, utilization of a clinically useful bifurcation lesion scheme helps the operator determine which stent strategy will provide the best procedural and long-term outcomes for different bifurcation lesion types.

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