Contemporary Bifurcation Treatment Strategies: The Role of Currently Available Slotted Tube Stents

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Treatment of coronary bifurcation lesions remains complicated and fraught with procedural challenges. Although numerous techniques have been proposed for treating bifurcations, no approach completely circumvents the limitations of the current stent platforms. This article discusses management strategies currently available for treating bifurcation lesions, including techniques to optimize deployment and outcomes.
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Coronary bifurcations remain a challenging lesion subset, constituting 15% to 20% of all percutaneous coronary interventions (PCI).[1-3] Bifurcation disease has been the focus of intense interest. These lesions subtend large areas of myocardium, suffer from higher risks of stent thrombosis and symptomatic restenosis, and are often the reason coronary bypass surgery is chosen over PCI.[4-6] Furthermore, procedural challenges are considerable. Although numerous techniques have been proposed for treating bifurcations, no approach completely circumvents the limitations of the current stent platforms, which were designed for tubes, not complex, variable branching geometries.[7-9] This review focuses on the currently available slotted tube stents for the management of bifurcation coronary disease.

Drug-Eluting Stents Versus Bare Metal Stents

The outcomes of coronary bifurcation stenting have improved substantially, in large part a consequence of potent drug-eluting stents (DES) that inhibit neointimal accumulation, preventing the high rates of restenosis associated with bare metal stents (BMS).[10] Registry data from BMS and DES studies illustrate the marked improvements in major adverse cardiac events (MACE) and target lesion revascularization (TLR) (Figure 1).[11-14] There are no large bifurcation-specific trials of DES versus BMS, although the Stenting Coronary Arteries in Non-Stress/Benestent Disease (SCANDSTENT) trial of BMS versus sirolimus-eluting stents (SES) did examine a subset of 126 patients with bifurcations.[15] Implantation of SES significantly reduced restenosis rates at the main branch (MB) (4.9% vs 28.3%; $P < .001$) and side branch (SB) (14.8% vs 3.4%; $P < .001$), and also significantly reduced MACE (9% vs 28%; $P = .009$) (Figure 2).[15] Given these data, DES have become the default strategy for bifurcation lesions, for those able to comply with dual antiplatelet therapy.[2,10,16]

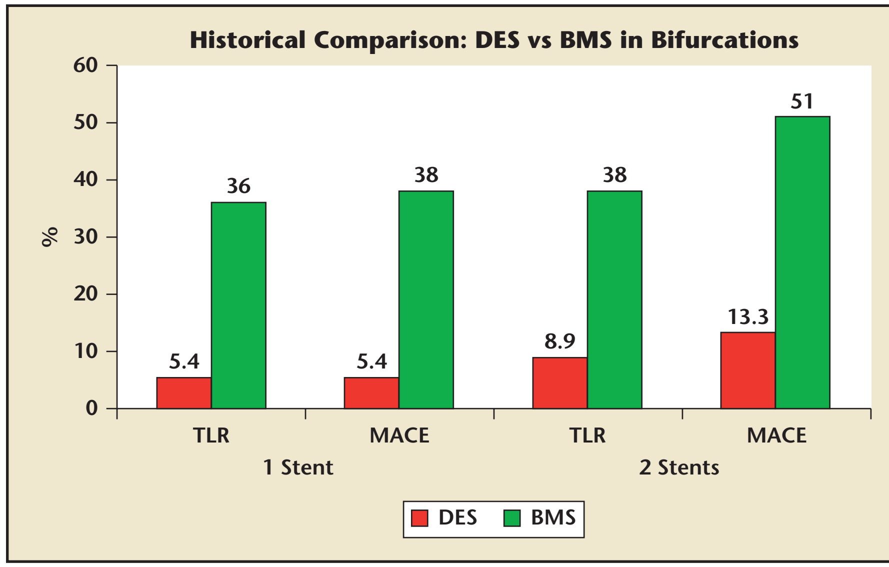
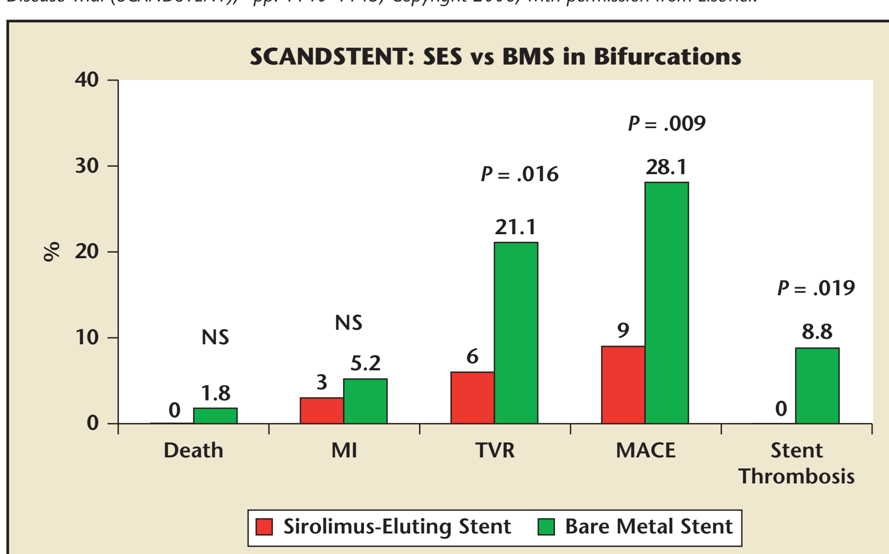


Figure 1. *Representative data from drug-eluting stent (DES) and bare metal stent (BMS) registries, demonstrating lower target lesion revascularization (TLR) and major adverse cardiac events (MACE) in 1- and 2- stent bifurcation lesions. Data from Yamashita T et al.[13] and Ge L et al.[14]*

Single MB Stent Versus 2-Stent Approach

Although in the past there has been considerable debate about whether a single MB stent was preferred over a 2-stent approach (SB and MB stents), multiple randomized trials have confirmed that a provisional strategy is appropriate and should be the default strategy for the majority of bifurcations. There have been 4 large contemporary randomized studies examining this issue (Figure 3).[17-20] These studies confirm that a 2-stent strategy does not reduce MACE or TLR compared with a single MB stent, but does increase contrast, fluoroscopy time, and periprocedural myocardial infarction (MI) rates. For example, Steigen and colleagues[18] from the Nordic collaborative group studied 413 patients with true bifurcation lesions and randomized them to either MB stenting or MB + SB stenting. Only 5% of the patients in each randomized group crossed over

Figure 2. *Results of the SCANDSTENT bifurcation substudy demonstrating superior outcomes of sirolimus-eluting stent (SES) versus bare metal stent (BMS). MACE, major adverse cardiac events; MI, myocardial infarction; SCANDSTENT, Stenting Coronary Arteries in Non-Stress/Benestent Disease Trial; TVR, target vessel revascularization. Reprinted from* American Heart Journal, *Vol. 152, Thuesen L et al, "Comparison of sirolimus-eluting and bare metal stents in coronary bifurcation lesions: subgroup analysis of the Stenting Coronary Arteries in Non-Stress/Benestent Disease Trial (SCANDSTENT)," pp. 1140–1145, Copyright 2006, with permission from Elsevier.[15]*



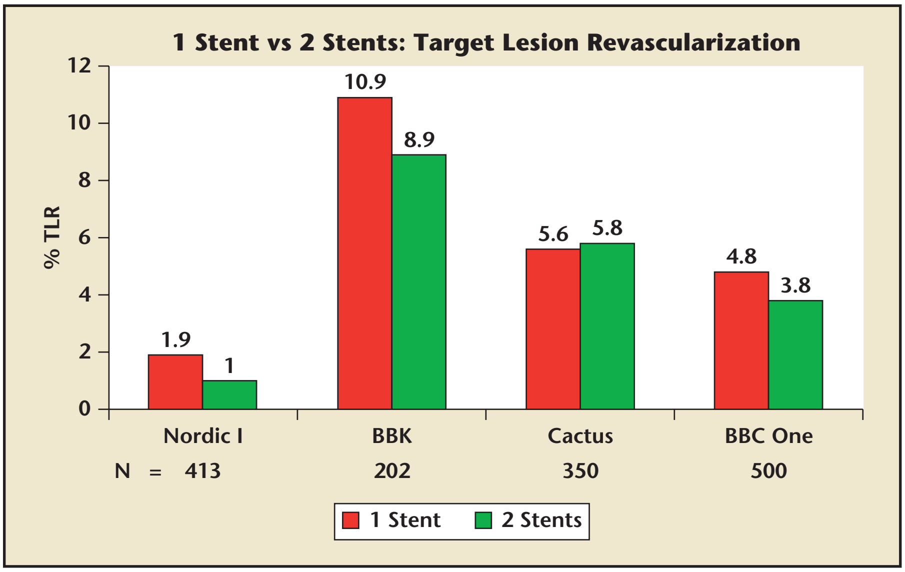


Figure 3. *Results of provisional 1-stent approaches versus 2-stent strategies for bifurcation lesions. There was no difference in percent target lesion revascularization (TLR) between the 1- and 2-stent approaches. BBC One, British Bifurcation Coronary Study; BBK, Bifurcations Bad Krozingen; CACTUS, Coronary Bifurcations: Application of the Crushing Technique Using Sirolimus-Eluting Stents. Data from Colombo A et al,[17] Steigen TK et al,[18] Ferenc M et al,[19] and Hildick-Smith D.[20]*

to the unassigned therapy. In the MB group, the primary treatment principles were (1) stenting of the main vessel (MV), (2) SB dilation if there was less than thrombolysis in myocardial infarction (TIMI) flow of 3 in the SB, and (3) SB stenting if TIMI flow was 0 in the SB after dilation. In the nonprovisional group, any 2-stent technique could be used. There were significantly longer procedural and fluoroscopy times and a larger volume of contrast used in the MB + SB group. Furthermore, an elevation of creatine kinase-MB > 3-fold the upper limit of normal was significantly greater in the 2-stent group (18% vs 8%; P = .011). Angiographic follow-up at 8 months revealed very low MB restenosis rates of 4.6% and 5.1% (P = .84), and acceptable SB restenosis rates of 19.2% and 11.5% (P = .062) in the MB and MB + SB groups, respectively. Clinical outcomes were not different (no difference in death, MI, target vessel revascularization, or composite MACE). Fourteen-month stent thrombosis was low in both groups (1.0% vs 0.5% MB only vs MB + SB respectively; P = ns).[21]

In the CACTUS (Coronary Bifurcations: Application of the Crushing Technique Using Sirolimus-Eluting Stents) study, 350 patients were randomized to a single MB stent or the mini-crush technique. Six-month mortality, MI, TLR, and overall MACE were not different. Stent thrombosis was 1.7% and 1.1% in the crush and provisional groups, respectively, and restenosis rates were equivalent (binary restenosis of 4.6% vs 6.7% in the MB and 13.2% vs 14.7% in the SB for crush vs provisional).[17] Although the 2-stent crush approach offered no advantage to a single MB stent, it was also true that if 2 stents were necessary, there was not a penalty in terms of a higher incidence of adverse events at 6 months. Unlike the Nordic I trial, the CACTUS study was notable for 31% of the provisional stent group having SB stenting. The criterion for crossing over from a 1- to a 2-stent approach was less stringent than Nordic I, 2 stents being allowed with > 50% residual SB stenosis, ≥ grade C dissection, or < TIMI 3 flow. In the Bifurcations Bad Krozingen (BBK) study, the crossover rate from provisional to 2 stents was nearly 19% and for the British Bifurcation Coronary Study (BBC One), much like Nordic, was only 3%.[19,20]

Another explanation for why the provisional approach was so effective may have to do with lesion selection. In general, studies of provisional stenting include focal SB stenoses.[18,22,23] SB lesions with more than focal lesion length are much less likely to respond to balloon dilation, and if the SB is large, often require a 2-stent strategy.

There are 2 provisional techniques for true bifurcation lesions.[1-3] The standard approach includes wiring both SBs, predilating the MB, and then stenting the MB while jailing the SB wire. Many have suggested it is preferable to not predilate the SB, because predilation distorts the carina. Furthermore, predilation may cause dissection, increasing the probability of tracking subintimally when reaccessing the SB. Also, predilation increases the probability a more proximal MB cell will be crossed, rather than recrossing into the SB through a more distal MB cell, which tends to

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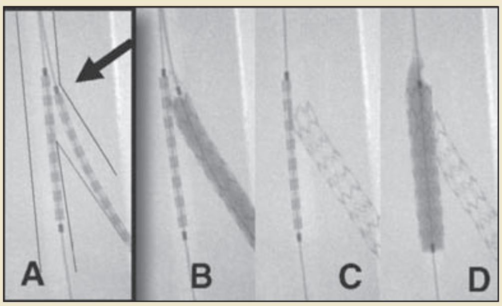
Mini-Crush



- **1–2 mm of SB stent positioned in MV (proximal SB stent marker on MB wire or SB just covers proximal edge of ostium)**
- **The SB stent is deployed and stent balloon withdrawn slightly with high RBP inflation (flares proximal stent)—then angiogram to make sure no distal dissection**
- **The SB stent is crushed by a MV balloon or a stent**

Figure 4. *Ex vivo model showing mini-crush bifurcation technique. MV, main vessel; RBP, rated burst pressure; SB, side branch. Reprinted with permission from Ormiston JA et al.*[38]

enhance ostial SB support.[7] If the SB is not compromised, a high-pressure dilation of the MB stent is performed. If, after stent deployment or high-pressure dilation, SB compromise occurs, the SB is rewired through the struts of the stent and dilated, followed by a final kissing balloon inflation (FKI). If threatened closure of the SB persists, then bailout stenting of the SB with a T-stent approach is appropriate, although a culotte or the internal crush technique can also be used.

The second provisional technique is the keep it open (KIO) approach and is used when the SB is diffusely diseased, the goal being to simply maintain its patency, avoiding a periprocedural MI. The KIO technique includes wiring both the MB and SB and then completely treating the MB (SB wire jailed throughout the entire intervention) without recrossing the SB or dilating it, thereby avoiding dissection and vessel closure.[2]

How necessary is the FKI with the provisional approach? The need for an FKI is indisputable when the SB has been dilated through the struts of the MB stent, a maneuver that invariably distorts the MB stent, causing a reduction in stent minimal area.[24] Less certain is whether a kissing inflation should be performed if the SB is not dilated; the Nordic III trial examined this issue.[25] Four hundred patients treated with a provisional stent approach were randomized to routine/uniform versus a selective kissing inflation strategy. There was no difference in outcome, suggesting that if the SB does not require dilation, a kissing inflation is unnecessary.

Another practical consideration is the jailing of the SB wire. In the T-stenting for Coronary Bifurcation Lesion Prospective Evaluation (TULIPE) study, trapping the SB wire was an independent predictor of lower TLR (odds ratio 4.3).[22] Jailing the guidewire behind the MB stent may facilitate rewiring the SB by reducing the angle between the SB and MB, helping to maintain SB patency and serving as a target for rewiring.

What Type of Wire to Jail?

In general, any nonhydrophilic workhorse wire is acceptable, particularly those with a core to tip design. Hydrophilic wires are not used given the risk of stripping the lubricious coating/jacket during retraction of the wire. Although there are rare case reports of the guidewire being retained during the jailing maneuver, successful utilization of the technique is simplified by trapping only a small amount of wire just proximal to the radiopaque tip; moreover, if substantial resistance does occur during withdrawal, threading a rapid exchange balloon over the jailed wire up to the proximal end of the MB stent can buttress the wire, allowing for easy removal.

2-Stent Approaches

In many cases, a 2-stent treatment is unavoidable. Examples include abrupt, persistent closure of the SB, where stenting becomes necessary to preserve SB patency and avoid a periprocedural MI. In addition, it is very difficult to obtain acceptable results when the SB plaque is lengthy. When the SB is of significant size (typically $>$ 2.5 mm in diameter) and the SB plaque length is substantial, an intended/elective 2-stent strategy is best. Additionally, when the angle of the SB is such that rewiring is exceptionally difficult, a 2-stent approach that does not sacrifice SB wire access until the SB is secured may be preferred. The 2-stent approaches used with currently available slotted tubular stents include (1) T-stent, (2) crush, (3) V stent/simultaneous kissing stents (SKS), and (4) culotte stenting.

T-Stent

The T-stent without crush is the most conventional of the 2-stent strategies.[1,4,5,22,26-31] When used in an elective manner, the classic T-stent approach is to place the SB stent first, taking care to avoid protrusion into the MB, followed by removal of the SB wire and stenting of the MB. The SB must be reaccessed and an FKI performed. The advantage of this technique is its simplicity, particularly compared with the crush and culottte, where reaccessing and postdilating the SB is more difficult; however, because the majority of SBs arise at a shallow angle, invariably the ostium of the SB is not fully covered, or excess stent protrudes into the MV. One variation of the standard T-stent reported by Rizik and colleagues[9] is the self-aligning T-stent approach, a technique that leverages the concept of the blocking balloon first reported by Dardas and associates[32] and Schwartz and Morsi[33] for isolated ostial SB disease. Unlike the standard approach, the self-aligning technique utilizes a blocking balloon in the MB during deployment of the SB stent. Prior to SB deployment, the proximal end of the SB stent is aligned with the MB wire, necessarily implying that prior to deployment, the SB stent is partially within the MB. During SB stent deployment, the MB balloon and SB stent are simultaneously inflated, facilitating proper alignment of the SB stent. After withdrawal of the SB stent deployment-balloon and wire, the MB is stented. Finally, the SB is rewired, followed by an FKI. In the 26 patients described, only 15% required further stenting of the ostium at the time of the original procedure, and only 2 patients had angiographic restenosis, both of which were in the SB ostia, leading to TLR.[9]

In the reverse T approach, the MB is initially stented followed by stenting of the SB.[1] The most frequently used reverse T technique is the provisional T and small protrusion (TAP). In this approach, the MB is stented, and the SB is dilated through the struts of the MB stent. Subsequently, the SB stent is positioned such that only 1 to 2 mm of the proximal stent is positioned within the MB.[26,34,35] An MB balloon is left uninflated during SB stent deployment. The deployment balloon is retracted slightly and kissing inflation is performed. An FKI may be done with 2 noncompliant balloons. The TAP technique was reported to have a high success and long-term outcome in the report by Burzotta and colleagues[34] who reported a TLR of 6.8% in 73 patients with very complex bifurcation disease. Al Rashdan and Amin[26] reported similar excellent results in 156 patients using the TAP/carina modification technique.

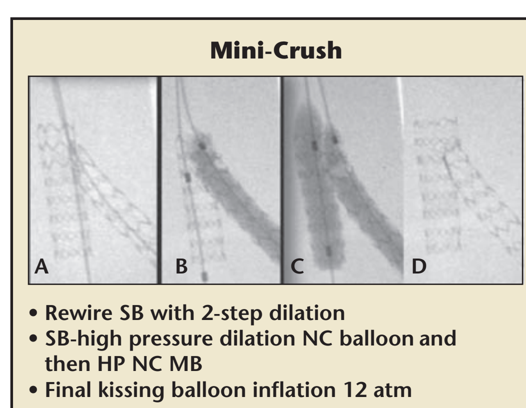
Finally, Rajdev and colleagues[36] have described a “cone crush” modified T-stenting approach. In this technique, the proximal SB stent is aligned with an uninflated MB-blocking balloon or stent and deployed without inflating the MB device. The SB deployment balloon is retracted several millimeters and inflated to high pressure, creating an ostial flare or cone. The MB is then stented, covering the cone, and the SB is reaccessed with a final kissing inflation.

Crush Stent

To prevent the incomplete coverage of the SB ostium associated with standard T-stenting, Colombo and coworkers[12,35] described and pioneered the crush technique. In the original description, the approach involved crushing 5 to 10 mm of the proximal SB stent within the MB artery. This led to substantial distortion within the SB ostium and the MB as well. A modification of the technique, the mini-crush, involves crushing only 1 to 2 mm of stent within the MB (Figures 4 and 5).[12] Ormiston and colleagues[37,38] demonstrated in an in-vitro model that the mini-crush compared with the standard crush substantially enhanced ostial SB expansion and minimized MB distortion and underdilation (Figure 6). In the mini-crush technique, the SB stent is positioned with 1 to 2 mm of stent protruding into the MB such that the proximal portion of the SB ostium is barely covered. After

The crush technique has several advantages, including the fact that access to either branch is not surrendered until stents are deployed and complete coverage of the SB ostium is ensured.

Figure 5. *Ex vivo model showing mini-crush bifurcation technique. HP, high pressure; NC, noncompliant; MB, main branch; SB, side branch. Reprinted with permission from Ormiston JA et al.[38]*



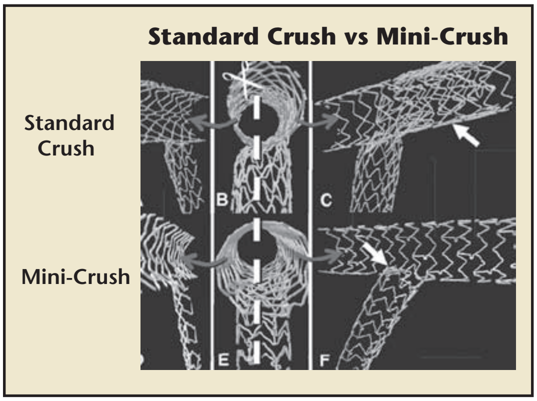


Figure 6. *This is an ex-vivo model demonstrating the differences in standard and mini-crush techniques. The mini-crush technique is associated with much less main branch and side branch distortion. Reprinted with permission from Ormiston JA et al.*[38]

deployment of the SB stent, angiography is performed to ensure no distal dissections. In the classic crush, the SB stent is crushed with the MB stent. Following stenting of both branches, the SB is rewired, dilated to high pressure with a noncompliant balloon, and finished with an FKI. This 2-step inflation technique significantly improves ostial expansion compared with a single kissing inflation (Figure 7).[38] Successfully recrossing and dilating the crushed SB stent is essential. Restenosis and stent thrombosis are substantially higher when an FKI is not performed.[39] Intravascular ultrasound (IVUS) has demonstrated significant underdilation of both branches when an FKI is not done.[39,40] In the CACTUS trial the performance of FKI compared with no FKI was associated with a lower incidence of in-hospital and follow-up MI (7.5% with FKI vs 29.0% without; P = .001), a lower incidence of TLR (6.3% with FKI vs 12.9% without; P = .25), and a lower incidence of angiographic restenosis in the MB (4.7% with FKI vs 16.0% without; P = .03) and the SB (11.9% with FKI vs 36.0% without; P = .001), as well as a lower incidence of stent thrombosis (0.9% with FKI vs 6.5% without; P = .06).[17]

The crush technique has several advantages, including the fact that access to either branch is not surrendered until stents are deployed and complete coverage of the SB ostium is ensured. The greatest challenge is rewiring and redilating the crushed SB stent. If a standard workhorse wire does not cross, hydrophilic wires can be helpful. Often an appropriately sized workhorse balloon will not cross into the SB, but a rapid-exchange 1.5-mm balloon nearly always does, allowing for subsequent delivery of larger balloons. Also, after leaving the initial wire in place, a second buddy wire can be placed in the SB and may provide adequate support for crossing. Rarely, a fixed wire balloon is necessary. Finally, using appropriately sized balloons to each branch is essential as undersizing the MB balloon during the final kissing inflation leads to distortion and suboptimal expansion/apposition of the MB stent.

There are many variations on the crush theme. In the standard crush, the SB is crushed with the MB stent, whereas in the "step crush" the SB stent is crushed by a MB balloon, which is then followed by the MB stent.[41] With the exception of not inflating the MB balloon with SB stent deployment, the mini-crush technique is much like the self-aligning T-stent approach described earlier.[9] Chen and Kwan[42] and Jim and coauthors[43,44] described the "sleeve technique," a variation of the step crush. In this approach, following the crush of the SB with a MB balloon, the SB is reaccessed and a kissing inflation is performed. The subsequent steps are then identical to the step crush approach. The reverse crush or internal crush, a technique not often used in contemporary practice, involves stenting the MB, followed by stenting of the SB with the proximal SB stent being crushed within the MB stent lumen.[45]

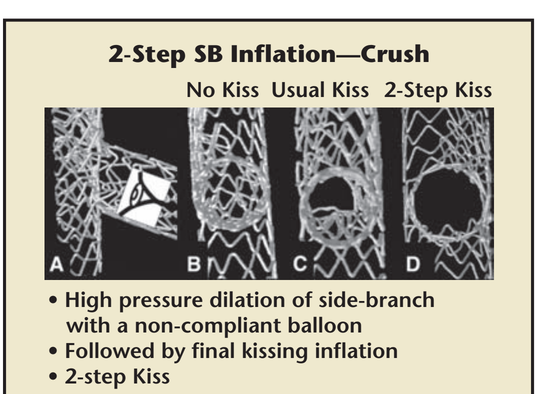


Figure 7. *This figure demonstrates much greater side-branch (SB) ostial expansion with the 2-step SB inflation. Reprinted with permission from Ormiston JA et al.*[38]

V and SKS Stenting

The V or SKS technique is a simple 2-stent approach to bifurcation disease that has the advantage of maintaining access to both branches at all times.[46-48] The technique is best for Medina 0,1,1 lesions in which the bulk of atherosclerotic plaque is distal to the carina. Although there are reports of treating diffuse proximal segments of disease with long "double stent barrels," most operators prefer to have minimal overlap of the proximal stents. The V and SKS approaches consist of positioning 2 stents simultaneously, the proximal portions of the stents forming a double barrel, neocarina in the MB.[1,49] The undeployed SB stent is delivered first, followed by the MB stent. The proximal portions of the stents are aligned, creating a proximal double barrel. When the neocarina (double barrels) extends 5 mm or more into the parent vessel, the technique is considered to be an SKS approach. The stents should be individually deployed, the SB stent first, the MB stent second, followed by a simultaneous inflation at 10 to 12 atm. This sequential deployment avoids shifting and misalignment of the proximal stents that can occur with simultaneous deployment. Further postdilation can be completed as necessary, always ending with a simultaneous inflation. Sharma[49] reported the outcomes of the V-stent/SKS technique in 200 consecutive patients. Procedural success was 100% for the MV, and 99% for the SB; initial clinical success was quite high as well (97%). In-hospital and 30-day MACE rates were low, at 3% and 5%, respectively. At a mean follow-up of 9 months the TLR rate was only 4%. In a modified SKS approach, used when the proximal disease is lengthy and there is a fear of a dissection, a proximal MV stent is deployed, acting as a safety cuff.[49,50] Then the SB is wired, and 2 stents are telescoped through the proximal stent and positioned and deployed in a typical V pattern, their proximal portions lying within the distal aspect of the "cuff" stent.

Practical considerations include selecting an adequately sized guiding catheter (generally 8 Fr allows optimal visualization) and sequentially inflating the stents rather than simultaneously deploying them. A particular challenge with the V-stent is a proximal dissection. If this occurs, placing a proximal bailout stent is difficult, and bias toward 1 branch inevitable. If a proximal dissection does occur, the double barrels can be extended proximally with 2 more stents, or the V-stent can be converted to a crush by compressing the SB stent with a MB balloon. The SB is then reaccessed, redilated with a kissing inflation, and finally, a proximal bailout stent is implanted. Frequently during rewiring, the wire crosses from the lumen of 1 stent to the other; IVUS is essential, confirming that the correct lumen has been accessed.

The physiologic severity of the SB stenosis following MB stenting is frequently overestimated, resulting in crossover to a 2-stent approach when a provisional strategy was initially chosen.

Culotte Stent

The culotte technique is the most challenging of the 2-stent strategies, but provides superior coverage of the carina and SB ostia.[51-53] In this approach, the initial stent is placed in the most angulated vessel (generally the SB). The MB is then rewired through the struts of the first stent, and then subsequently dilated and stented. Following placement of the second stent, the first stent is reaccessed and dilated. Using noncompliant balloons, separate high-pressure inflations are performed in each stent followed by an FKI of 10 to 12 atm. This technique is best for large vessels; generally each stent should be at least 3 mm in diameter.

The Nordic group compared the culotte with the crush technique in a randomized trial.[54] A total of 424 patients with a bifurcation lesion were randomized to crush (n = 209) and culotte (n = 215) stenting. At 6 months there were no significant differences in MACE rates between the groups—crush 4.3% and culotte 3.7% (P = .87). Procedure and fluoroscopy times and contrast volumes were similar in the 2 groups. A total of 324 patients had a quantitative coronary assessment at the index procedure and after 8 months. The angiographic endpoints of in-segment and in-stent restenosis of MV and/or SB after 8 months were found to be 12.1% versus 6.6% (P = .10) and 10.5% versus 4.5% (P = .046) in the crush and culotte procedure groups, respectively. Those in the culotte treatment group were more likely to have an FKI compared with those in the crush treatment group. Because of the short follow-up and significantly smaller rate of FKI in the crush procedure group, there are insufficient clinical data to recommend one technique over another based solely on lower event rates, although angiographically, there was a trend toward less in-segment restenosis and significantly reduced in-stent restenosis following culotte stenting.

Overall Approach

The key to the therapy of bifurcations is the SB.[55] There are a number of questions to ask in each bifurcation intervention, questions that predominantly address the SB. Does the ostium of the SB have disease? Is this a true bifurcation lesion? How important clinically is the SB? What is the SB diameter and the amount of myocardium subtended? Will the SB cause angina if restenosis occurs or if an inadequate initial result is obtained? Dauerman and colleagues[56] found that if the SB was less than 2.5 mm in diameter, it was unlikely to cause the need for repeat revascularization. Is there a high risk that the SB will close with MV stenting, and if it closes, will it be recrossable? Is the SB of such size and the lesion geometry of such complexity, that surrendering access to the SB should be avoided? How long is the SB disease? If only confined to the ostium and short in length, the likelihood that a second stent will be necessary is unlikely. Finally, is the SB dilatable, and will lesion modification with a cutting balloon or rotablator be necessary for complete expansion? All these issues will establish the SB strategy and determine whether a second SB stent is necessary. Figure 8 outlines a typical strategy to bifurcations given contemporary slotted tube designs.

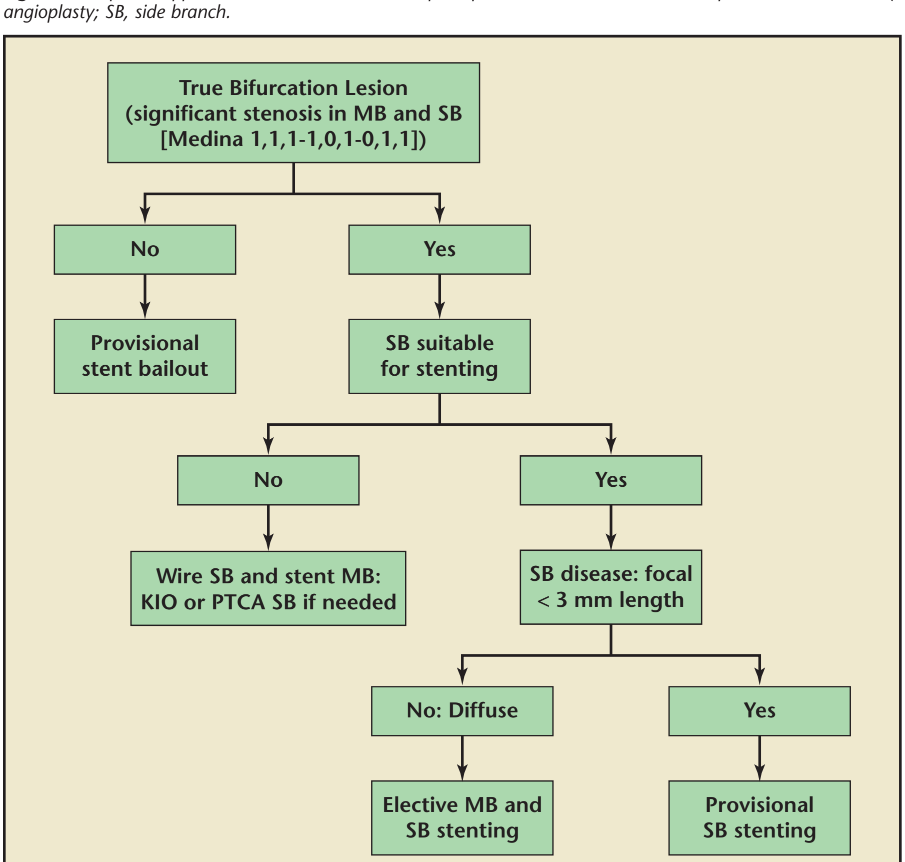
Use of intravascular ultrasound (IVUS) can be invaluable in these complex subsets, particularly in verifying that optimal stent expansion has been achieved. Costa and colleagues[40] and Hahn and associates[57] examined 25 crush stents by IVUS, demonstrating incomplete stent apposition in the MV segment proximal to the carina in more than 60% of lesions. A minimum lumen area of $<$ 5 mm was found in 76% of the SB stents. Often an optimal angiographic result at the SB is found to be inadequate by IVUS, necessitating further dilation of the SB.[2] The physiologic severity of the SB stenosis following MB stenting is frequently overestimated, resulting in crossover to a 2-stent approach when a provisional strategy was initially chosen. Fractional flow measurements can be useful, demonstrating no significant lesions in most circumstances.[58,59]

Although there are no compelling randomized data demonstrating the superiority of either of the 2-stent approaches, there are data suggesting that the angle of the SB does have a significant impact on the results of the 2-stent techniques.[7] Dzavik and colleagues[60] studied the outcomes of 133 patients undergoing crush stenting. The patients were divided into those with low-bifurcation angle ($<$ 50° angle) and those with a high-angle ($>$ 50°). MACE occurred more frequently in the high-angle group (22.7% vs 6.2%; $P = .007$). Bifurcation angle $\geq$ 50° ($P = .004$), no final kissing balloon inflation ($P = .012$), and creatinine clearance $<$ 40 mL/min ($P = .031$) independently predicted MACE. A subsequent study by this group extended these observations to culotte stenting as well.[61]

Conclusions

Coronary bifurcations remain a challenging lesion subset, constituting 15% to 20% of all coronary percutaneous interventions. Although current drug-eluting slotted tube stent platforms were not designed for bifurcating lesion geometries, their application in this lesion subset has become very effective, particularly compared with BMS. There is now consensus that the provisional approach, with MB stenting only, is the preferred strategy for the majority of bifurcations, although when SB stenting is necessary, outcomes are acceptable. In patients having true bifurcations (Medina 1,1,1), large, stentable SBs ($>$ 2.5 mm), and nonfocal proximal/ostial plaque

Figure 8. *Proposed approach to bifurcation. KIO, keep it open; MB, main branch; PTCA, percutaneous coronary angioplasty; SB, side branch.*



distribution, an initial 2-stent strategy is often preferable. Which 2-stent approach to use is less certain. Meticulous attention to optimal stent dilation is more important than the particular 2-stent technique chosen. Finally, generous utilization of IVUS and fractional flow reserve may enhance optimal deployment. ■

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

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Main Points

- The outcomes of coronary bifurcation stenting have improved substantially, in large part as a consequence of potent drug-eluting stents. Studies indicate marked improvement in rates of restenosis, major adverse cardiac events, and target lesion revascularization, when compared with bare metal stents.
- There has been considerable debate about whether a single main branch (MB) stent was preferred over a 2-stent approach (side branch [SB] and MB); multiple randomized trials have since confirmed that a provisional strategy should be the default strategy for the majority of bifurcations.
- Data suggest that the angle of the SB has a significant impact on the result of the 2-stent technique.
- Utilization of intravascular ultrasound and fractional flow reserve may enhance stent deployment and postprocedural outcomes.

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