



Percutaneous Intervention Of Bifurcation Lesions

Yasser Ahmed Abd El-Hady, MD

Professor Of Cardiology, Beni Suef University



✓ I do not have any potential conflict of interest to report.

WHAT IS BIFURCATION LESION?



Definition of Bifurcation Lesions

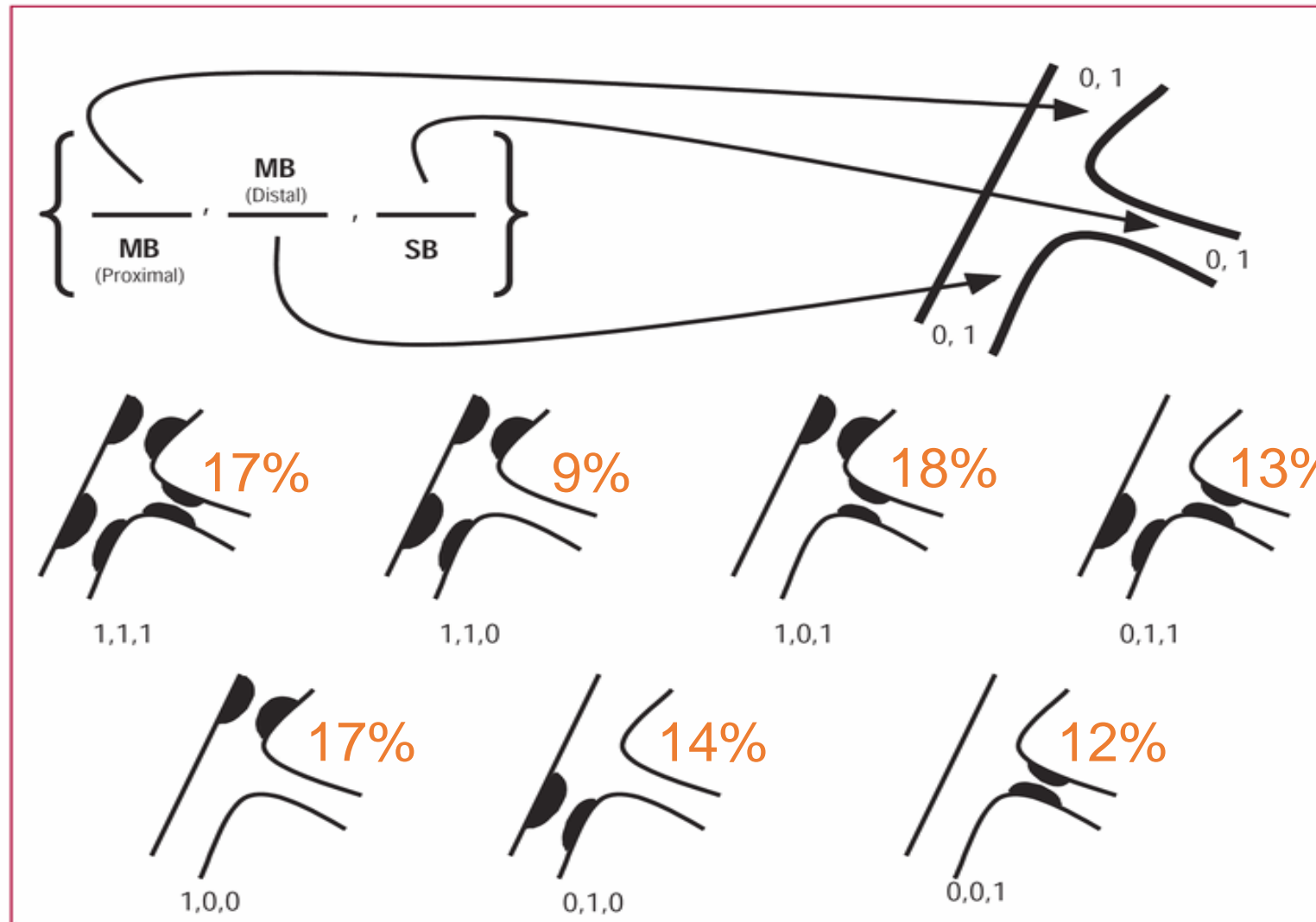
- ✓ A lesion in the parent vessel very close or involving a significant side branch
- ✓ What is a Significant Side Branch ?
 - ✓ Reference diameter ≥ 2 mm ?
 - ✓ Significant myocardial territory ?

A branch that you don't want to loose !

The challenge of Bifurcation Lesions

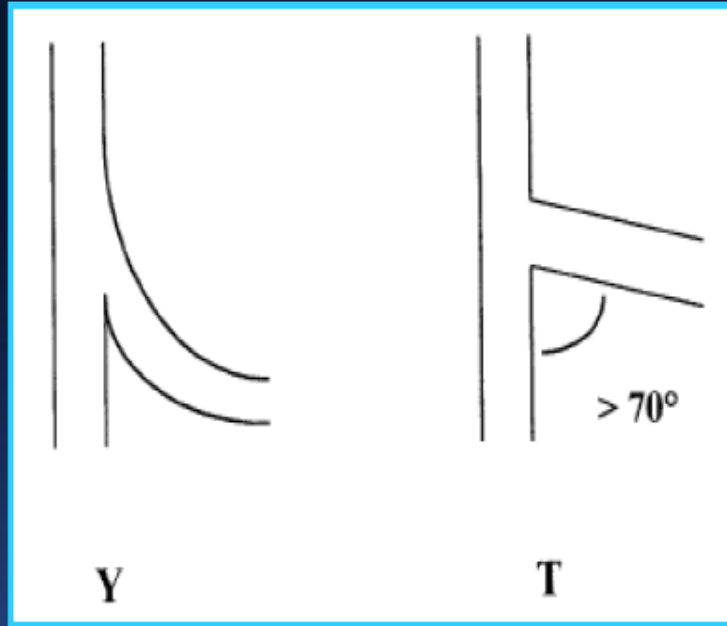
- Higher risk of peri-procedural complication
- Higher risk of restenosis
- Not all lesions are the same
 - Size of vessels
 - Variable plaque distribution
 - Extent of side branch disease
 - Variable angulation
 - Dynamic changes during PCI (Plaque shift or Dissection)
- An appropriate strategy saves time and minimize complications.
- We should have plan B, C and D.

Medina Classification



Anatomical Considerations

Angulation



	Y	T
SB access	Easy	Difficult
Plaque shift	More	Less

Y-angulation **precise stent placement with complete ostial coverage is often difficult or geometrically impossible.**

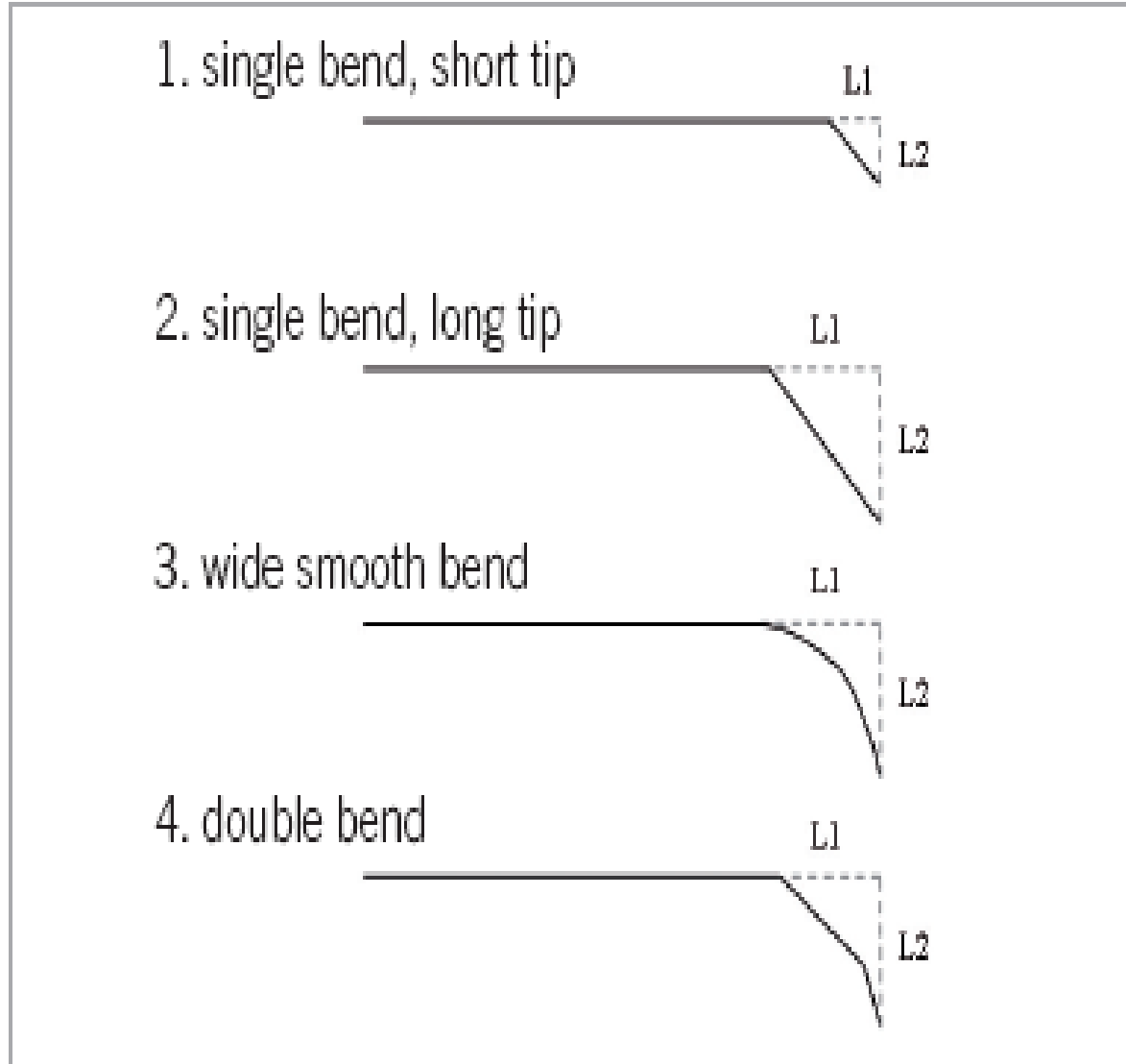
Technical Considerations

- Guide Catheter Selection.
- SB wiring and rewiring.
- Which branch should be wired first?
- Should we predilate MB & SB?
- FKB
- POT

Guiding Catheter selection

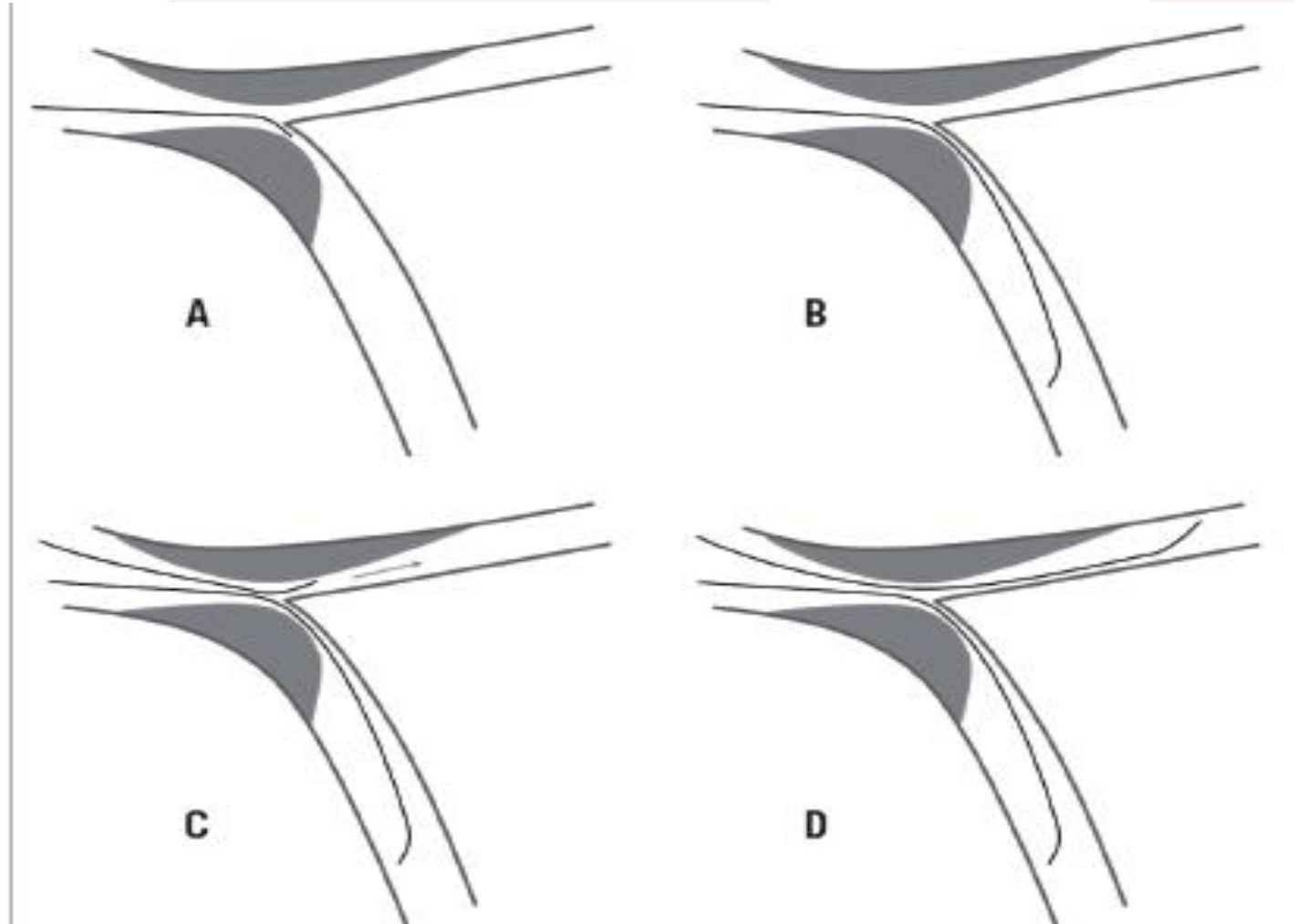
- 7 or 8 French guiding in techniques requiring simultaneous insertion of two stents (standard crush, V and SKS techniques and modified T) or use of rotablation.
- 6 French guiding catheters and hence radial approach can be used in all other techniques especially with the recent low profile balloons.

Side branch wiring should be the standard approach unless the SB is very small.

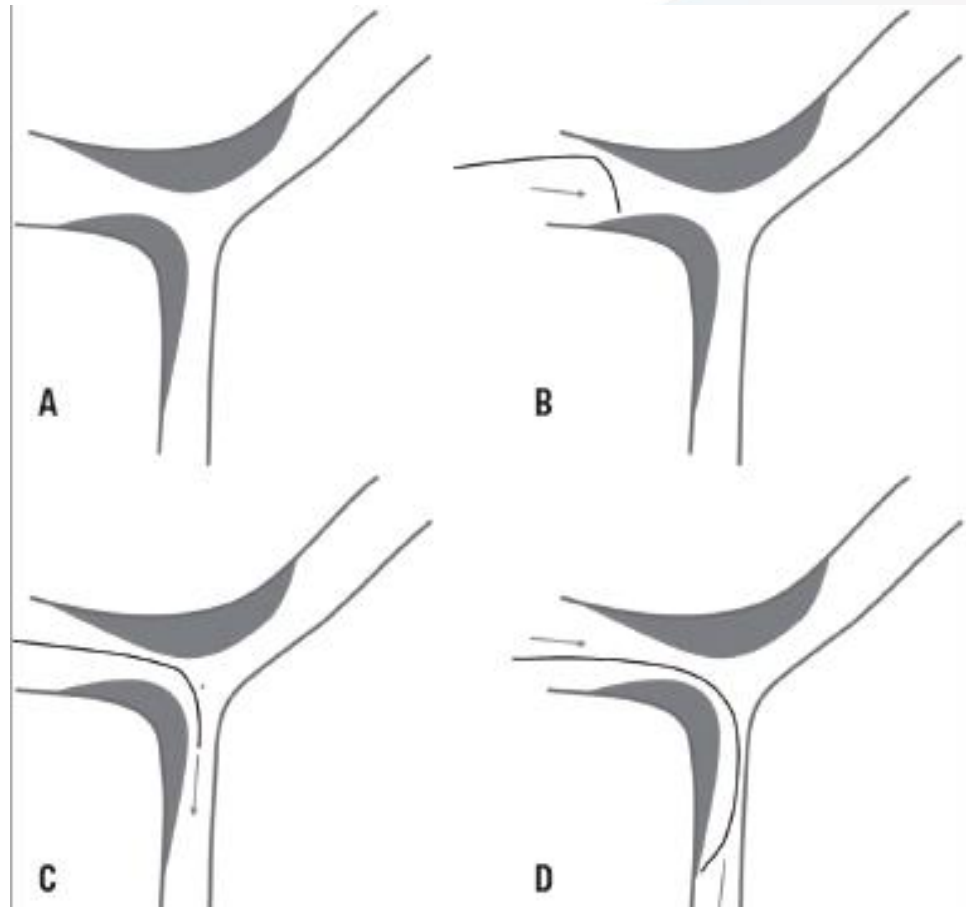


- J tip angle (L1) is usually modulated according to the side branch take off angle.
- Length of tip(L2) is usually adjusted according to diameter of the main vessel lumen.

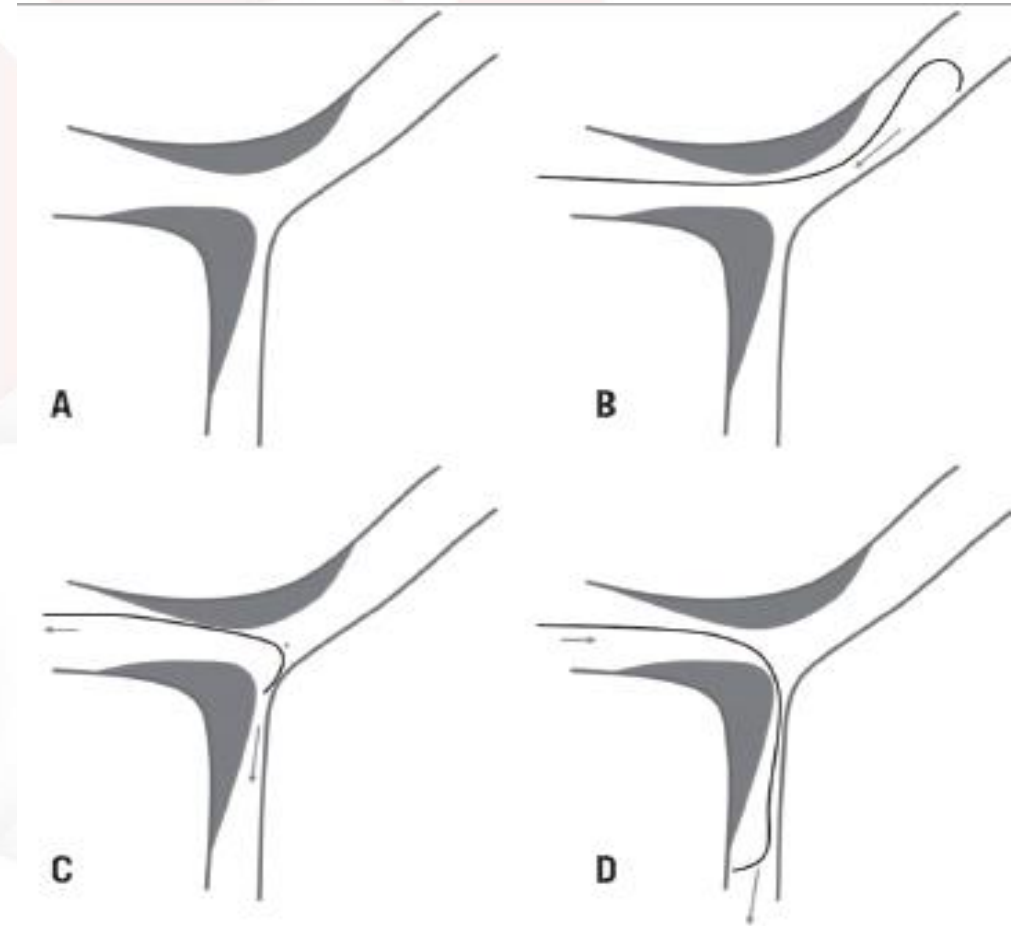
Which branch should be wired first the MB or SB?
Wire the branch which appear more difficult to access.



Anterograde Wiring



Pullback wiring



➤ *Advantages of SB wiring*

- Keep SB open
- Mark for SB in case of its occlusion.
- Anchoring modality to facilitate balloon to pass across the ostium of SB.
- As rescue procedure to pass low profile balloon behind stent struts to regain flow in SB in case of its occlusion.

➤ *Type of guide wire:*

Both polymer coated and non polymer coated can be safely jailed.

Lesion Preparation: Predilatation of MB => mandatory

- Information about how the lesion is going to behave
 - Helps to plan the **stenting strategy**
 - More successful stent delivery by creating a **pathway** for the delivery system
 - Helps ensure optimal stent **expansion** and full stent **apposition** by **modifying the lesion before stenting**
- To **reduce ischemia** during stent positioning (Left Main++)
- To estimate **lesion length** and **diameter** using the balloon
- Precise **stent placement** with better vessel contrast **filling**
- May **prevent damage to the drug coating** during delivery

SHOULD WE PREDILATE SB LESION OR NOT?

- Predilatation of SB is generally not routinely recommended except in the following situations:
 - ✓ Severe ostial stenosis
 - ✓ Decrease in SB flow after wiring.
 - ✓ Extensive SB disease or calcification extending beyond the ostium
- ***Disadvantages:*** May cause ostial dissection that prevents access to SB and potential increase in requirement of SB stenting and increase the risk of restenosis.
- ***Advantages:*** increased ostial SB lumen, facilitated rewiring of the SB after stenting and avoiding rewiring and post-dilatation of the SB after implantation of the MV stent.

Tips and Tricks in SB re-wiring after MB Stent Implantation

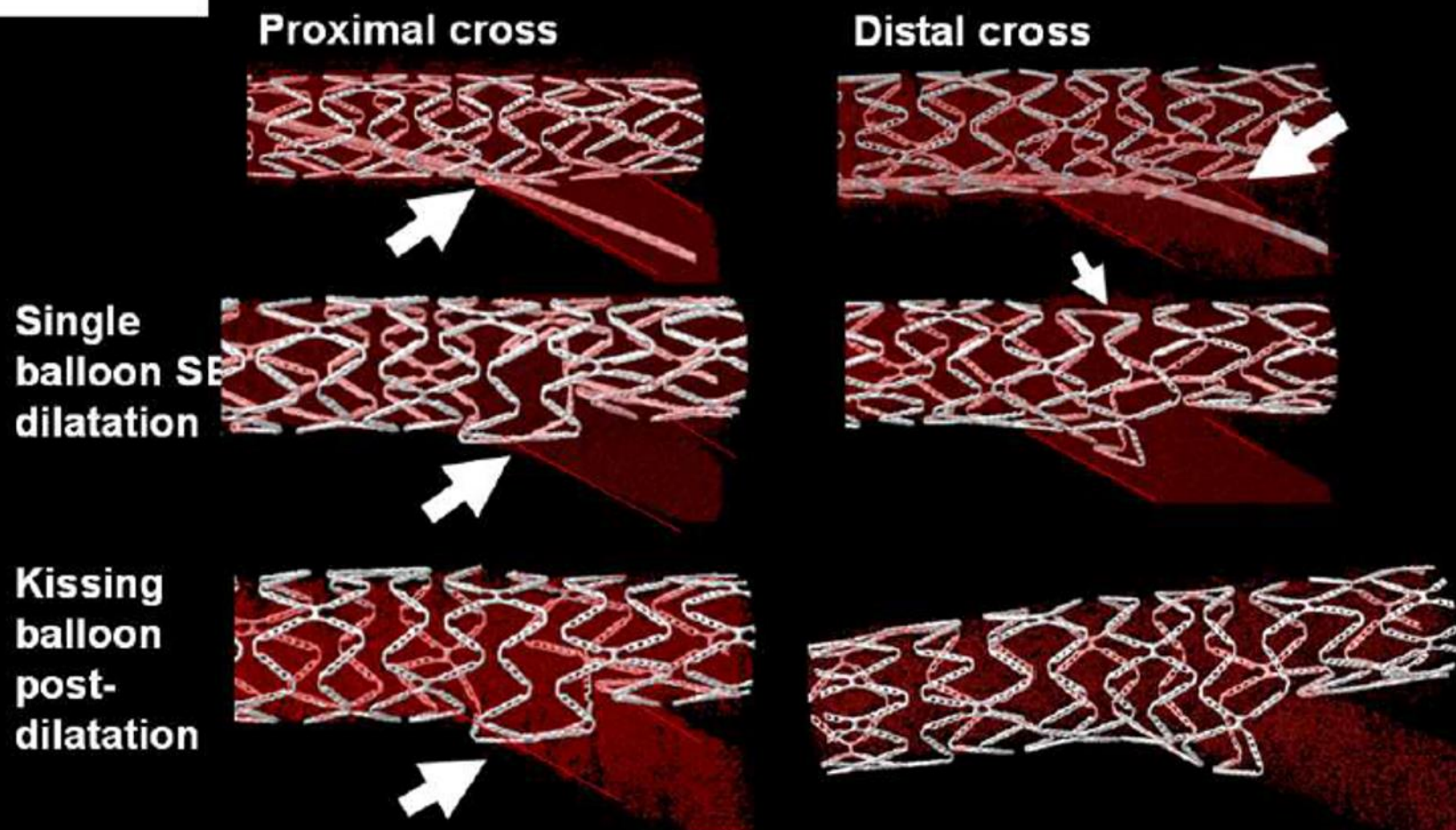
- On withdrawal of jailed wire in SB keep attention of guiding catheter to avoid injury of coronary ostium.
- Best way is to wire the side branch by using a pullback rewiring technique.
- Obtain a curve sufficiently wide to let the wire scratch the MV stent struts.
- Difficult wiring of SB may mandate good lesion preparation in MB.

Tips and Tricks in SB re-wiring after MB Stent Implantation

- Very small balloon inflation on the jailed wire may restore flow and facilitate rewiring in case of SB total occlusion after MB stenting.
- Difficult rewiring mandate changing either the shape of the guide wire's tip or the guide wire itself in favor of stiffer, more hydrophilic ones or use of microcatheter.
- On exchange of wires, withdraw MB wire first and push it in SB to ensure distal strut passage.
- In provisional stenting, rewiring across the distal side cells of the MB stent is associated to better ostium scaffolding & ↓ need of SB stenting.



Stenting MV across the SB. Distal wire cross creates better SB scaffolding than prox



Final kissing balloon inflation (FKBI)

Technique:

- Select the MB balloon equal to distal RD of MB and select the SB balloon equal to RD of SB.
- High pressure (> 12 ATM) inflation of the balloon in the SB first, followed by high pressure inflation of the balloon in the MB. Subsequently, simultaneous equal low pressure inflation of MB and SB balloons (8ATM).
- Simultaneous deflation of both balloons is important to avoid distorting the MV stent.
- Final POT should be considered.
- NC balloons give high success rate and low rate of TLR

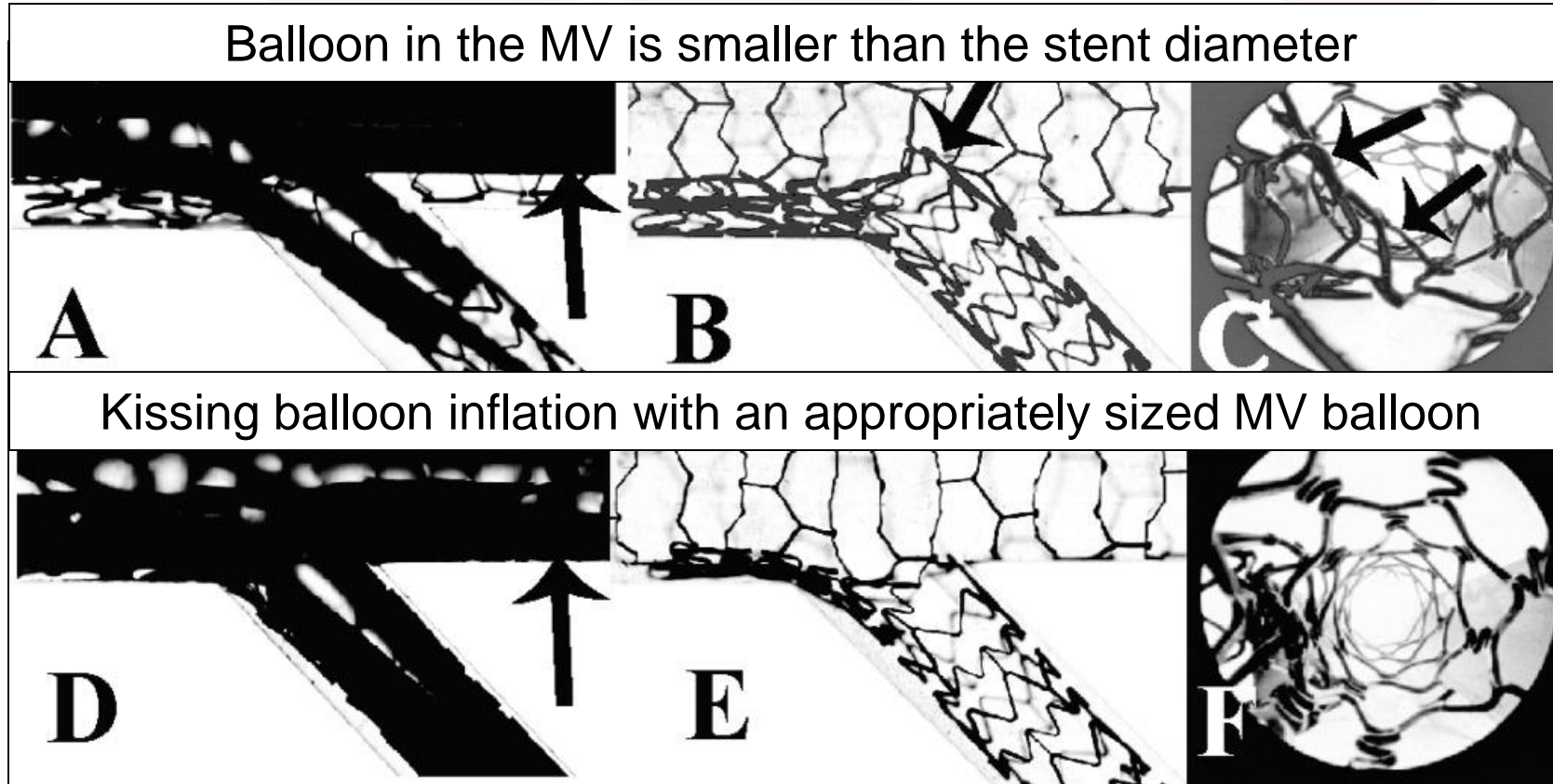
Final kissing balloon inflation (FKBI)

➤ *Value*

- Correct the proximal malaposition
- Optimize SB ostium strut opening
- Optimize the geometry of the carina

- FKBI is mandatory of the two stents technique (Crush and Culotte) showed significant reduction in MACE.
- FKBI is controversial in provisional stenting (In NORDIC study, similar clinical outcome with and without FKBI) but reduced angiographic restenosis).

Importance of good “kissing” in Crush Stenting



Use a balloon of **appropriate size**, inflated at **high pressure**

PROXIMAL OPTIMISATION TECHNIQUE (POT)

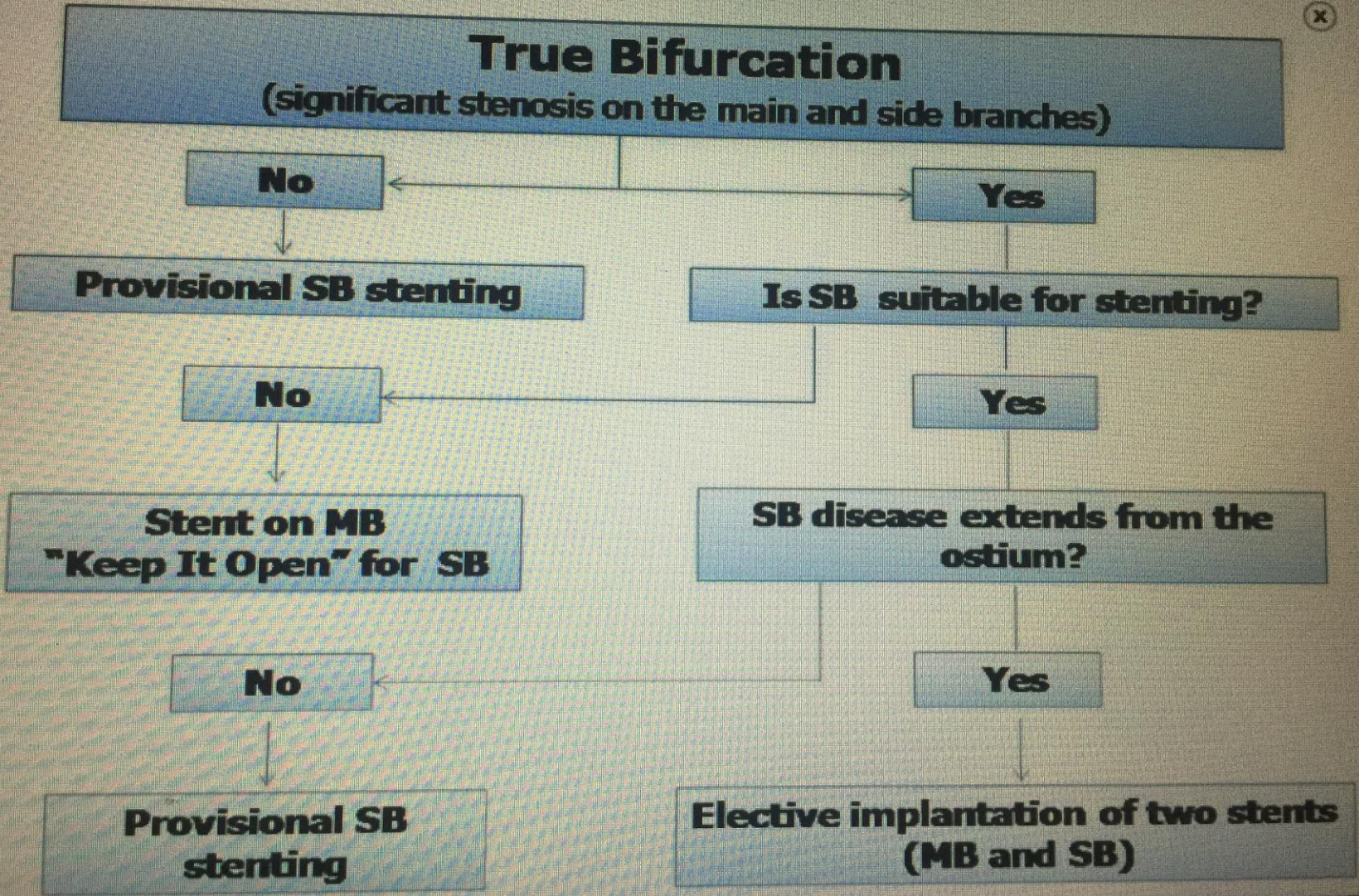
Technique:

- Carried out by short bigger (0.5 mm larger than RD) NC balloon just proximal to Carina.
- An extra 6-10mm is needed proximal to the carina while choosing the length of of MV stent.
- Careful positioning of balloon is critical:
 - Optimal position -----Distal shoulder of the balloon just proximal to the carina while the proximal end is completely within the stent to avoid proximal vessel injury.
 - Too distal-----Side branch occlusion due to carina shift.
 - Too proximal-----Has no effect on pushing the struts towards SB ostium.

PROXIMAL OPTIMISATION TECHNIQUE (POT)

Value

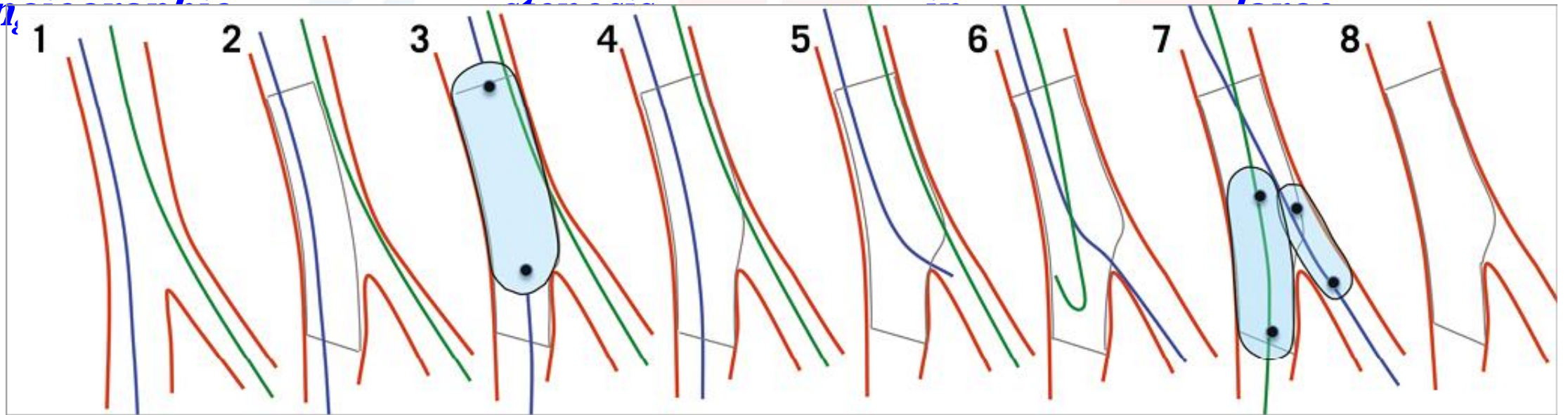
- If there is significant size difference between proximal and distal MB as in case of large SB.
- When access of side branch is difficult as it changes the orientation of SB ostium.
- Provides solution to under deployment of proximal MB stent.
- Thus, POT should be considered a standard step in bifurcation treatment.



A systematic Approach to Coronary Bifurcation PCI

- The provisional approach could be first choice in most cases (*90%*).
EBC recommended *KISSS* principle (*Keep It Simple, Swift and Safe*)
- Two stent approach as intention to treat or elective two stents approach (*10 %*) in cases with : lesions in large SB > 2.5mm with extensive disease extending > 5-10 mm beyond the bifurcation.

Provisional side branch (SB) stenting approach. From 1 to 8: wiring both branches. Main branch (MB) stenting using a stent diameter according to the distal MB reference. Proximal optimization technique (POT). After 4, the procedure can be stopped. If SB needs attention, wire exchange, wiring the SB through the MB distal strut. Kissing balloon inflation with short non-compliant balloons in order to avoid SB dissection and stent distortion proximal to the carina. Second stent in SB only if the results are unsatisfactory after SB balloon inflation < 3 TIMI flow or > 70 % an.



Techniques of Provisional SB Stenting:

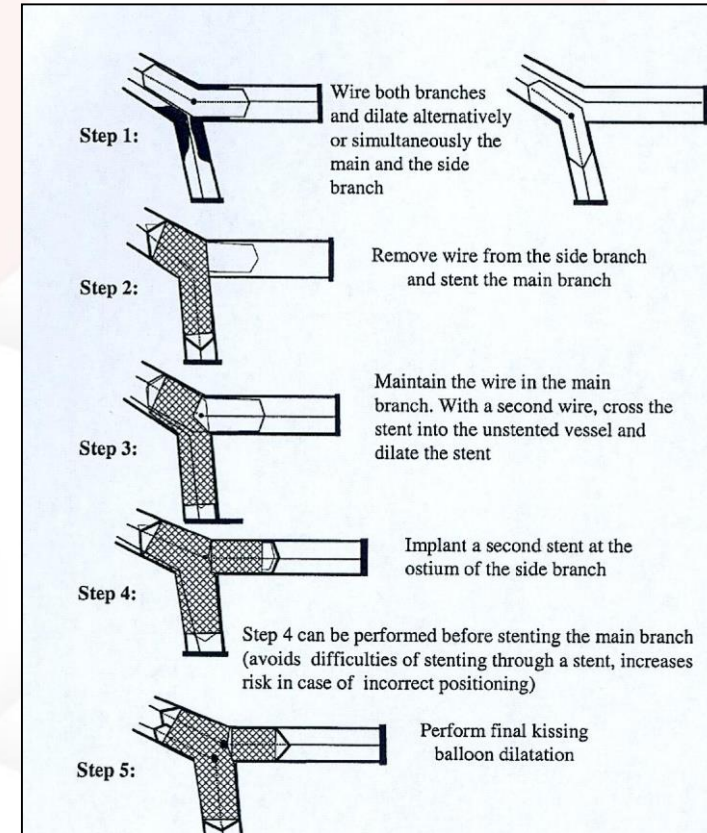
- T - Stenting
- Reverse or internal crush or Culotte
- TAP (T and small protrusion)

T-Stenting

- Advance second stent in SB (after dilation of MB stent).
- Position at the ostium and try to minimize any possible gaps.
- Deploy the SB stent.
- Second FKBI is performed.

Disadvantage

Risk of leaving a small gap between SB and MB stents → ostial restenosis of SB



Reverse or internal Crush

- Second stent is advanced into SB without deployment.
- Advance balloon with diameter of MB and shorter than MB stent at the level of bifurcation.
- Retract SB stent to the ostium with protrusion $< 3\text{mm}$ in MB.
- Deploy it and remove the balloon.
- Angiogram to verify the absence of dissection or the need of second stent then remove the SB wire.
- High pressure Inflation the MB balloon to $> 12\text{ ATM}$.
- Rewire the SB and pass a balloon with diameter of SB and perform high pressure inflation (12-20 ATM).
- FKBI.

Advantages :

Minimize any gaps between the MB and SB stents

TAP (T and small protrusion)

- A second stent is advanced to SB with 1-2mm protrusion in the MB
- A balloon is advanced to MB.
- Simultaneous inflation of SB stent and MB balloon to high pressure >12 ATM.
- **OR** SB stent is deployed while the balloon is deflated and retract SB balloon and FKBI.
- Both balloons are deflated and removed.

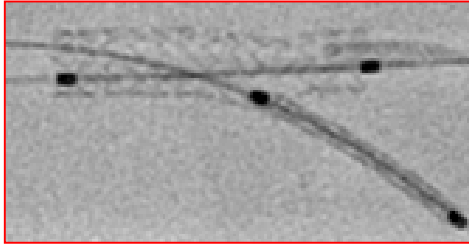
Advantages:

- 6 F guiding catheter
- Simple and does not require wire re-crossing through metallic struts.
- Good coverage of SB ostium.

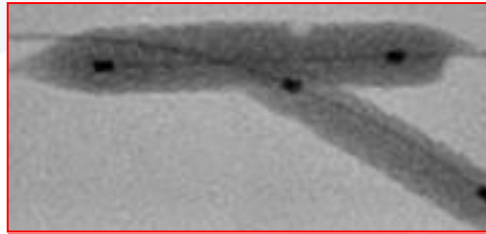
Disadvantages:

- No crushing to SB stent.
- SB stent protrudes partially into MB.

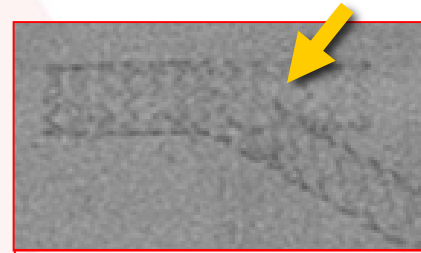
“T and Protrusion” (TAP) - SB stent is deployed so that it protrudes into MB to prevent gaps. Kissing Balloon Post-dilatation does not partially crush the SB stent.



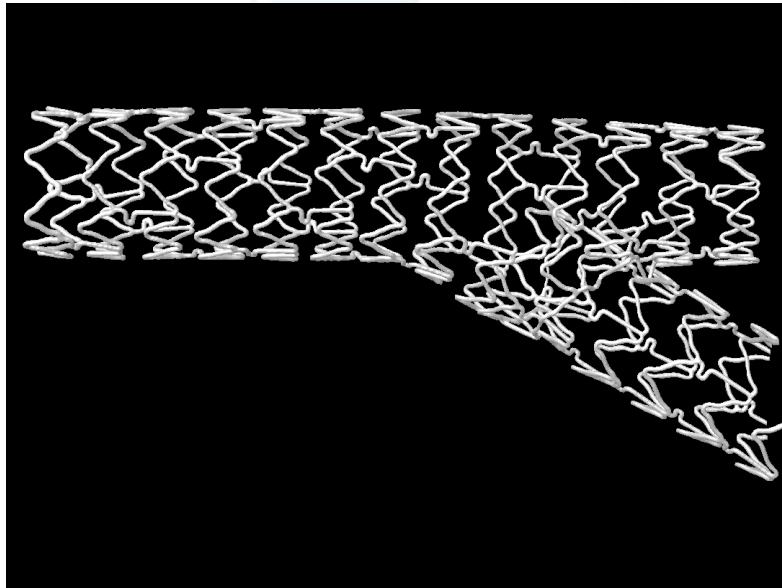
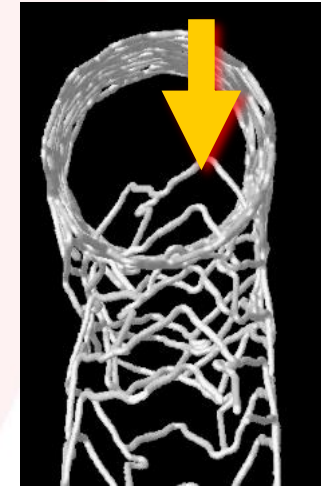
SB stent protrudes into MB



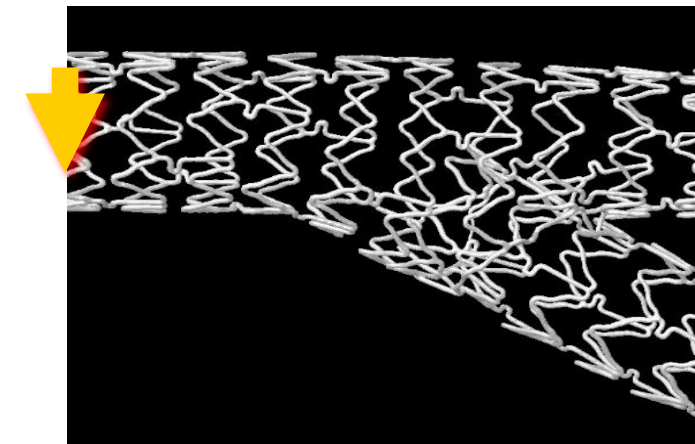
SB stent and MB balloons inflated together (kissing)



“Kissing” balloons do not crush the SB stent



SB stent protrudes into MB

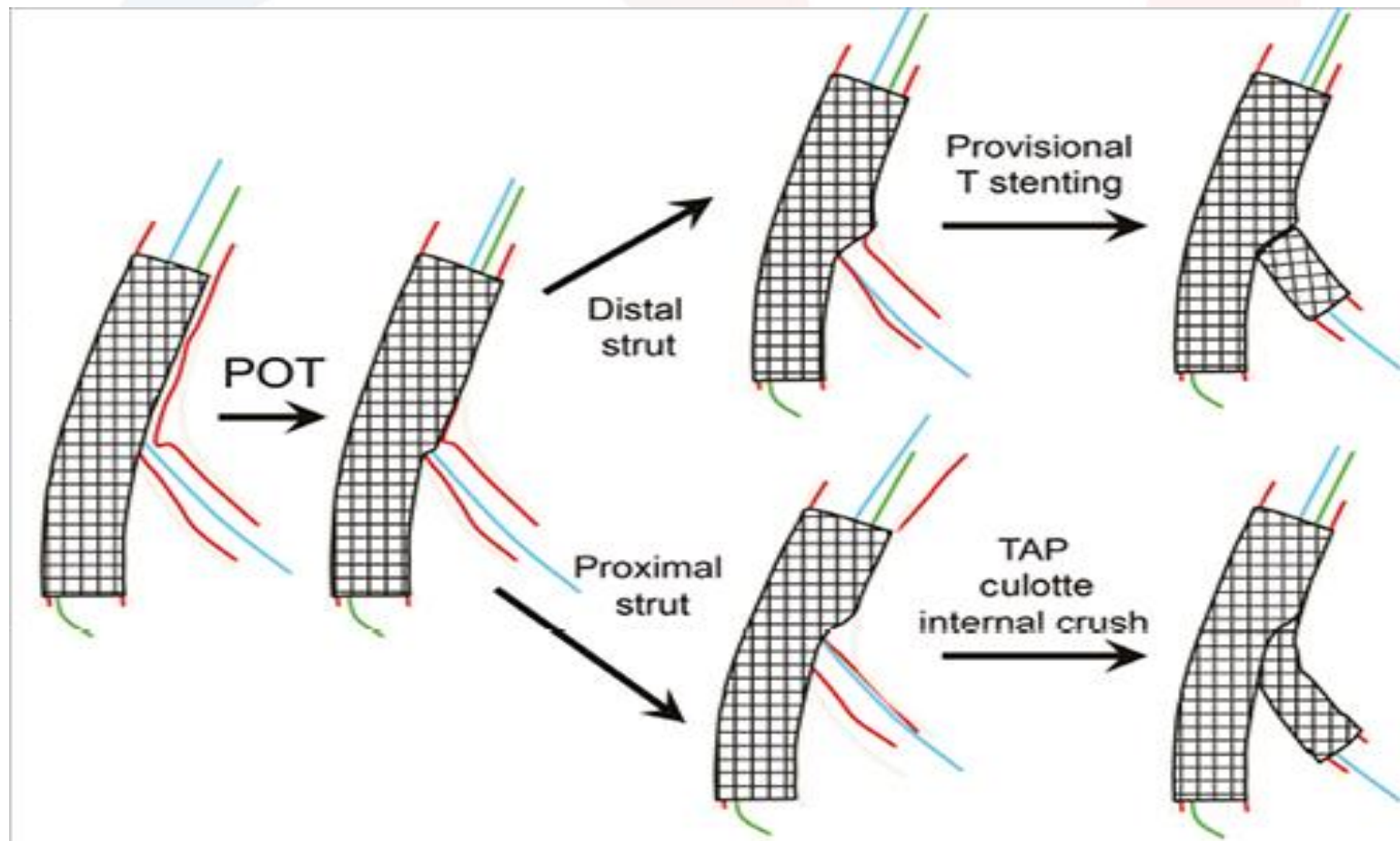


Selection of the technique should be influenced by the angle:

T shape angulation: TAP technique.

Y shape angulation: reverse culotte or crush techniques.

SB wire passage through the proximal or distal cells?



Techniques of Two stents as intention to treat

- V and SKS.
- Crush technique and its variations.
- Culotte technique
- Modified T technique
- Reverse TAP technique

V and SKS techniques

- Wire both branches and fully predilate.
- Position two parallel stents covering both branches and extending into main branch:
- V: minimal protrusion
- SKS: double barrel into the MB
- Deploy one stent then deploy the second stent or simultaneously.
- FKBI

Advantages:

Fast technique in emergency situations as distal LM stenting in CS.

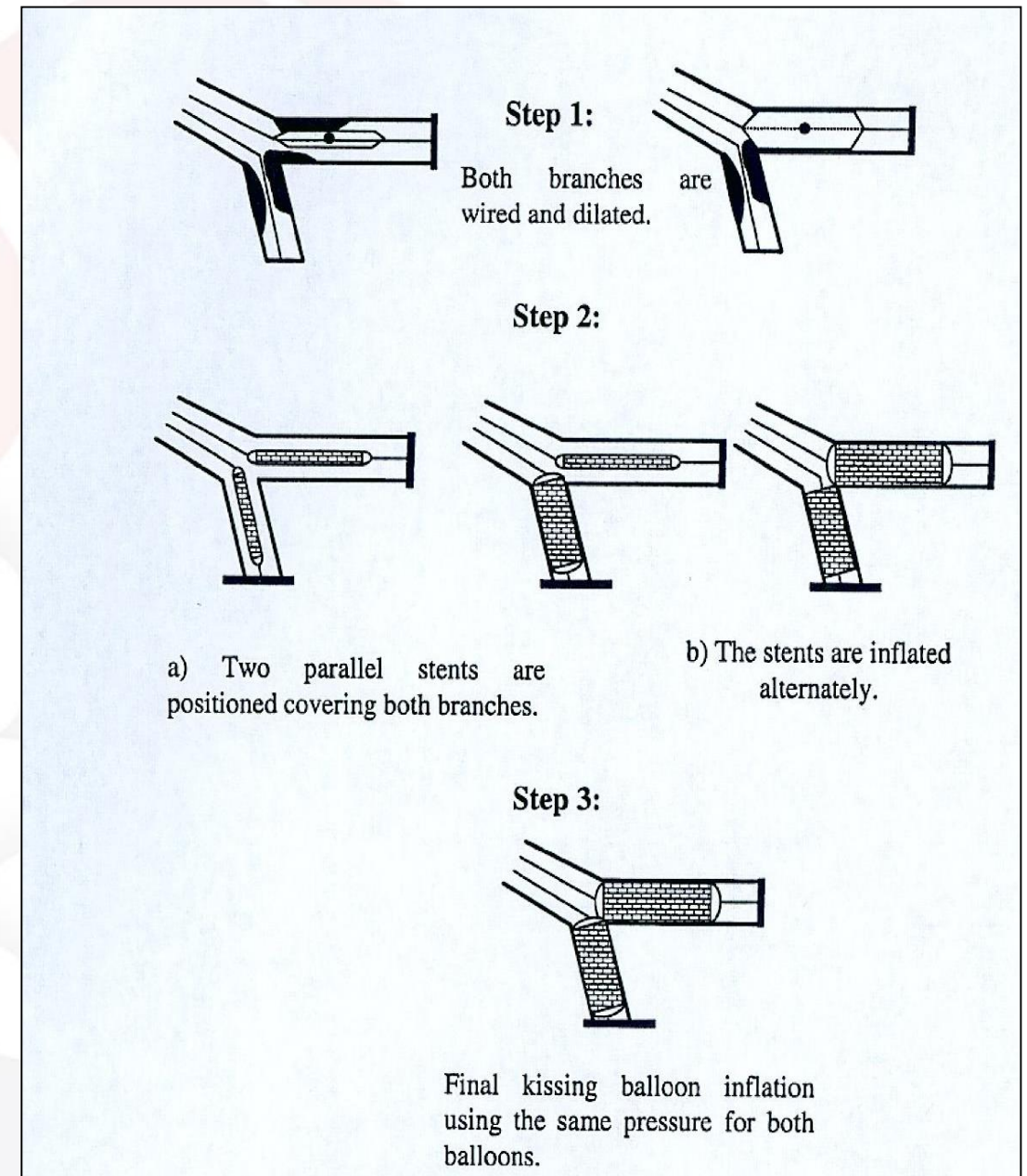
You never lose the access to both branches.

No need to recross any stent.

Disadvantages:

Risk of thromobsis at the new carina proximal to the bifurcation.

The MB proximal to bifurcation should be free of disease in V stenting.



Crush Technique Variations

- Standard crush
- Mini-crush
- Step crush, Balloon Crush or Double crush.
- DK-crush

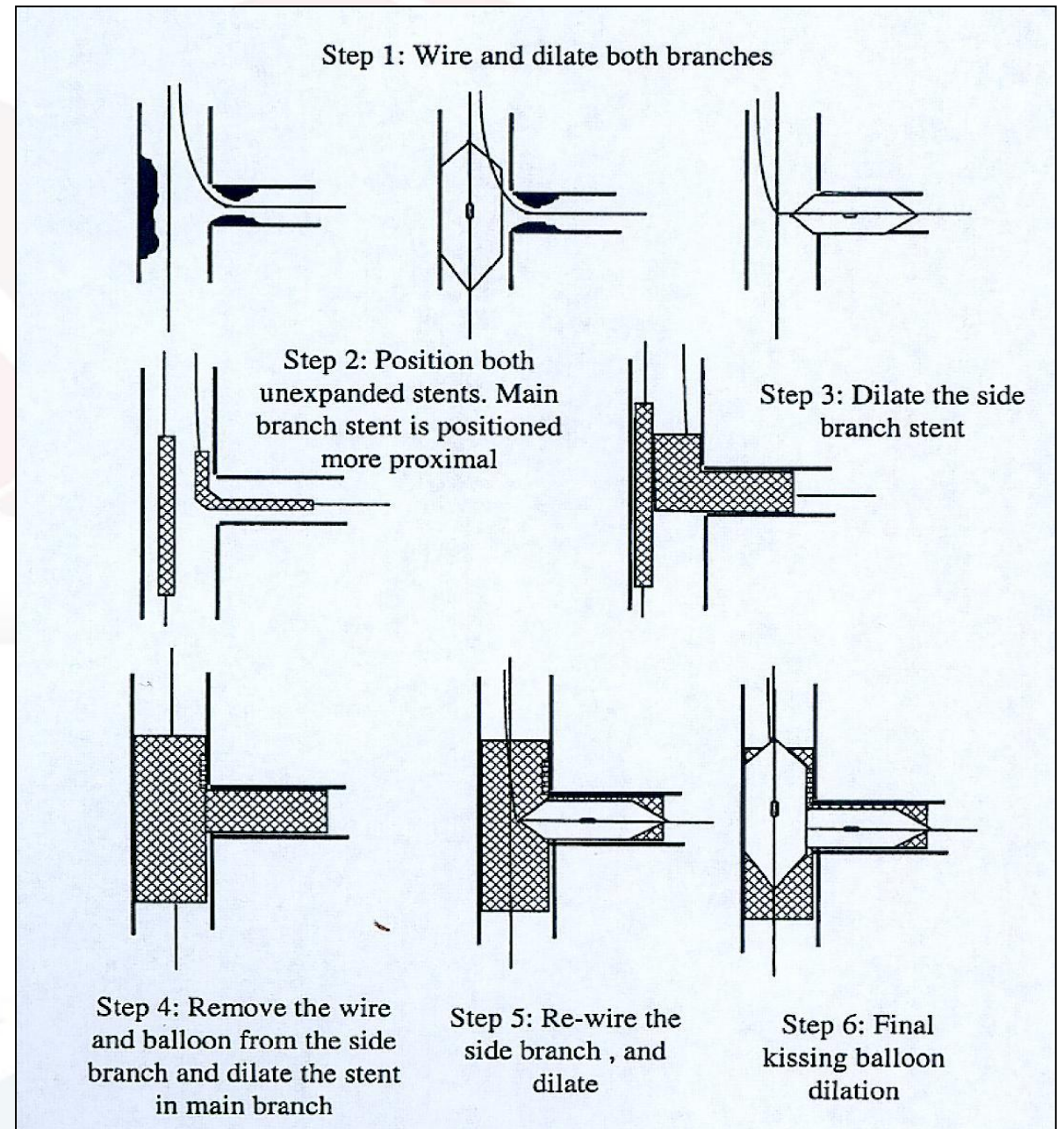
Standard Crush technique

- Wire both branches and predilate.
- Advance the two stents (MB stent positioned proximally), SB stent is pulled back into MB by (3-5) mm.
- Deploy SB stent at high pressure then the balloon is deflated and removed.
- Angiogram to verify absence of dissection or the need for additional stent in SB.
- Remove the wire from SB.
- Deploy the MB stent to crush SB stent.
- Rewire the SB and perform high pressure balloon dilatation.
- FKBI

Advantage: Excellent coverage to SB ostium.

Disadvantages: Need 7 or 8 F guiding catheters, difficult to re-cross the wire through multiple metallic layers.

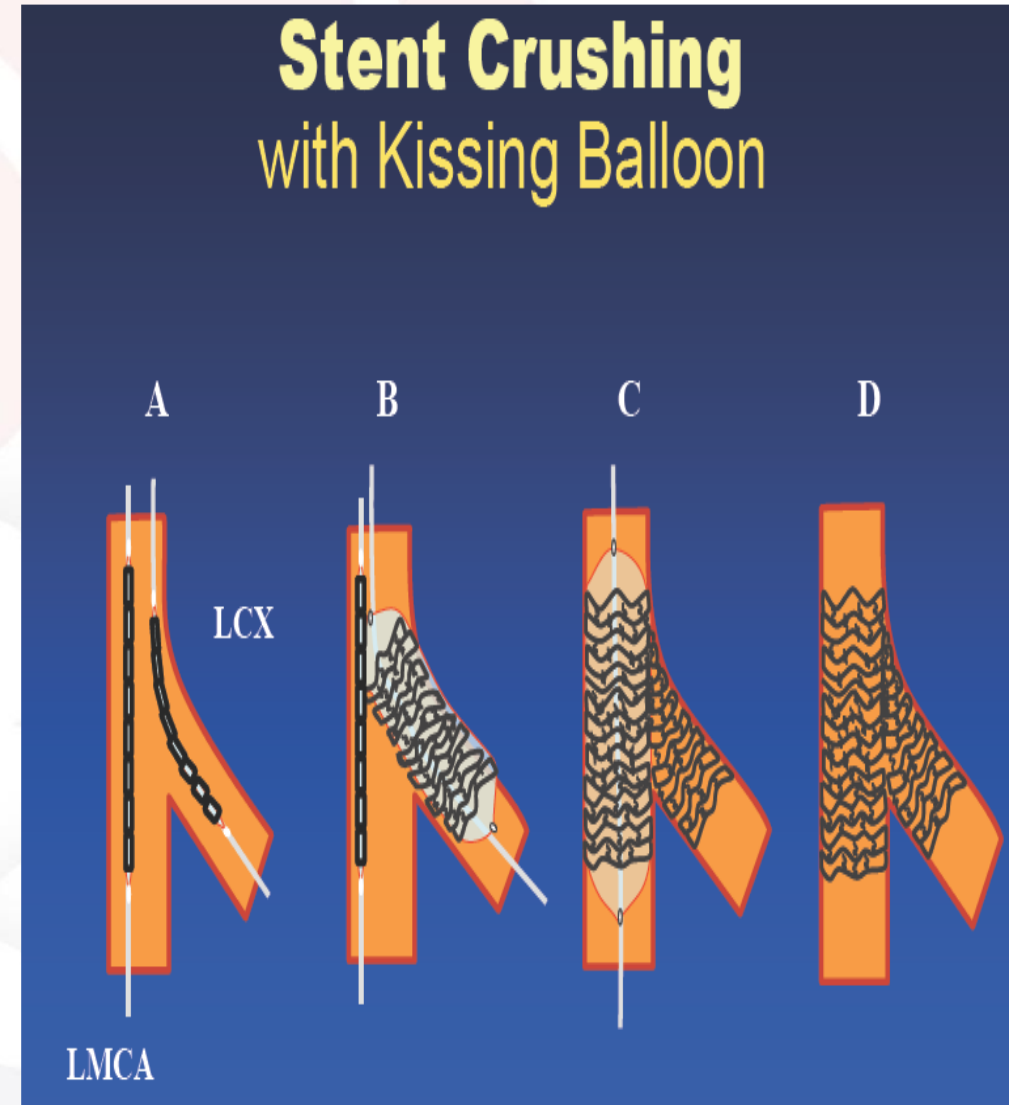
Mini-crush modification simply consists of less protrusion of SB stent (2-3 mm) which makes re-crossing of the struts easier.



Step or Balloon or Double crush technique

- Both branches are wired and predilated.
- Advance the SB stent with protrusion 2-3mm in MB.
- Advance a balloon to MB at level of bifurcation.
- Deploy SB stent at high pressure.
- Angiogram to check the results then remove SB wire.
- Inflation of MB balloon at high pressure to crush the SB stent (first crush) then remove the balloon.
- MB stent is advanced and deployed (second crush).
- Recross to SB stent by the wire then high pressure balloon dilatation.
- FKBI.

Advantage: Can be done through 6 F guiding catheter.



DK crush

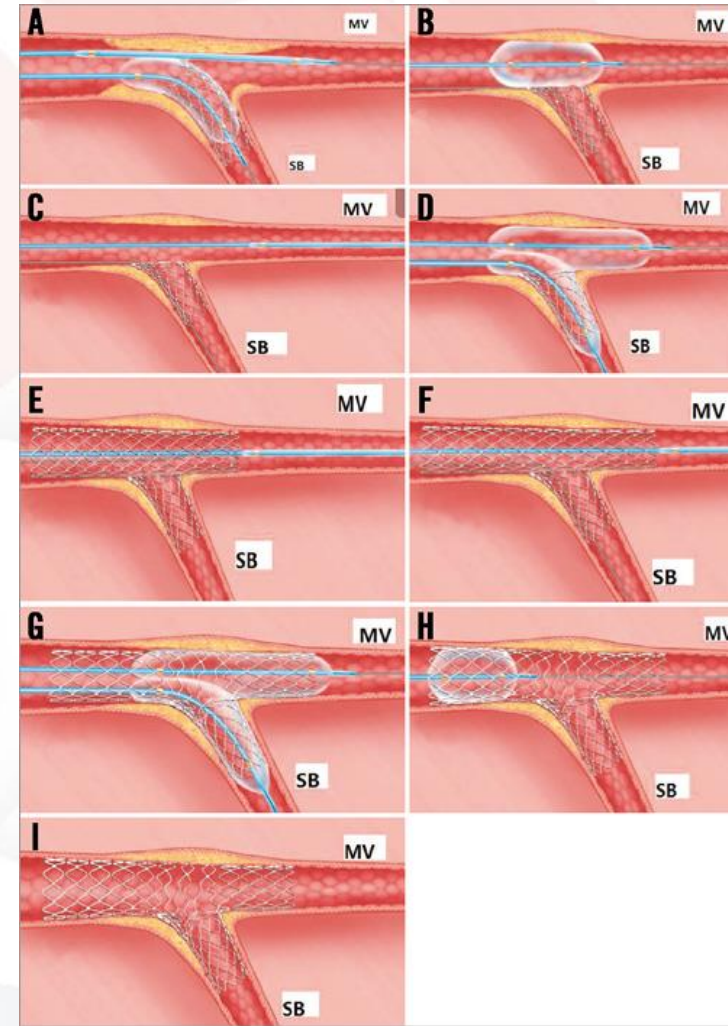
- Both branches are wired and predilated.
- Advance the SB stent with protrusion 2-3mm in MB.
- Advance a balloon to MB at level of bifurcation.
- Deploy SB stent at high pressure, remove the wire.
- Inflation of MB balloon at high pressure to crush the SB stent (first crush).
- KBI is performed after crushing SB stent with the balloon (first kiss) and remove SB wire.
- MB stent is advanced and deployed (second crush).
- Recross to SB stent by the wire then balloon dilatation.
- FKBI (second kiss).

Advantages :

The first KBI facilitate access to SB stent.

Optimize stent apposition at SB ostium.

Recently has been shown to perform favourably against provisional stenting.



Culotte technique

- Wire both branches and predilate
- Deploy a stent in the more angulated branch (SB).
- Remove the wire from the stented branch and cross with a wire and balloon into the unstented branch (MB) and dilate the struts.
- Place a second stent into the unstented branch (MB) and expand the stent leaving some proximal overlap.
- Cross with a wire the first stent (SB) and perform FKBI

Advantages:

Suitable for all angles of bifurcation

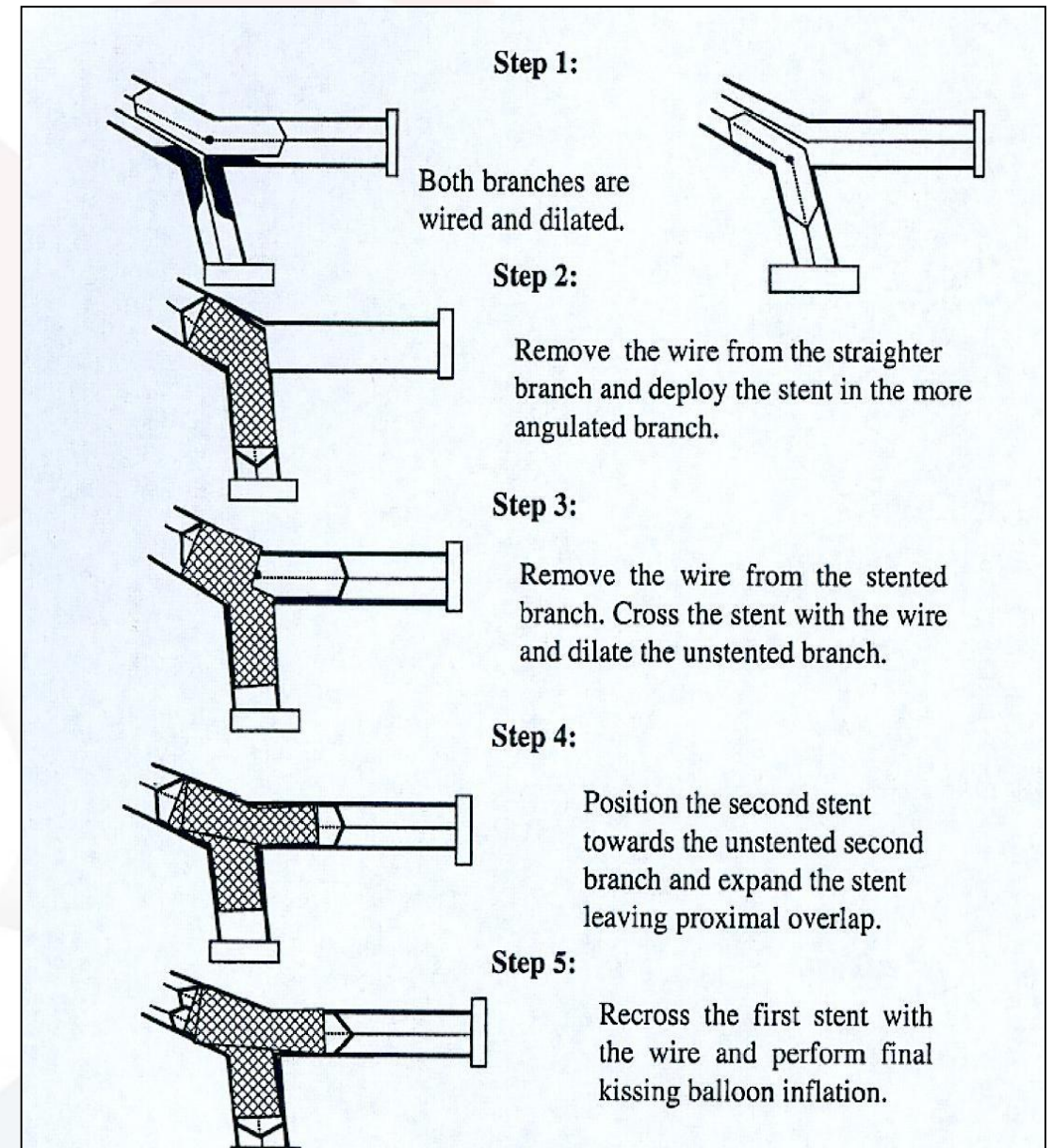
Provide near perfect coverage of of SB ostium.

Disadvantages

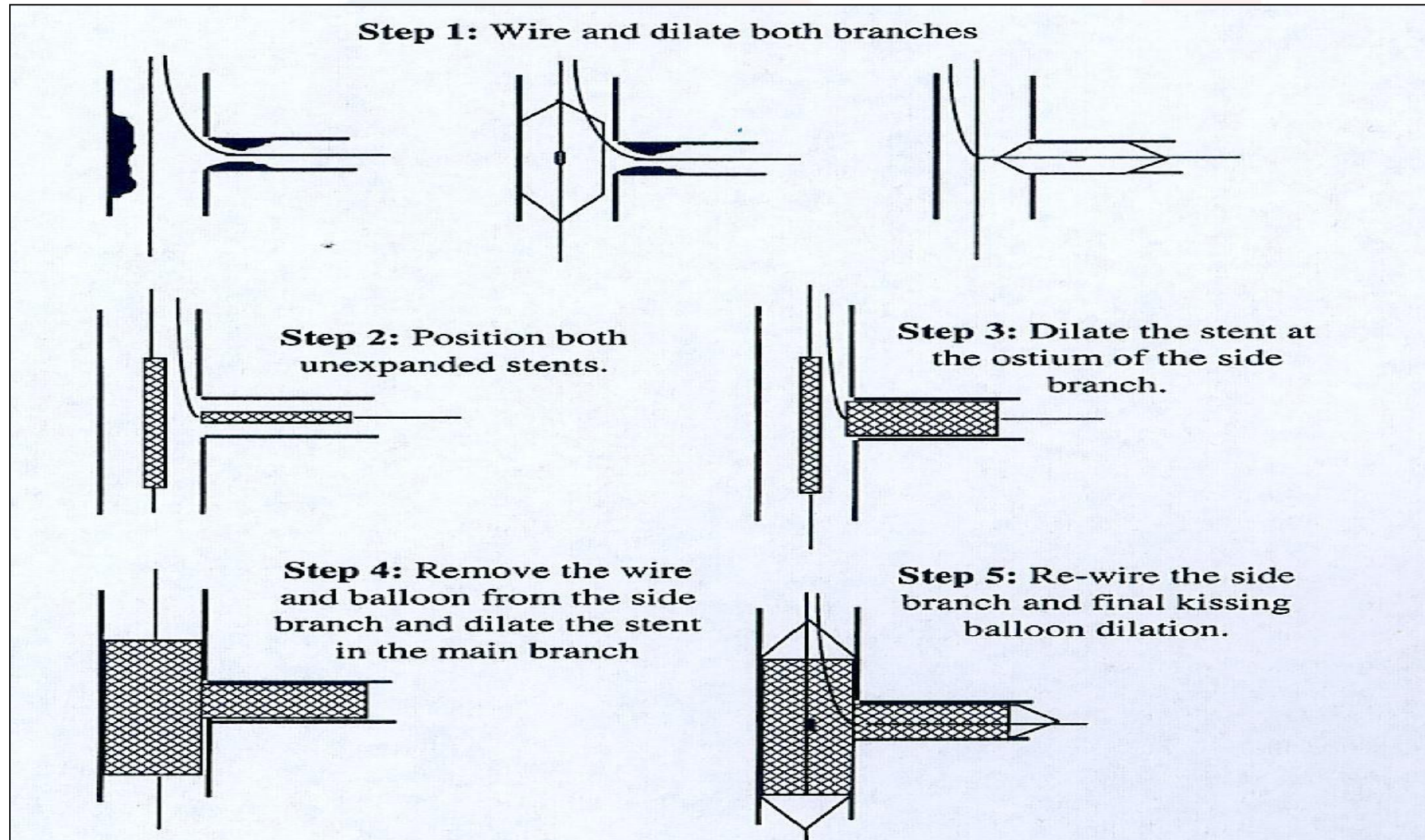
High concentration of metal at the carina and in the proximal part of bifurcation.

Rewiring of the struts is time consuming

Open cell stents only can be used in this technique.



Modified T Stenting Technique

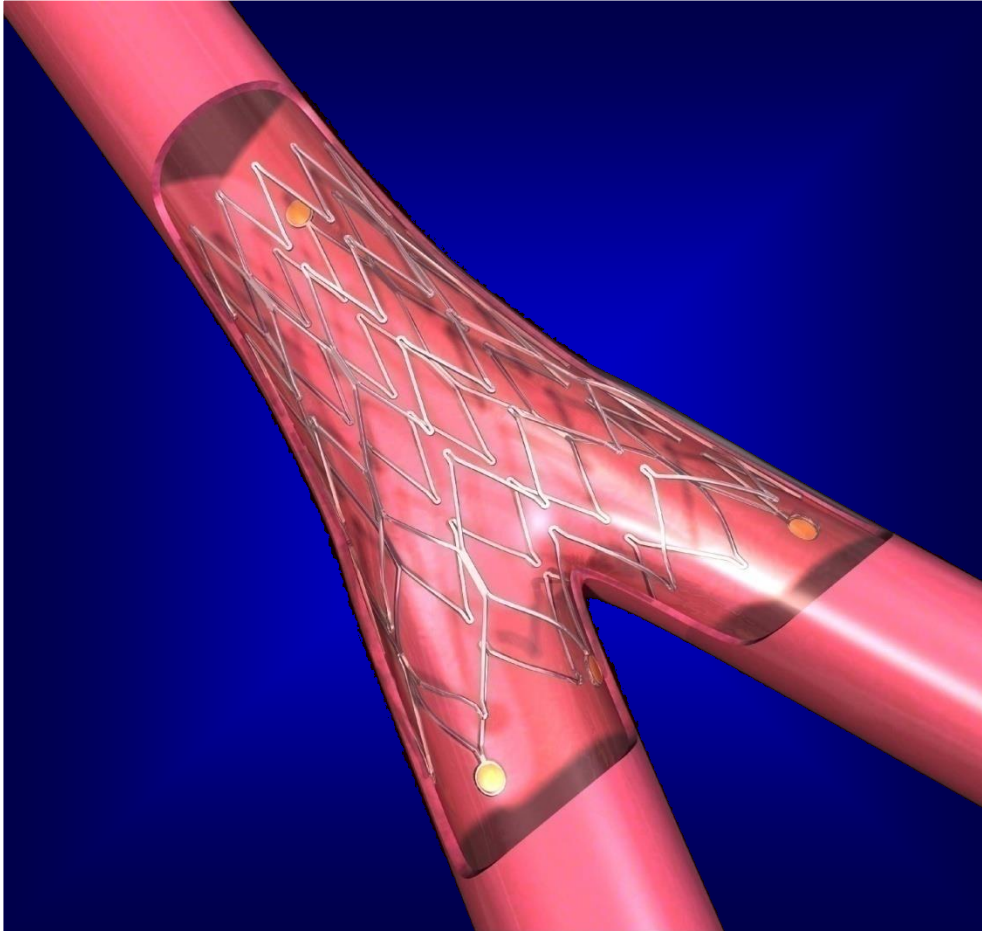


Reverse TAP technique

- Wire both branches and predilate.
- Position SB stent with 1-2mm protrusion
- Position MB balloon opposite to the bifurcation
- Inflate SB stent and MB balloon simultaneously
- Pull back half of the balloon of SB stent into MB and do kissing again.
- Remove SB wire, position and inflate MV stent
- Finally rewire SB and do FKBI

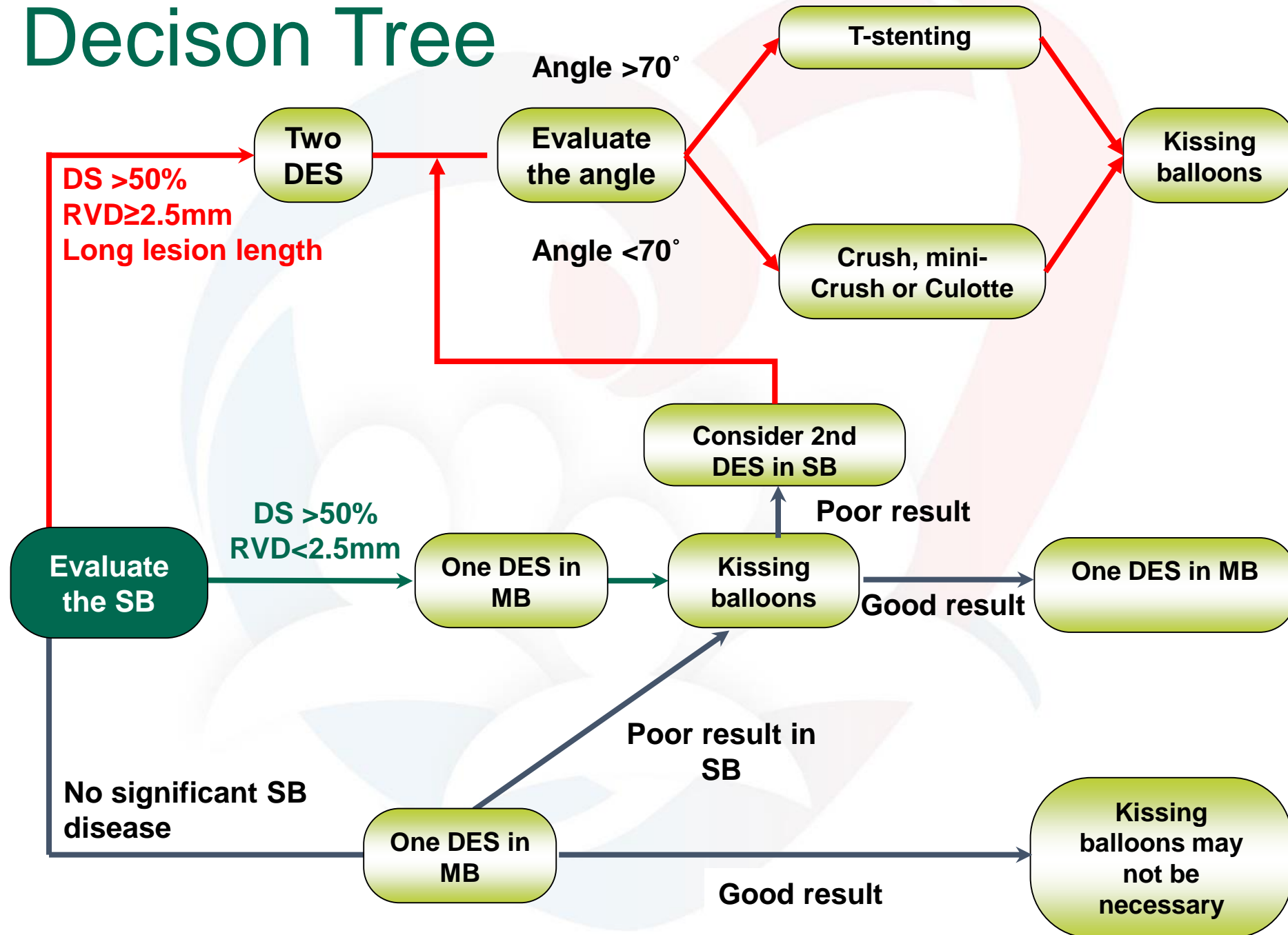
Dedicated Bifurcation Stents

Speciality Designs



DEVAX AXXESS Biolimus-eluting Stent

Decision Tree



Conclusion

- Provisional stenting remains the gold standard for most bifurcations adopting the KISSS principle. Ensuring optimal result in the MB may be more important than optimizing the angiographic appearance of SB
- Large sized branches with osteal disease extending $> 5 - 10$ mm from the carina are likely to require two stent strategy.
- Value of FKBI in one stenting is controversial and KBI should be used when angiographically significant $> 75\%$ stenosis in SB remains after MV stenting.
- FKBI is mandatory in 2 stents techniques.
- POT should be considered a standard step in bifurcation treatment.

What would be your strategy in this LAD, Diagonal Lesion?



What would be your strategy in this Left main Lesion?





Thank You