Bifurcation Lesions

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Introduction

Coronary bifurcations are involved in 15–20% of all percutaneous coronary interventions (PCI). It remains one of the most challenging lesions in interventional cardiology in terms of procedural success rate as well as long-term cardiac events. The optimal management of bifurcation lesions is a subject of considerable debate.

Definition

Bifurcation lesion is defined as a lesion with stenosis >50% involving a bifurcation with a significant side branch vessel (SBV). A significant SBV is a branch, whose loss is of consequence to a particular patient (symptoms, location of ischemia, viability of the supplied myocardium, collateralizing vessel, left ventricular function, etc.) [1, 2].

Medina Classification

Medina classification is the most commonly used classification which indicates the location of significant stenosis (>50%) in the bifurcation tree (Fig. 16.1). This classification divides lesions into seven categories using a three-component binary key based on visual assessment of lesion severity. Stenosis >50% is assigned 1 for each of three arterial segments of bifurcation in the following order, proximal main vessel (PMV), distal main vessel (DMV), and side SBV [1, 2].

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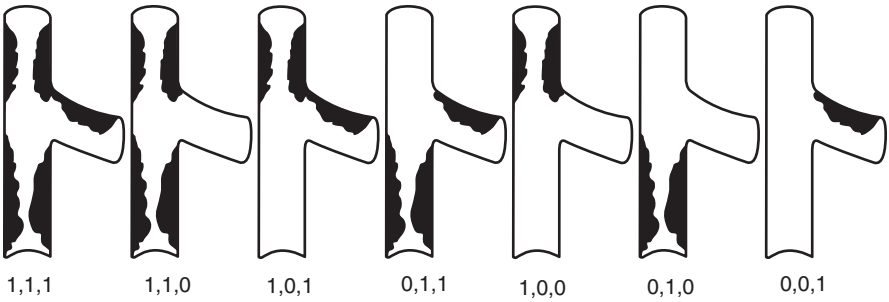

Fig. 16.1 Medina classification for bifurcation lesions. (Used with permission from Bifurcaid Application [3])

Table 16.1 Guide catheter selection

LCA bifurcation lesions	Provisional: 6 Fr VL/EBU guide
	Dedicated 2 stent: 7 Fr VL/EBU guide
RCA bifurcation lesions	Provisional: 6 Fr IM or AL 0.75
	Dedicated 2 stent: 7 Fr IM or AL 0.75

Approach to Bifurcation Intervention

Access

- Femoral or radial:
  - 6 Fr for provisional stenting approach or DK crush.
  - 7 Fr Guide is required for most of the dedicated 2 stent strategies, left main PCI and if SB > 2.25 mm.
  - If opting for femoral access, a 45 cm long sheath is preferred as it provides extra support.

Guiding Catheter Selection (Table 16.1)

Optimal Angiographic Views

- Distal left main: *LAO Caudal (30–60°, 25–30°) or AP caudal (0, 25°–40°).*
- LAD/diagonal bifurcation: *RAO cranial (10°, 40°) or AP cranial (0, 25°–40°).*
- Diagonal ostium visualization: *LAO cranial (40–45°, 25–30°).*
- For early diagonals: *LAO caudal (45–55°, 25–30°).*
- LCX/marginal: *AP caudal (0, 25°–40°), and LAO caudal (45–55°, 25–30°).*
- Distal RCA/ RPDA: *AP/LAO Cranial (0–55°, 30°).*

Coronary Wiring

- Polymer coated wires which are easy to recross and can be jailed (e.g. Fielder™, Whisper) are preferred for SBV wiring, and workhorse wires (e.g. Runthrough™) are preferred for MV wiring.

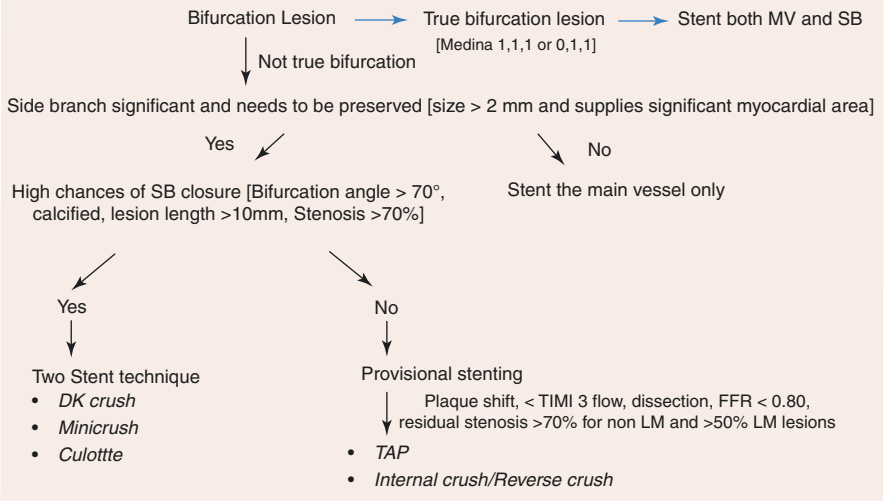

Fig. 16.2 Interventional algorithm for bifurcation coronary lesions

- The more complex lesion/branch should be wired first.
- When wiring the second vessel, avoid excessive torqueing and 360° turns of the wire. Use small side-to-side movements to prevent intertwining.
- While shaping the wire tip, try to best adapt the length and angulation of the tip curve to the given anatomy.

Lesion Preparation

- Adequate lesion preparation is essential for bifurcation lesions. Use of cutting balloons and atherectomy devices may be required for severely calcified lesions.

Bifurcation Algorithm (Fig. 16.2)

Provisional Stenting Approach

These are the common steps for provisional stenting:

- Wire only the MV and perform MV pre-dilation.
- Assess for plaque shift into SBV. If there is plaque shift and TIMI 3 flow is compromised, wire the SBV and perform PTCA (1:1 sizing) or Cutting balloon (CB) PTCA (1/4 size smaller than reference vessel) of the SBV.
- Reassess side branch. If TIMI 3 flow is restored, without dissection or residual stenosis proceed with provisional stenting of the MBV (nominal pressure) keeping the wire in the SBV.

- Remove the jailed SBV wire. If high-pressure balloon post-dilation of the MBV stent is required, rewire the SBV and perform post-dilation.
- Reassess the side branch again. If the patient is chest-pain-free, there is TIMI III flow and no dissection in SBV, take final angiogram; otherwise perform kissing balloon inflation (KBI)* or bailout stenting of SB using the TAP or inverted crush strategies (Fig. 16.3).

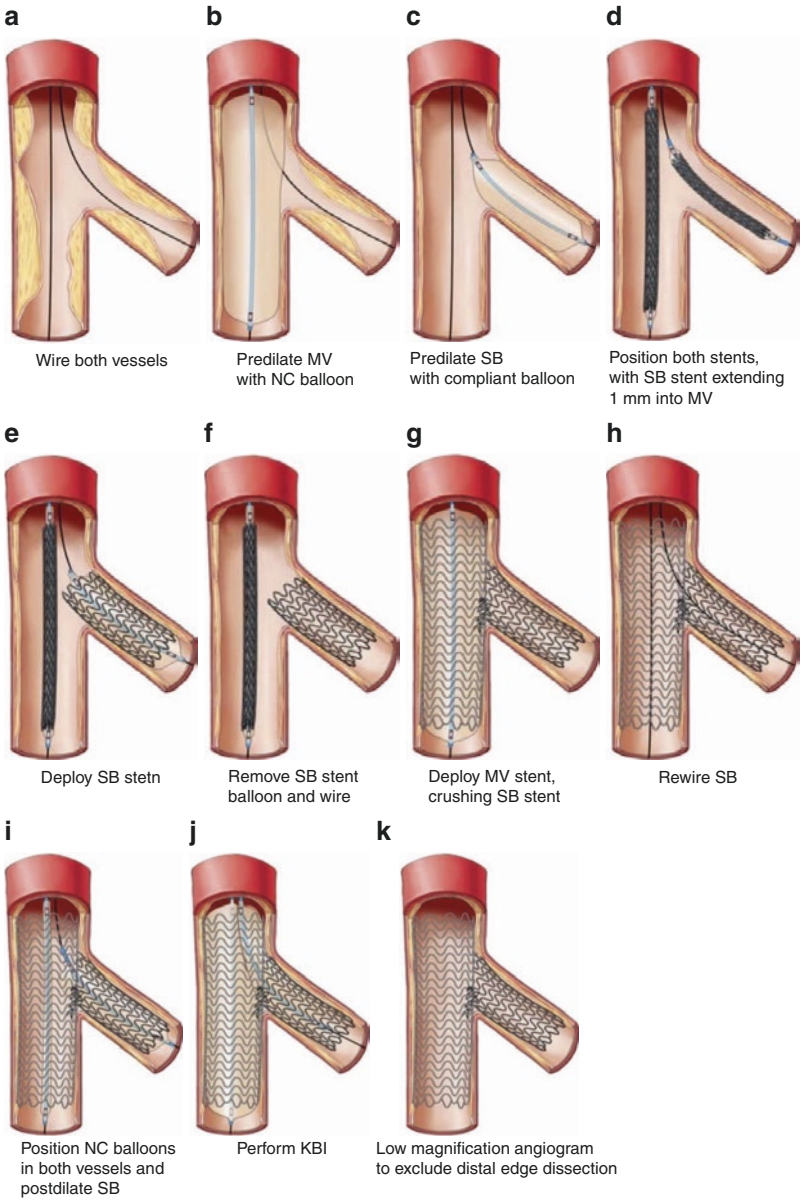

Fig. 16.3 T-stenting and protrusion (TAP)) beginning after main vessel stenting. (Used with permission from Bifurcaid Application)

- *KBI: Rewire the SBV through the strut of MV stent. Initially perform PTCA of jailed side branch using a smaller complaint balloon at high pressures (18–20 atm) to open the stent struts. Perform final KBI with NC balloons in the MBV and SBV (1:1 sizing). The proximal optimizing technique (POT) is recommended following KBI to ensure optimal stent expansion in the proximal MV.

Two-Stent Approach

These are the common steps for two-stent techniques:

- Wiring of MBV and SBV and lesion preparation using PTCA/CBA/Atherectomy.
- PTCA of more severe stenosis is preferably performed first.
- Stenting strategy will depend on the anatomical characteristics as described below.
- Mini crush (Fig. 16.4), DK crush (Fig. 16.5), and Culotte (Fig. 16.6) are the preferred two-stent techniques (Table 16.2).

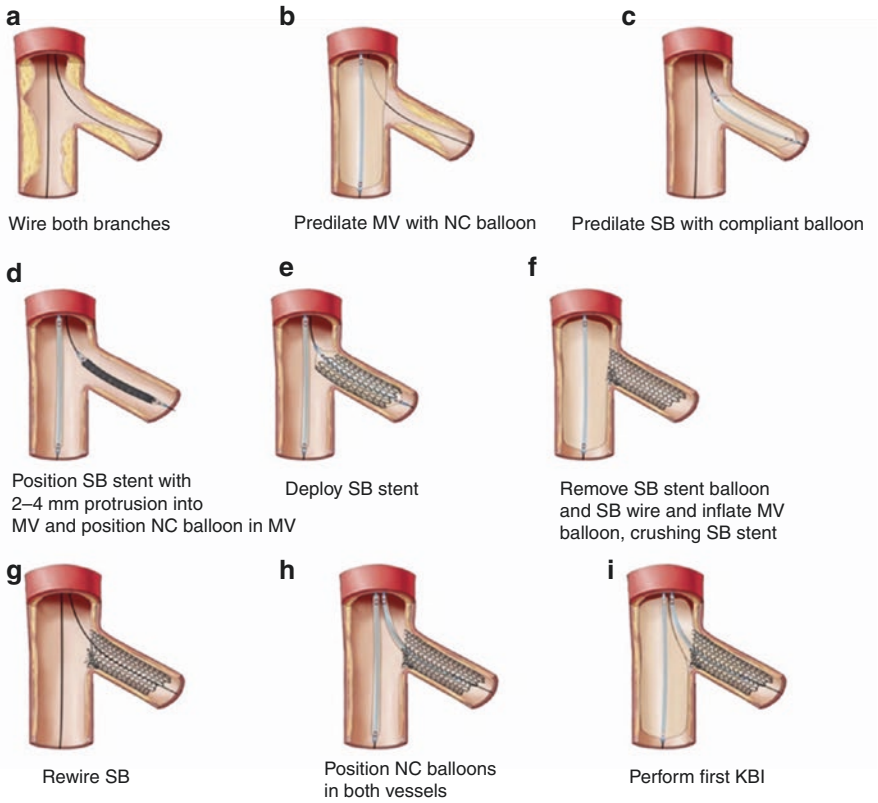

Fig. 16.4 Mini-crush stenting technique. (Used with permission from Bifurcaid Application)

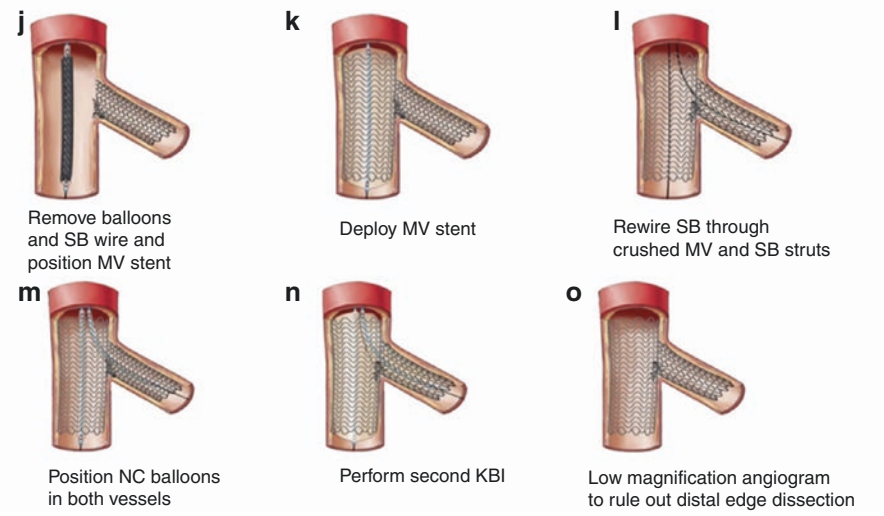

Fig. 16.4 (continued)

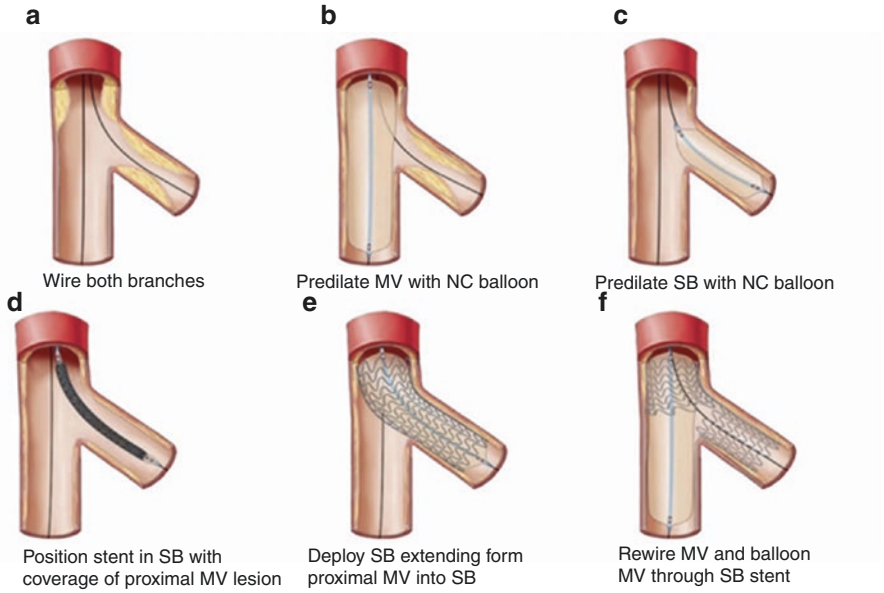

Fig. 16.5 Double kissing (DK) crush technique. (Used with permission from Bifurcaid Application)

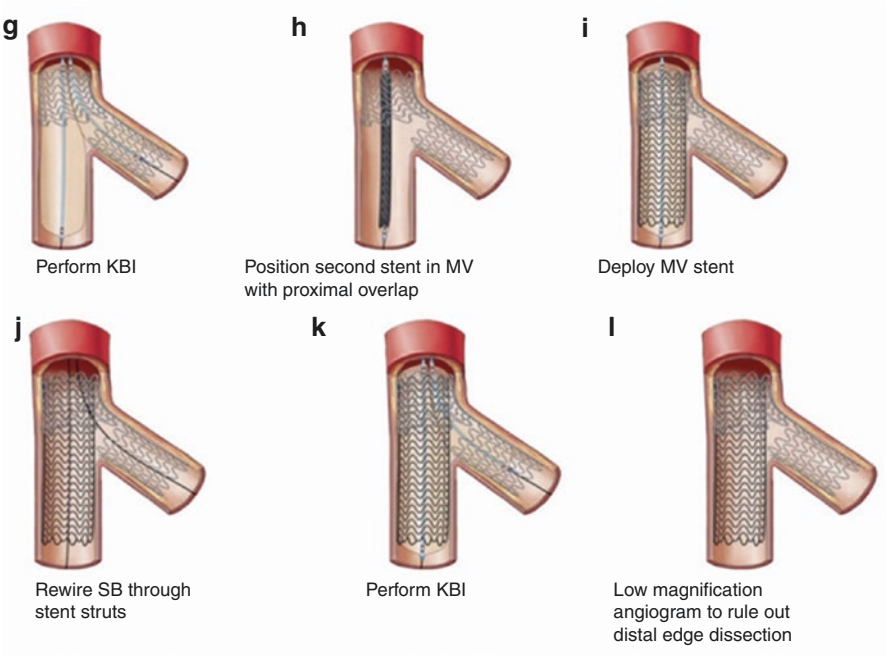

Fig. 16.5 (continued)

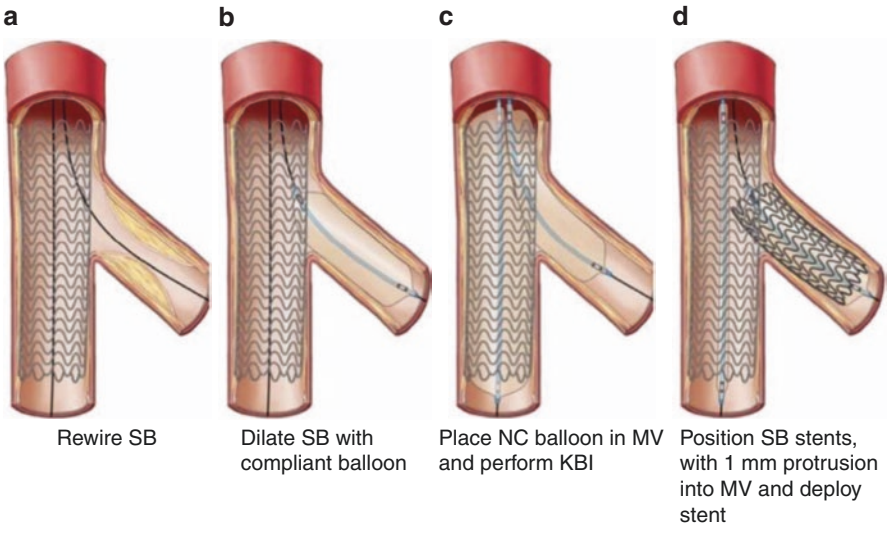

Fig. 16.6 Culotte technique. (Used with permission from Bifurcaid Application)

Fig. 16.6 (continued)

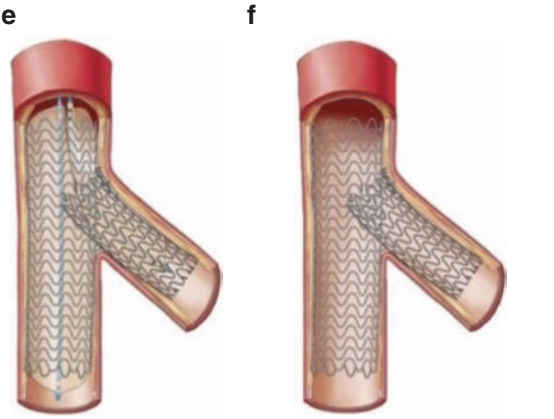

Table 16.2 Important studies comparing provisional versus dedicated two-stent strategy

Study	Year	Total number (provisional/2 stent strategy)	2-stent technique used	Clinical follow up (months)	Primary end-point (provisional vs 2-stent strategy)
Colombo et al. [4]	2004	85 (22/63)	T-stent, V stent, and Y stent	6	Angiographic restenosis of either branch (18.7% vs. 28%; p = NS)
Pan et al. [5]	2004	91 (47/44)	T-stent	11	Angiographic restenosis of either branch (7% vs. 25%; p = NS)
NORDIC [6]	2006	413 (207/206)	Crush, Culotte, other unspecified	6	MACE [cardiac death, MI, ST or TVR] (2.9% vs. 3.4%; p = NS)
BBK [7]	2008	202 (101/101)	T-stent	12	Angiographic restenosis of SB at 9 months (23% vs. 27.7%; p = NS)
CACTUS [8]	2009	350 (173/177)	Crush	6	MACE [Cardiac death, MI, or TVR] (15% vs. 15.8%; p = 0.95)
BBC ONE [9]	2010	500 (250/250)	Crush, Culotte	9	MACE [Cardiac death, MI, or TVF] (8% vs. 15.2%; p < 0.05)
Lin et al. [10]	2010	108 (54/54)	DK crush Culotte T-stenting	8	MACE [Cardiac death, MI, ST, or TVR] (21% vs. 6%; p < 0.01)
DK CRUSH II [11]	2011	370 (185/185)	DK crush	12	MACE [Cardiac death, MI, or TVR] (17.3% vs. 10.3%; p = 0.07)
NORDIC Baltic IV [12]	2013	450 (221/229)	Culotte, T stent, other unspecified	6	MACE [Cardiac death, MI, TLR], or ST (5.5% vs. 2.2%; p = 0.07)
Kim et al. [13]	2015	419 (206/213)	Crush	12	MACE [Death, MI or TVR] (18.5% vs 17.8%; p = NS)
EBC TWO [14]	2016	200 (103/97)	Culotte	12	MACE [Death, MI or TVR] (7.7% vs 10.3%; p = NS)
DK CRUSH V [15]	2019	484 (242/242)	DK crush	36	TLF (16.9% vs 8.3%, P = 0.0050

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