Challenges and Limitations of QCA in the Analysis of Bifurcation Lesions

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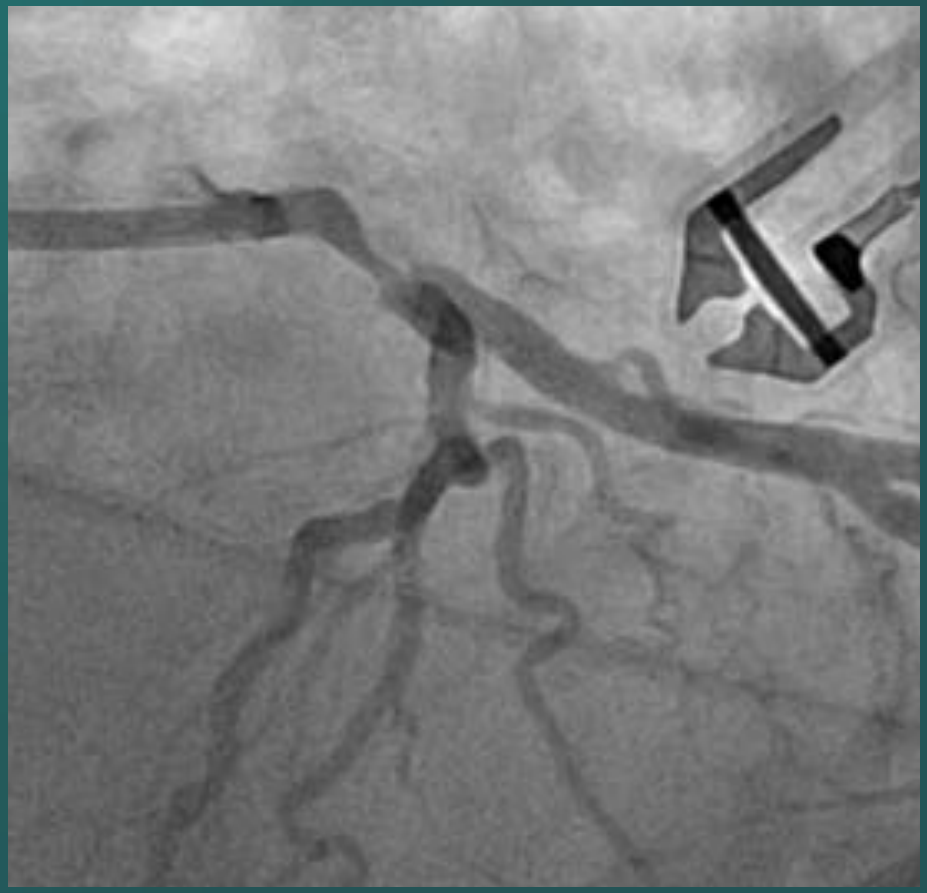
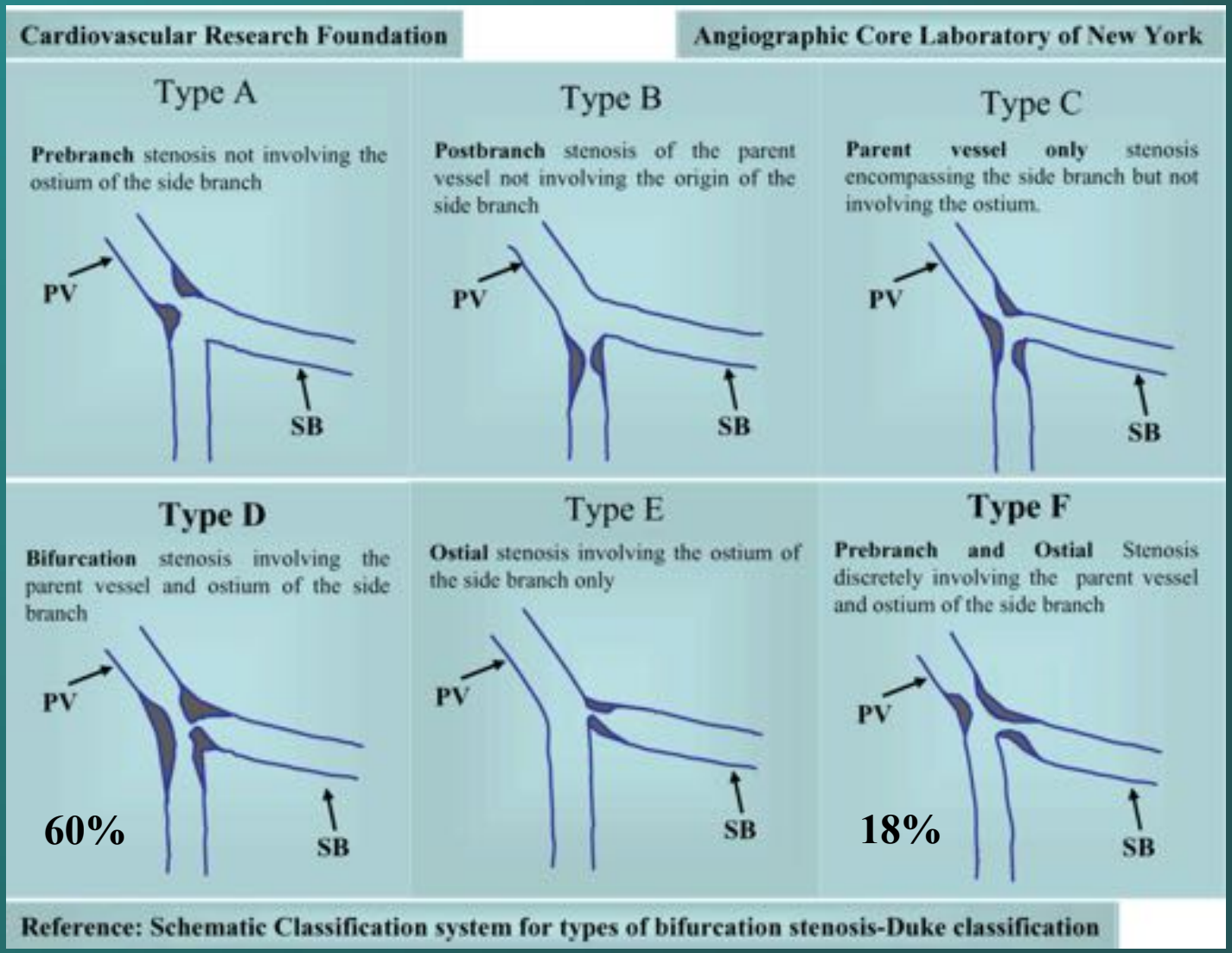
The realities of bifurcation lesions are the greatest challenges of QCA

- Lesion location is variable in bifurcation disease (ostial side branch, within the carina)
- One bifurcation lesion but 3 vessel segments (4 for trifurcations)
- How to quantify extent of lesion length?
- Bifurcation stenoses rarely seen in one single view- require multiple views for analysis

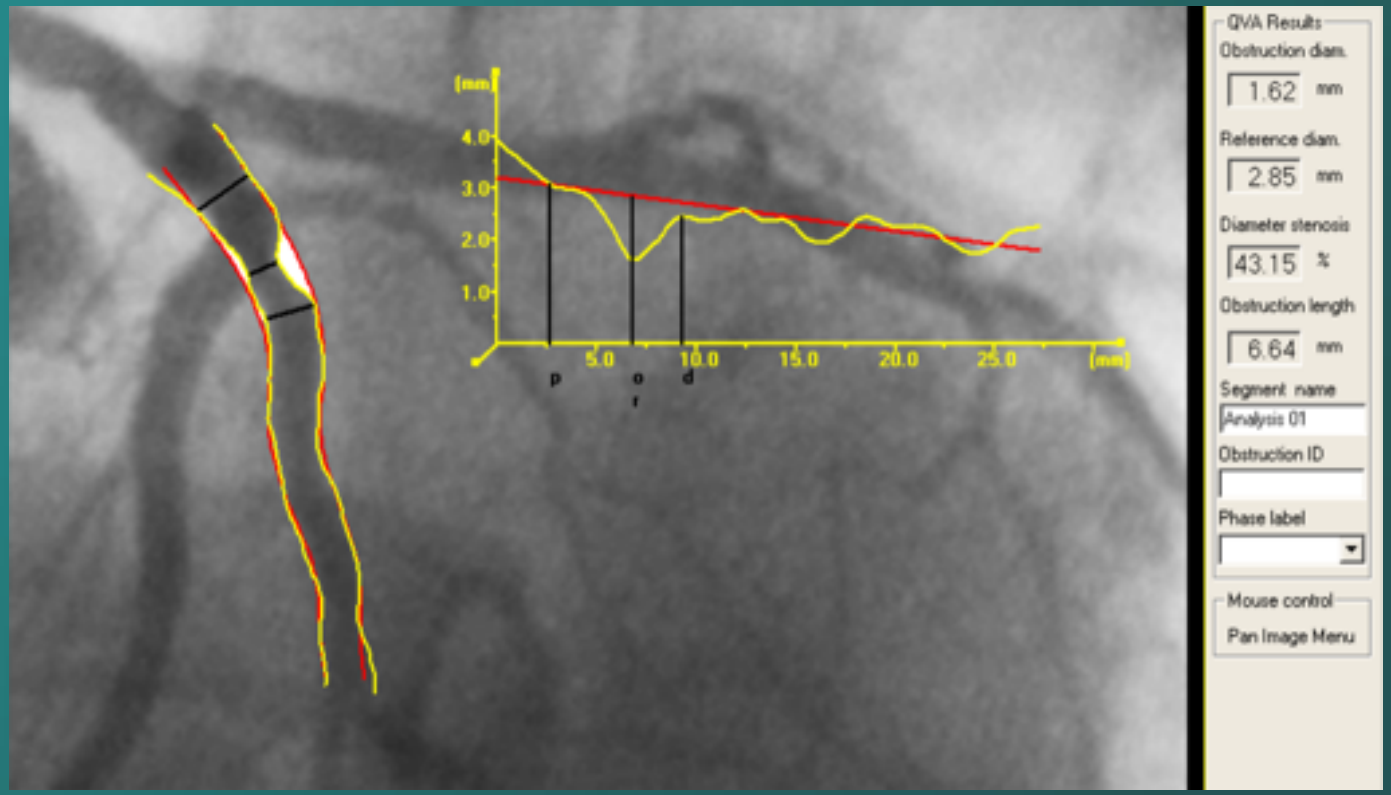
Bifurcation lesions rarely can be analyzed in one single view



BIFURCATION Types



Limitations of Standard Analysis



Problem: Mismatch between prox vessel and distal vessel

Results in: Overestimated Reference

Overestimated %DS

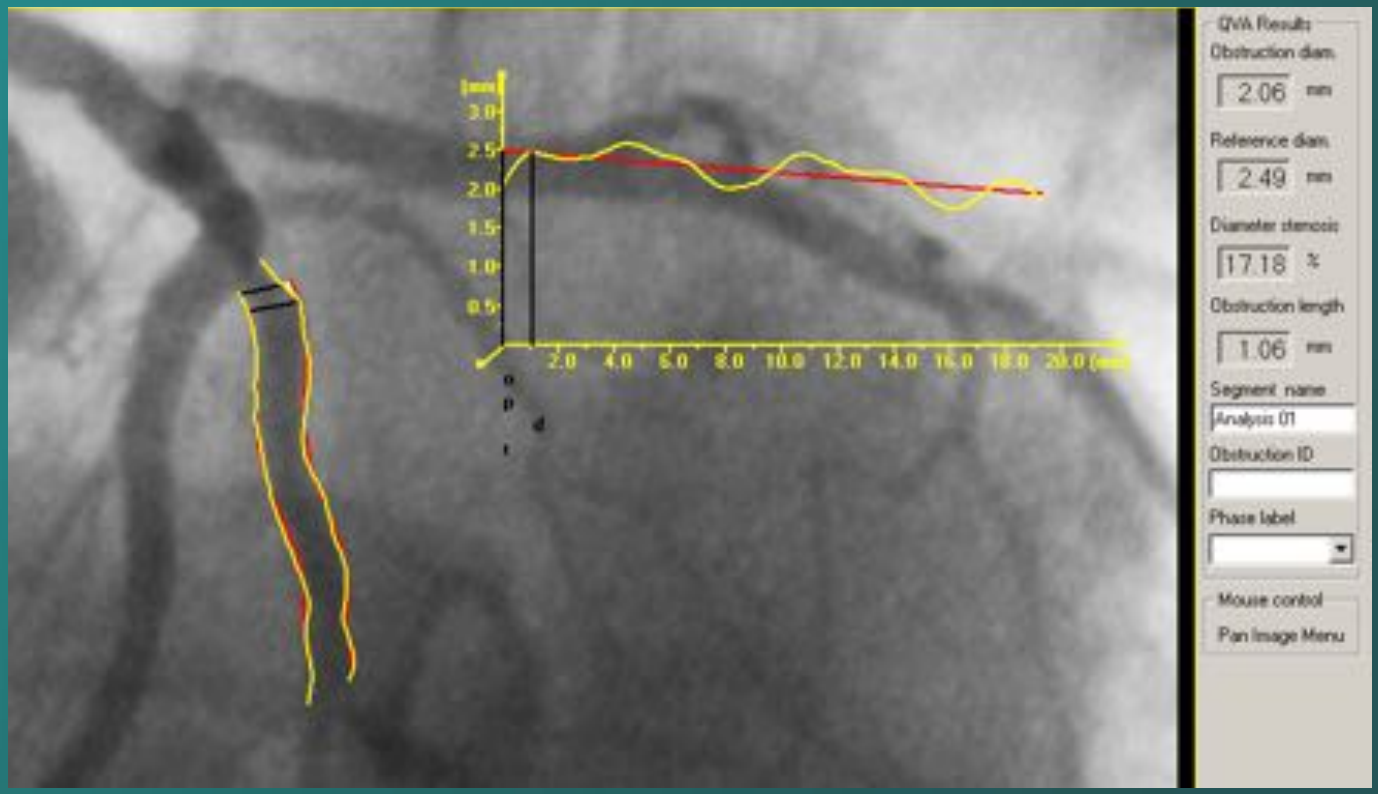
Better for lesion length

Solutions:

Use Distal Reference or

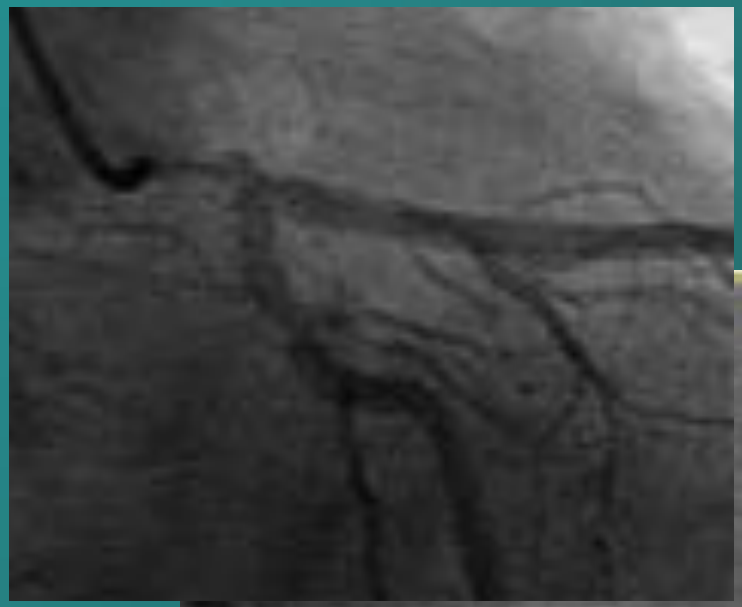
Limit analysis to distal PV

Greatest Limitation: Reference Diameter

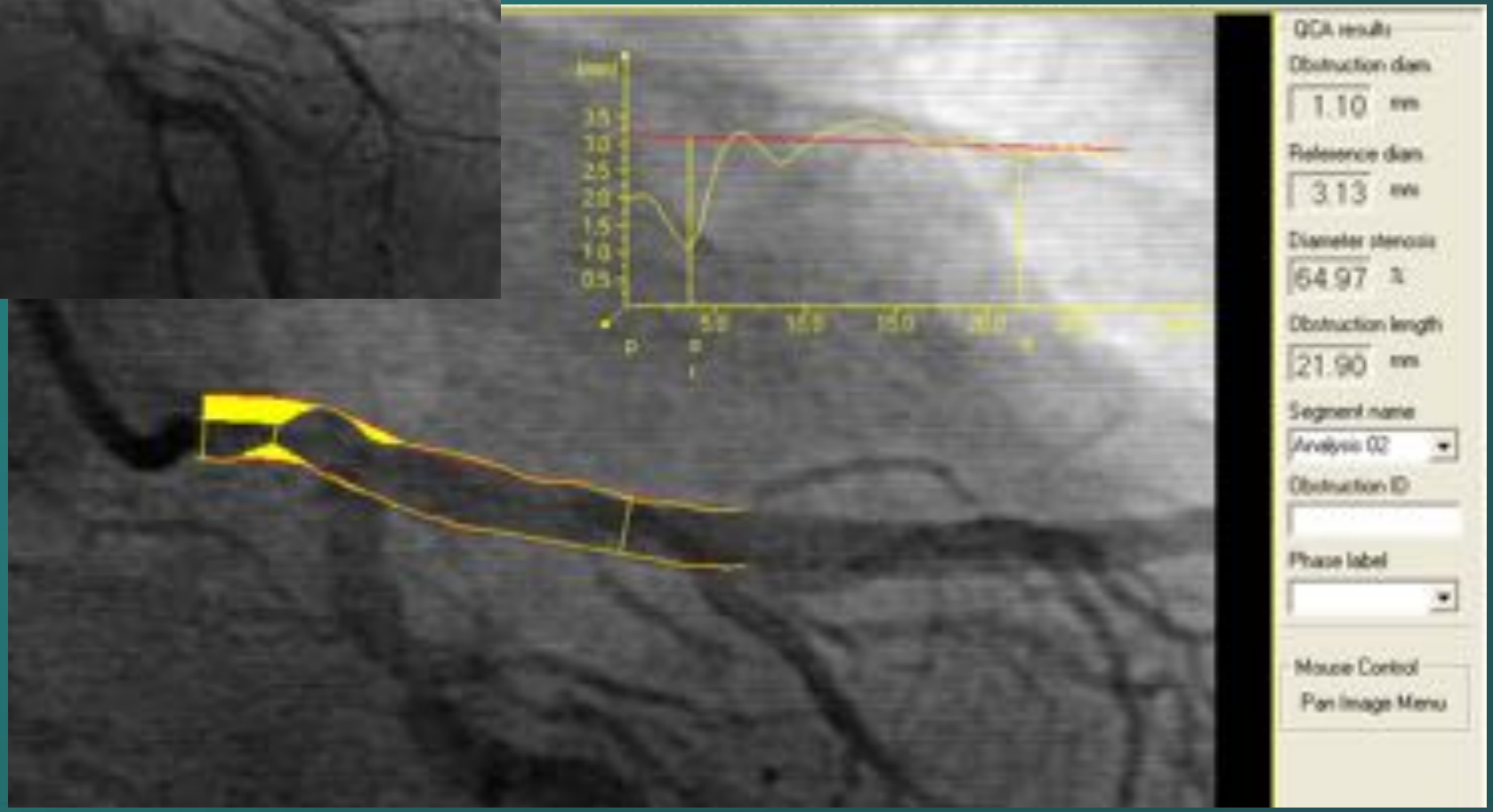


- **Problems:** Vessel contour track into MLD
  Cannot assess lesion length
- **Results in:** Underestimates reference
  Underestimates %DS
- **Solution:** Use Distal Reference

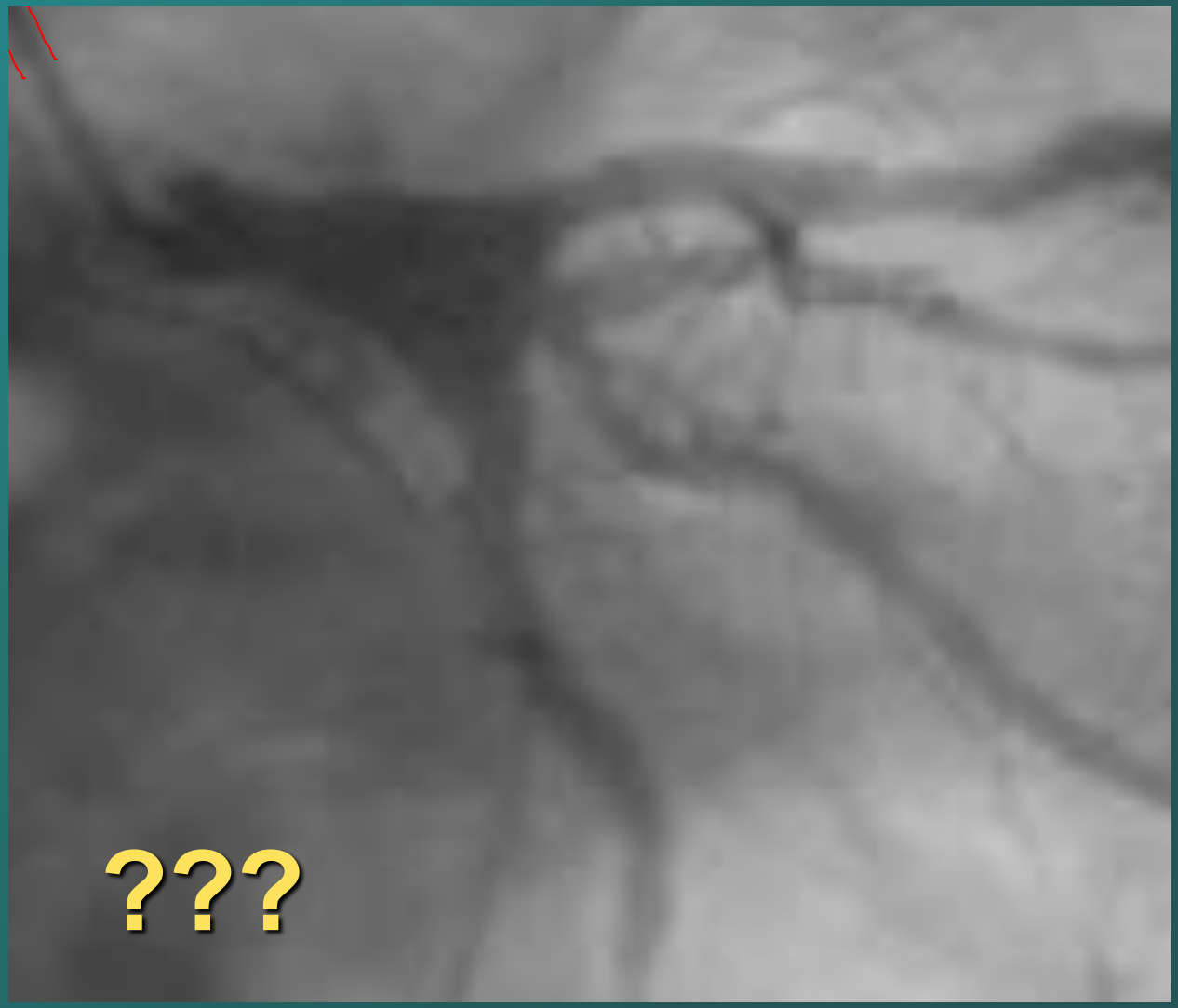
Greatest Limitation: Ostial Lesion



- **Problems:** Vessel contour track into MLD
- **Results in:** Underestimates reference
  Underestimates %DS
- **Solution:** Use Distal Reference?

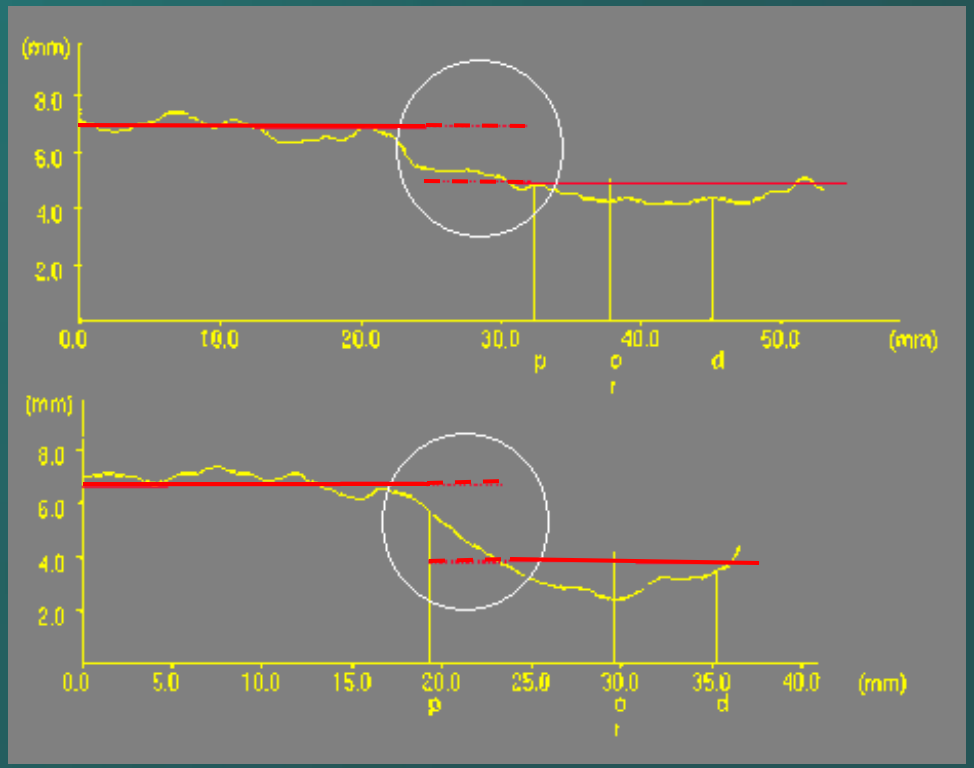


Left Main Trifurcation with extreme proximal:distal vessel miss-match

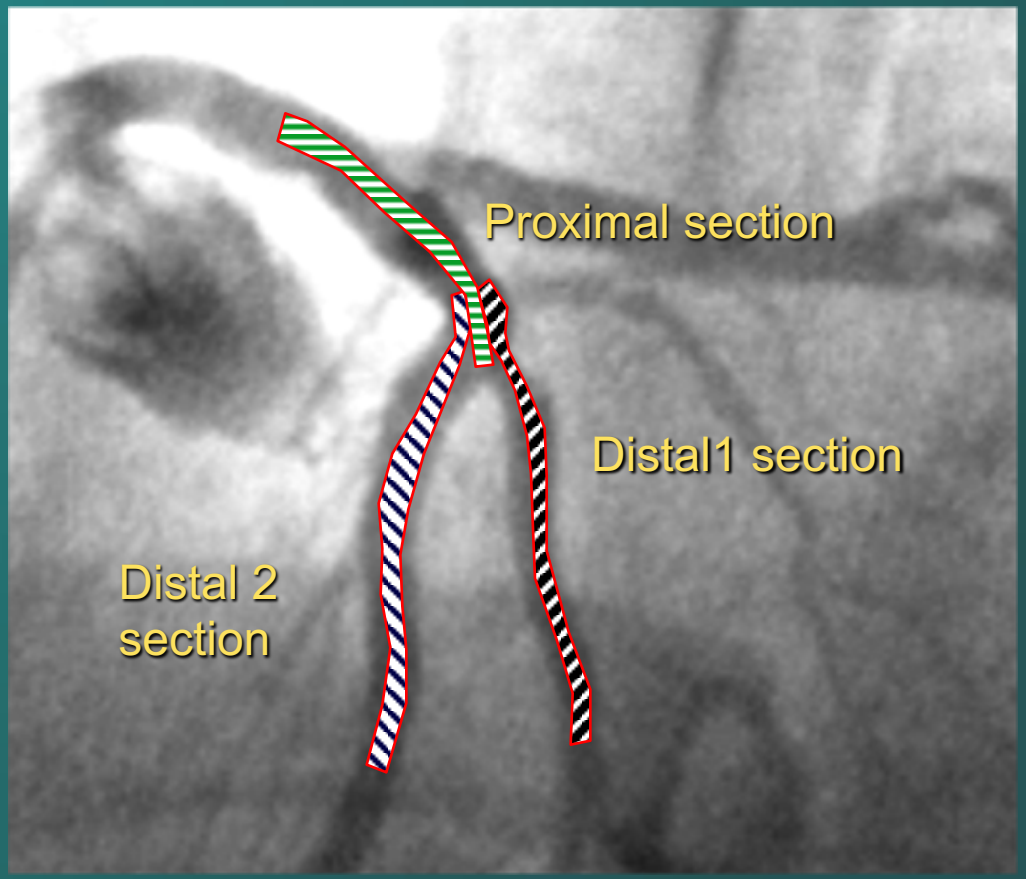


Reality of the bifurcation "Step down"

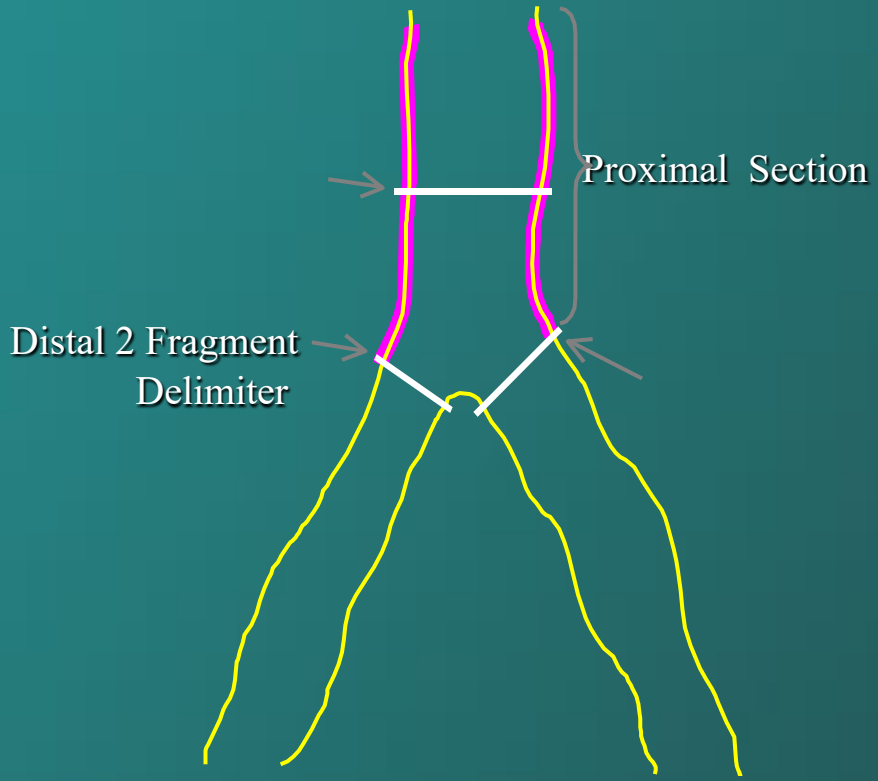
Method to determine the proper reference diameter for each individual segment

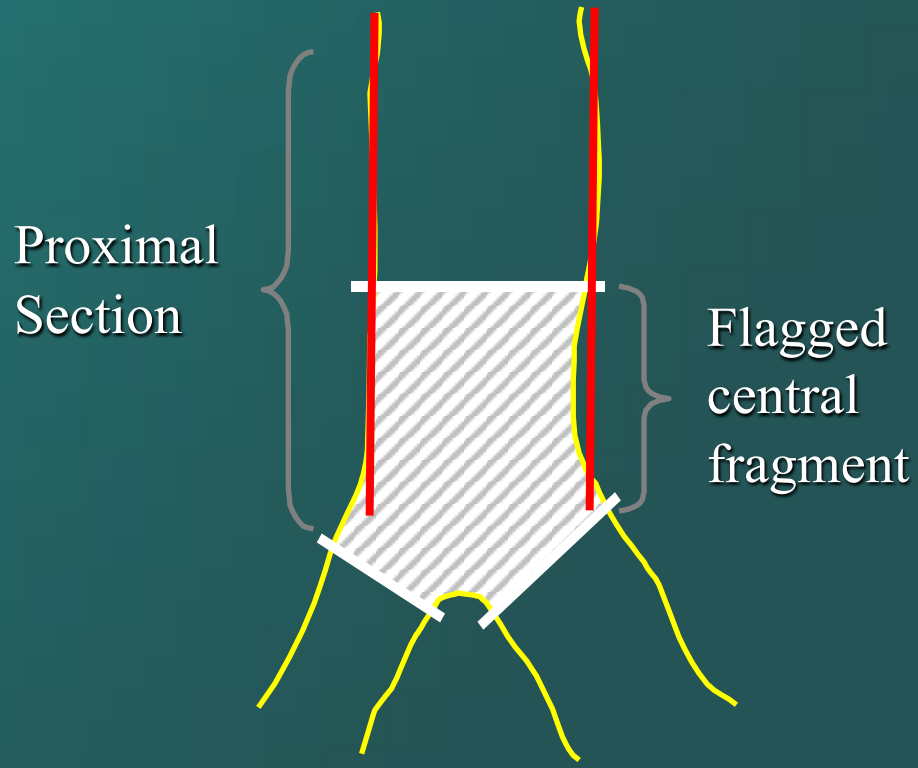


Three sections model for the bifurcation analysis (MEDIS)



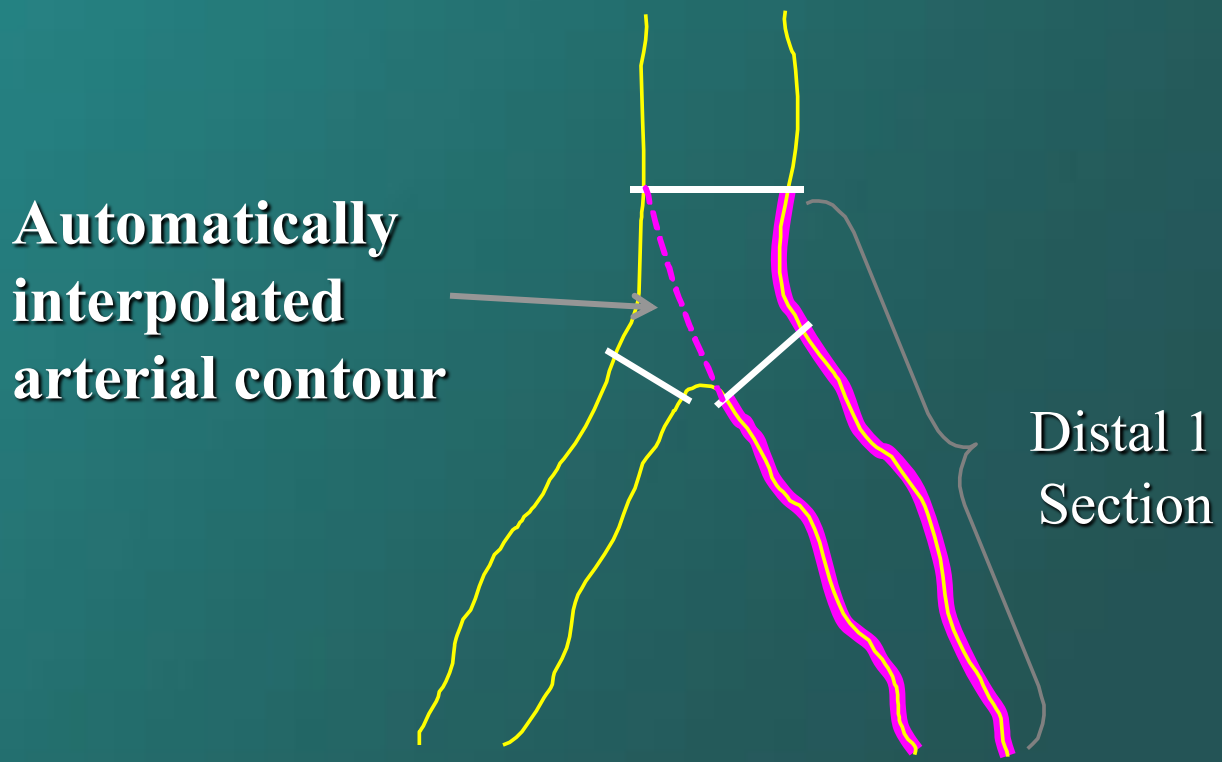
Arterial contour: 4 segments



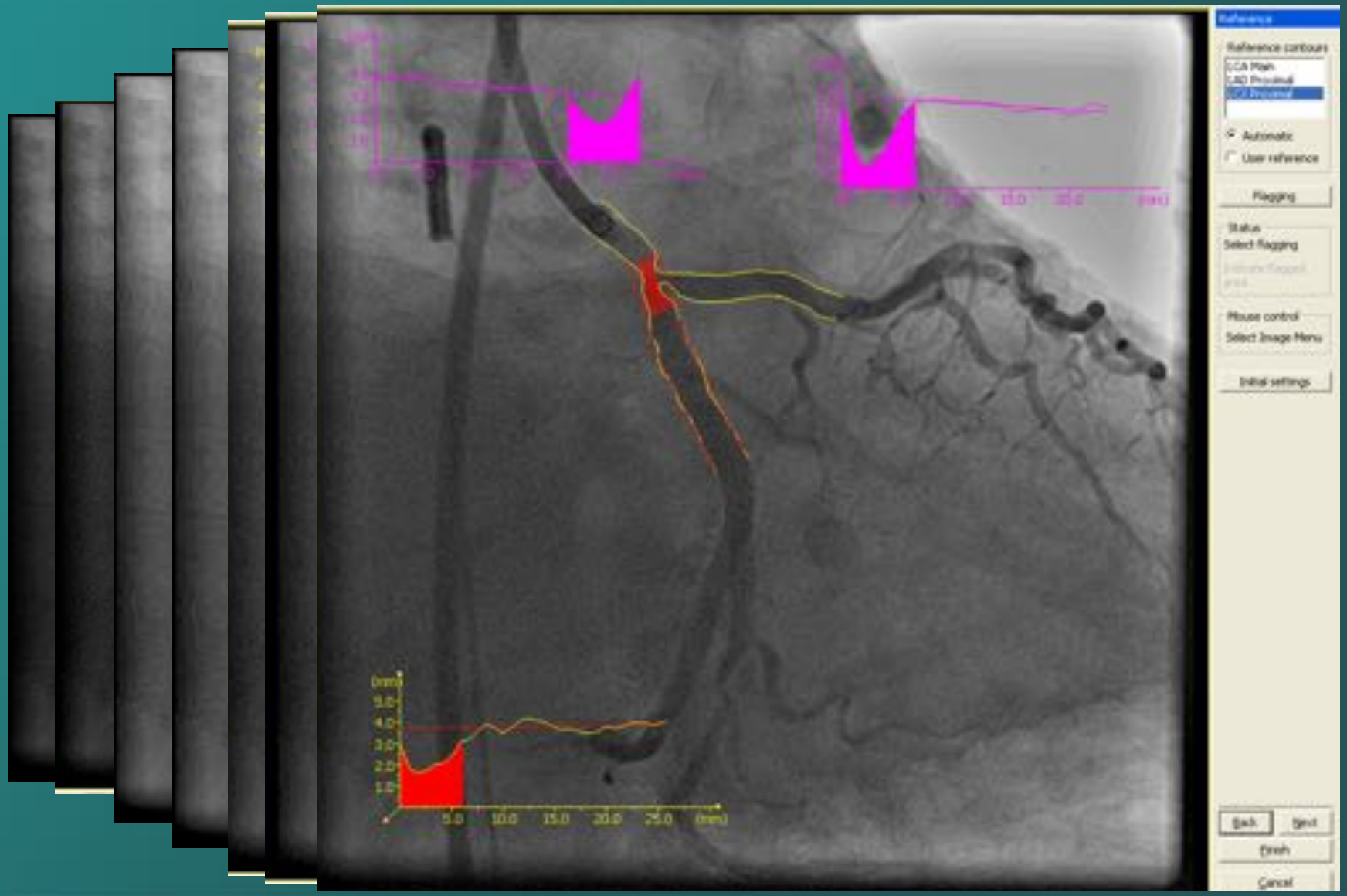


Concept is to exclude the carina from consideration in the assessment of the reference measures (avoids overestimation of reference for the distal vessels)
The problem is that the carina is left "in limbo"

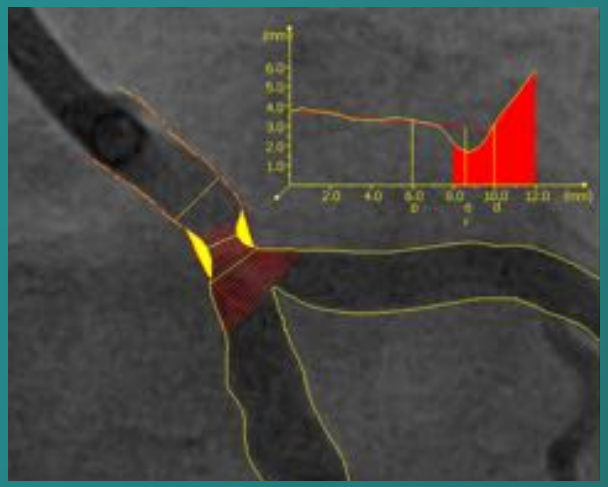
To measure diameters in the central fragment of a distal section, an artificial contour in the central fragment is generated automatically

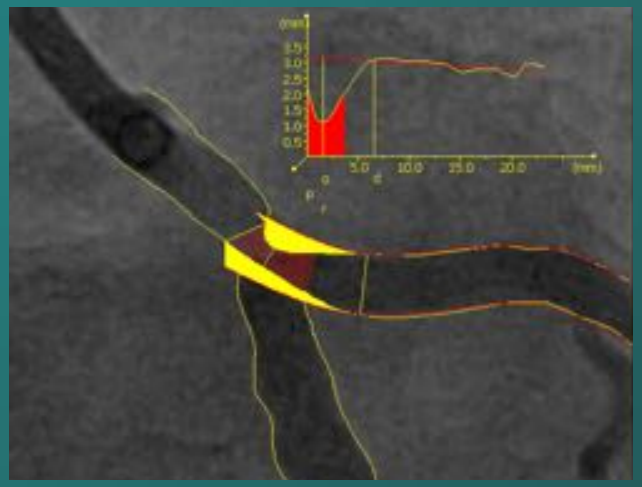


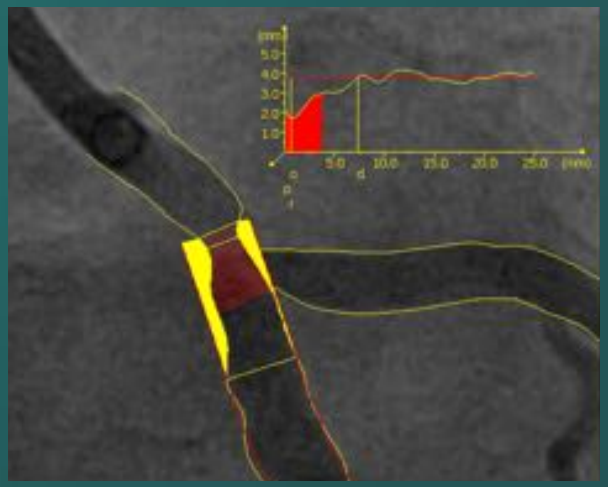
Analysis using the MEDIS Bifurcation Software



Different Results for Same Lesion



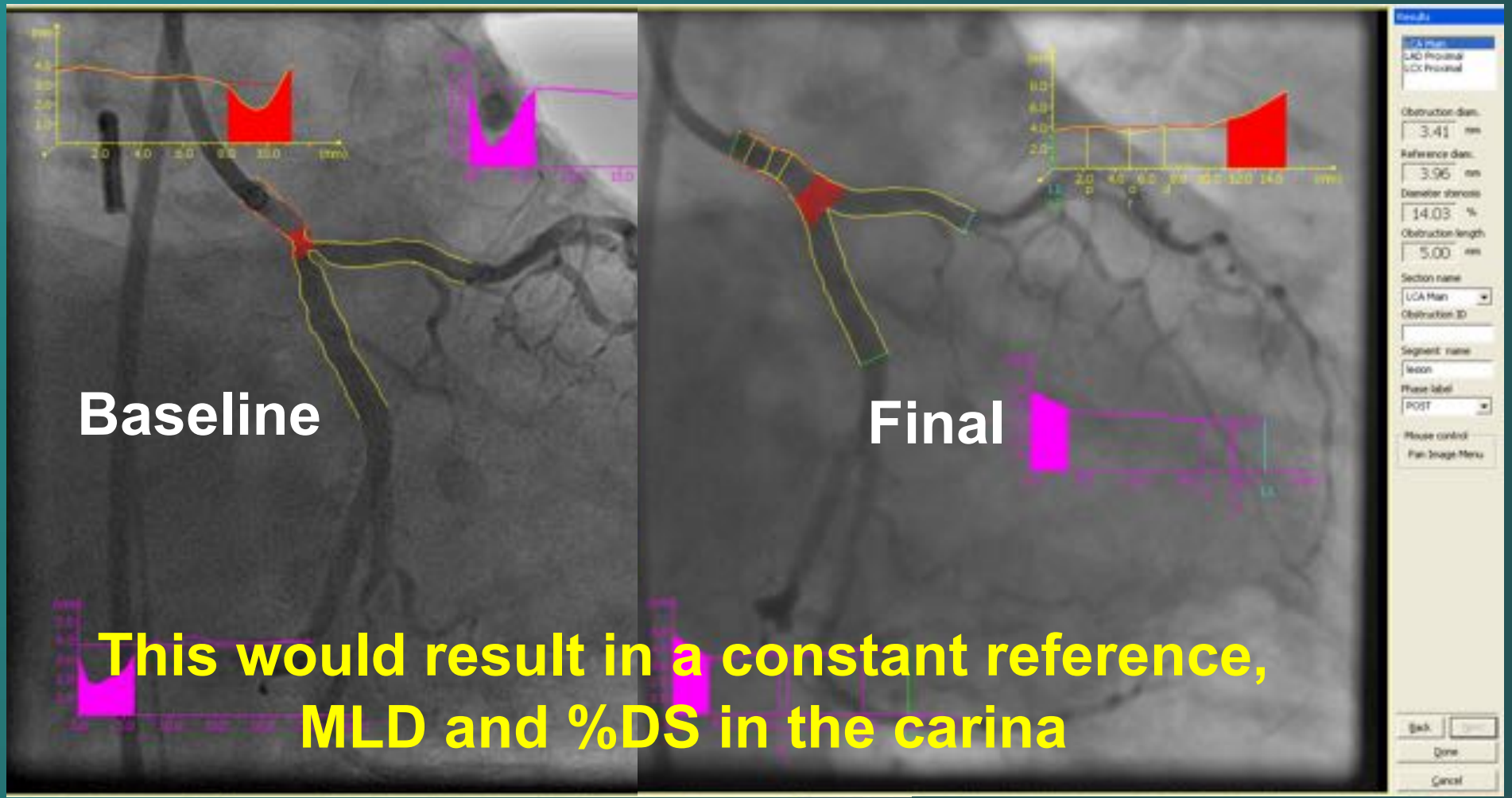




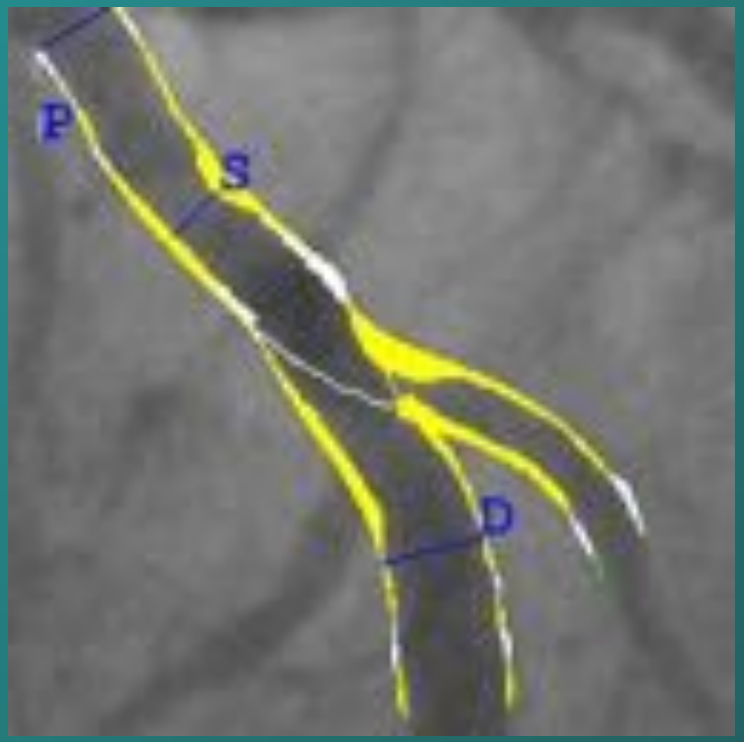
Default MLD for LAD in the carina

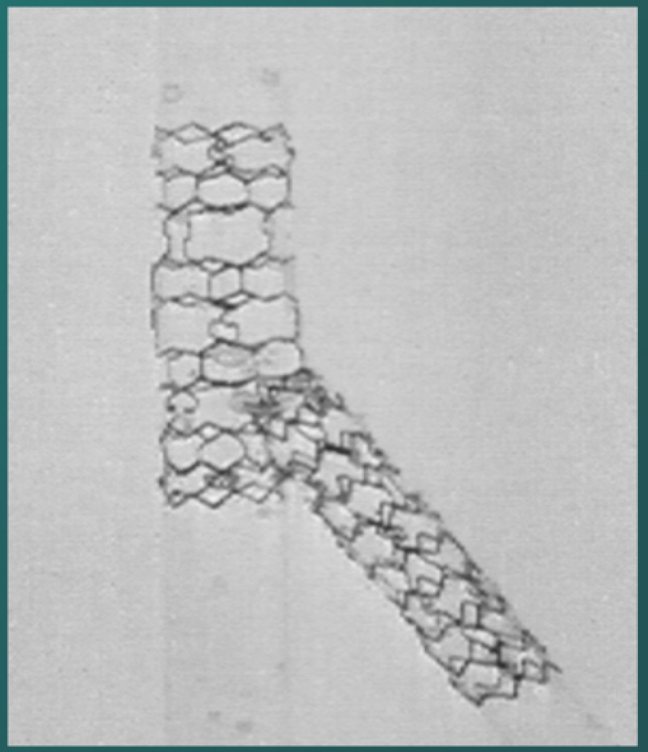
This can be manually changed to the LAD

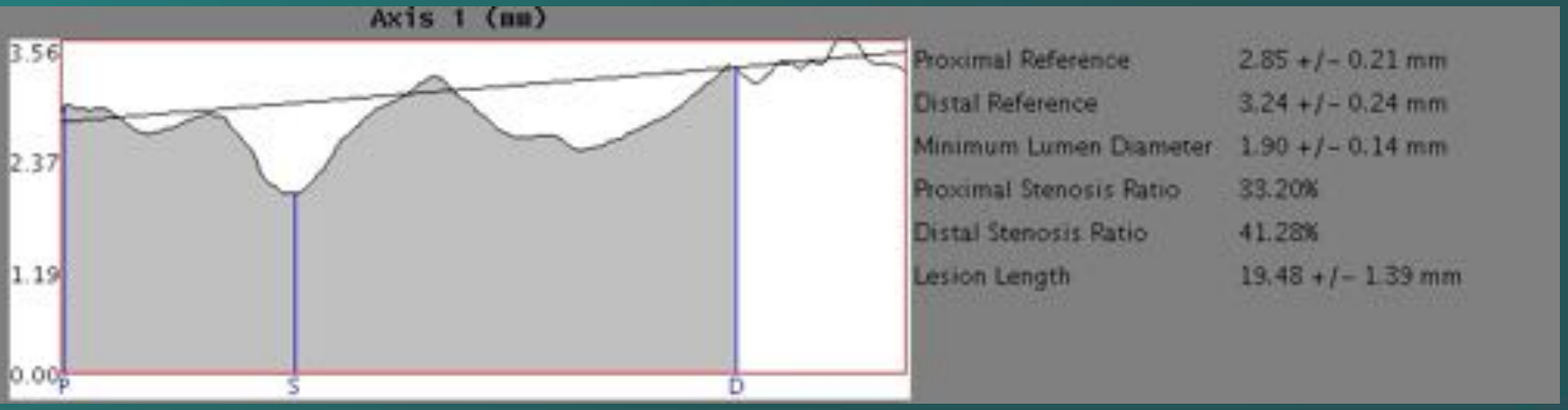
The challenge is to determine (inter-(extra)-polate) the true diameter of the carina simulating the undiseased state????



GE: Bifurcation Quantification Prototype







Constent RVD relation between PV and SB in the normal coronary tree

N= 47 pts (173 bifurcations)

Finet et Gilard

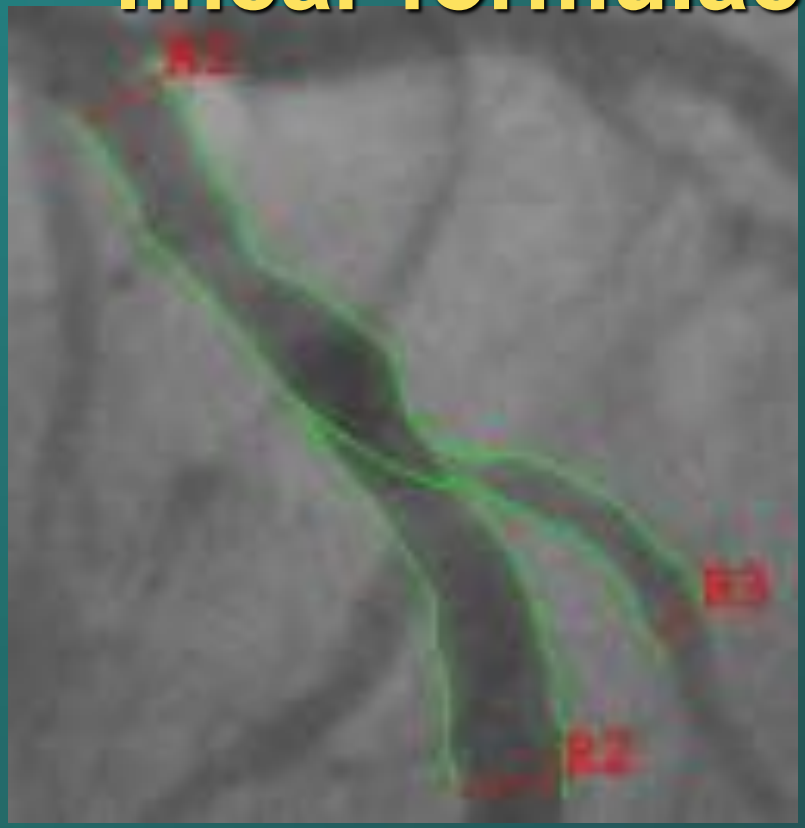
Experimental approach	Murray's law
$D_p = 0.66 \cdot (D_{v_1} + D_{v_2})$	$D_p^3 = D_{v_1}^3 + D_{v_2}^3$

Dp: parent vessel diameter

Dv1: daughter 1 vessel diameter

Dv2 : daughter 2 vessel diameter

GE: Bifurcation prototype provides calculated RVD based on Murray's and linear formulae

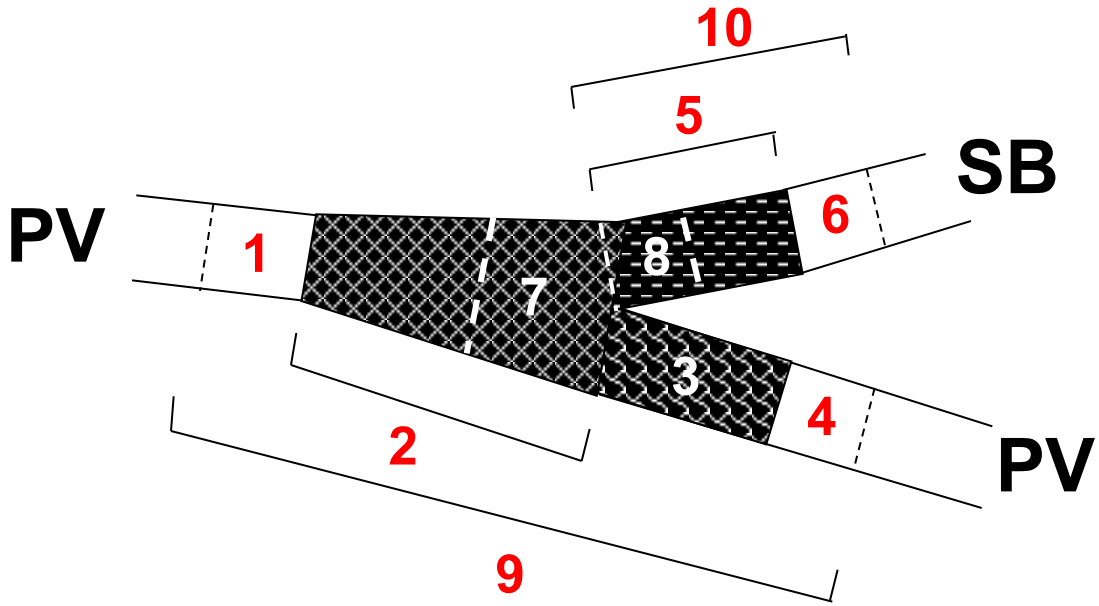


Angles		BIFURCATION MODEL	Measured	Murray Estimation	Linear Estimation
Proximal-Left Angle	158 deg	Reference1	2.82 +/- 0.21 mm	3.43 mm	3.30 mm
Left-Right Angle	50 deg	Reference2	3.28 +/- 0.24 mm	2.59 mm	2.56 mm
Proximal-Right Angle	151 deg	Reference3	1.72 +/- 0.13 mm	1.83 mm	1.90 mm

Novel bifucation software solves some but not all problems

- **Benefits:**
  - Single analysis of the 3 vessels, fast, easy, more reproducible)
  - More accurate reference vessel diameter (outside carina)
  - More accurate %DS (outside carina)
- **Limitations:**
  - Reference in carina is interpolated for the segment analyzed (LAD vs LCx vs LM)
  - Single lesion in Carina is reported 3 times (with different reference, MLD, %DS depending on vessel analyzed)
  - Cannot always acquire in a single best view

QCA Methods and Reporting



1 – Proximal Edge
2 – Proximal Stent
3 – Distal PV Stent*
4 – Distal Edge of the PV Stent
5 – SB Stent*
6 – Distal Edge of the SB Stent*
7 – Carina
8 – Ostium of the SB (5mm)
9 – PV In-Lesion
10 – SB In-Lesion

**if additional stent(s) placed*

Suggestions

- Lesions in the carina should be reported only once
- Methodology and algorithm for contour and reference (by flagging carina) appear sound for the proximal and distal segments, however:
  - Carina should be included in the proximal parent vessel segment or on its own
  - Interpolation across carina is artificial (should not be done)
  - Carina reference should be the true (un-diseased) diameter (this would result in a constant reference and %DS no matter which segment it is linked to)
  - Challenge is to figure out contour of carina at baseline when there is disease in this segment
- Reporting should allow one single MLD and DS for the entire bifurcation lesion
- Allow multiple segment of interest analysis (DES bifurcation software) to avoid having to do multiple segment analyses