Bifurcation stenting in the drug-eluting stent era. Insights from bench testing

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Bifurcation stenting in the drug-eluting stent era. Insights from bench-top testing

Methods

- Stents were deployed in a phantom
- Their exteriors were photographed at each stage of deployment
- Interiors were photographed through a paediatric endoscope

Background to "Crush" Bifurcation Stenting

- The "Randomized Trial to Evaluate Sirolimus-eluting Stents in Coronary Bifurcations" showed marked reduction in restenosis with SES vs BMS historical controls

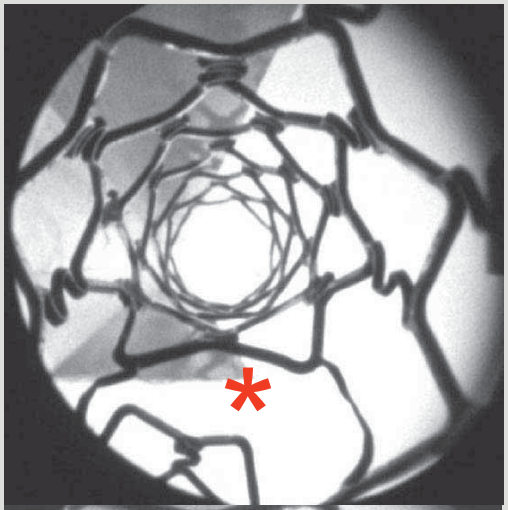
  (Colombo, Circulation March 04)

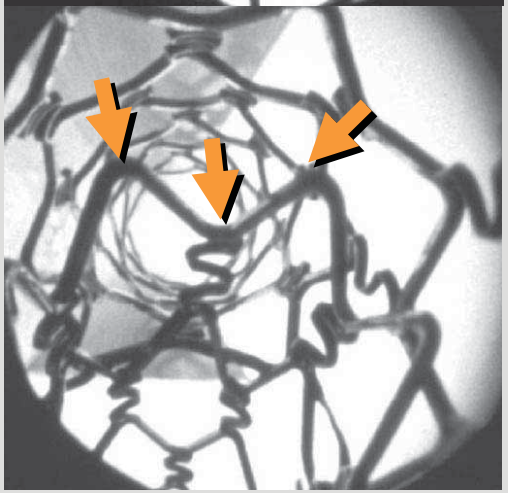
- Most restenoses with 2 DES were at the ostium of the side-branch

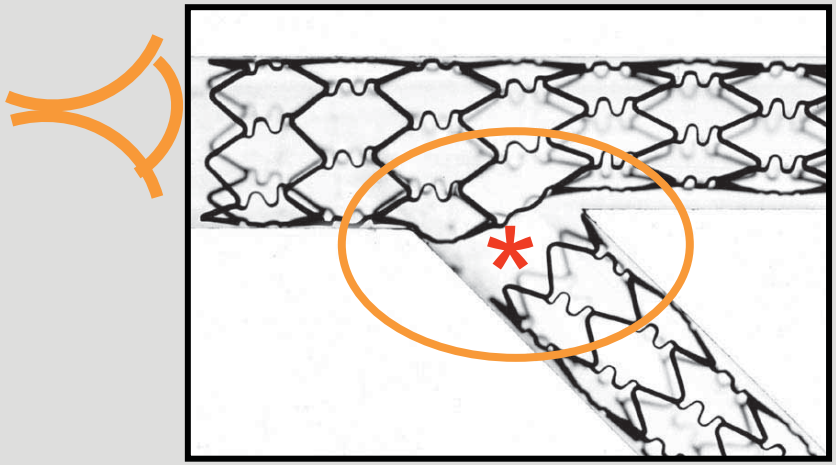
- "T" stenting was used when 2 DES needed

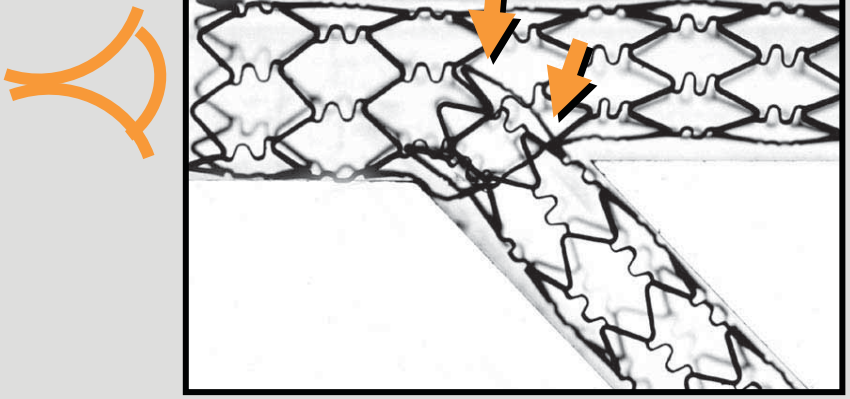
“T” Stenting limitations

- Side-branch stent may be too proximal or too distal
- Restenoses occurred at the side-br ostium





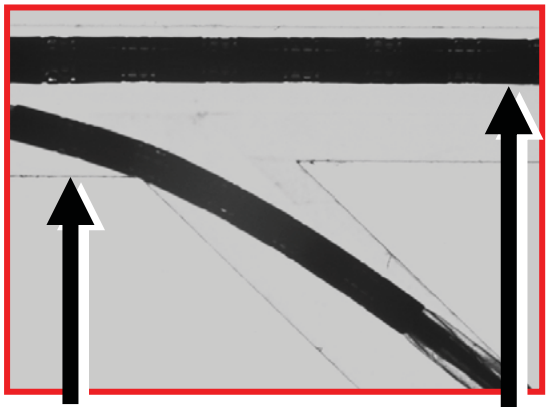




- **“Crush” technique ensures full coverage of the side-branch ostium without gaps in scaffolding or drug delivery.**

To perform the “Crush” Technique ---

- Place undeployed stents in both branches

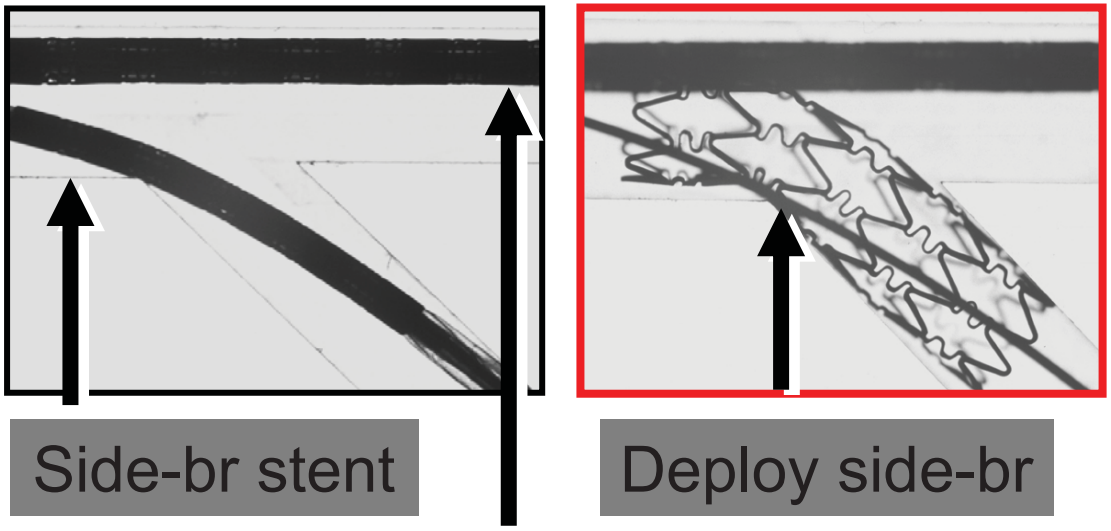


Side-br stent

Main br stent

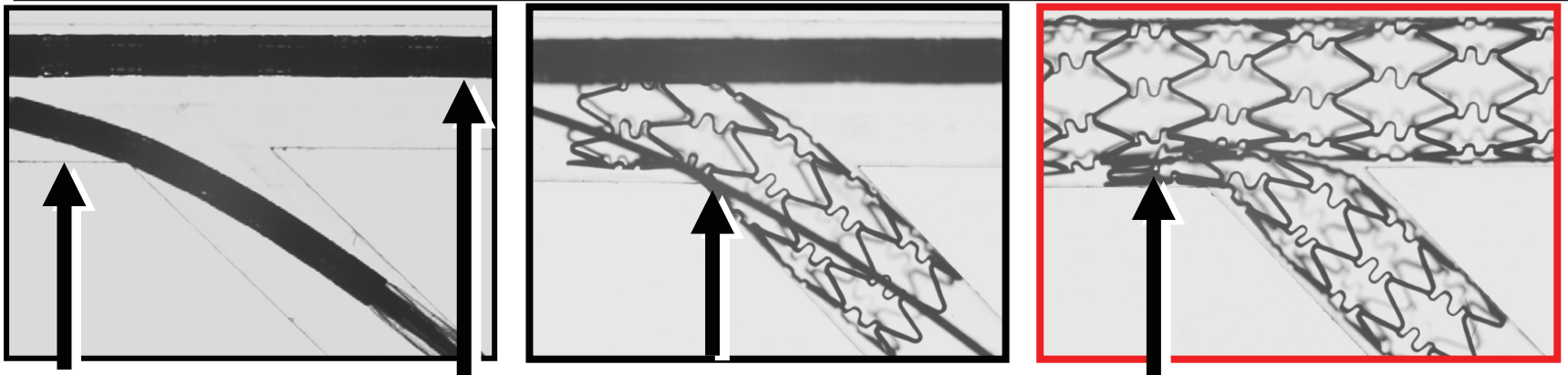
“Crush” Technique (Benchtop)

- Place undeployed stents in both branches
- Deploy side-branch stent



“Crush” Technique (Benchtop)

- Place undeployed stents in both branches
- Deploy side-branch stent
- **Deploy main-branch stent crushing side-branch stent**



Side-br stent

Main br stent

Deploy side-br

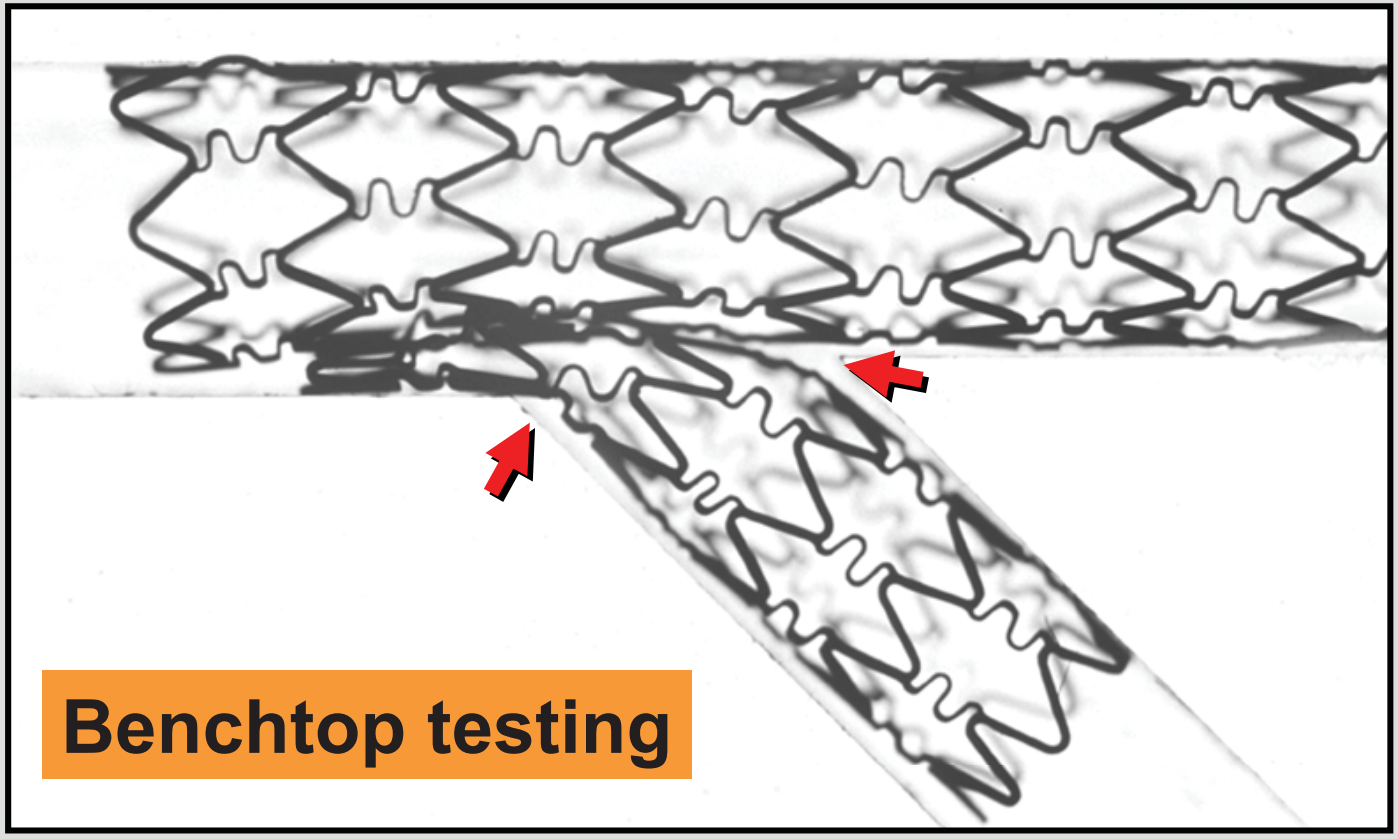
Deploy main br stent which crushes side-br stent

Advantages of “Crush” Technique

- **Safe-** Access to branches maintained until stents deployed
- **Simple and quick-** Limited ischemic time eg in L main
- **Covers ostium-** potentially no gaps
- **Challenge.** The most difficult aspect is kissing balloon post-dilatation

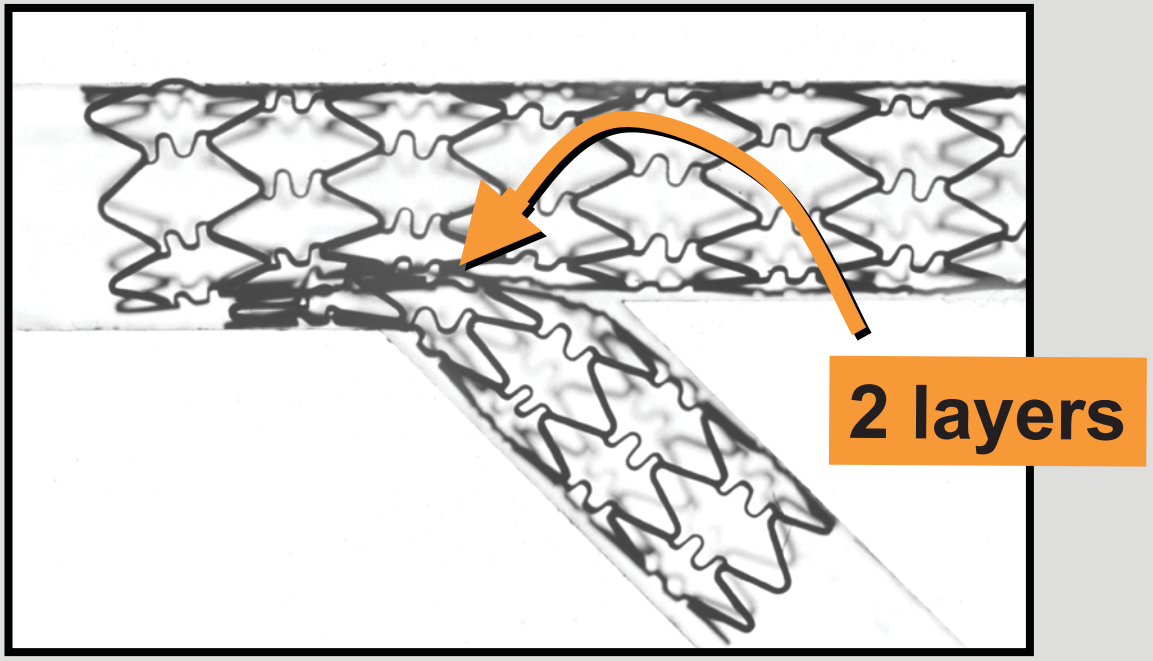
Potential limitations of “Crush”

1. Struts (and drug) not well apposed to ostium of side branch before “kissing” balloon post-dilatation



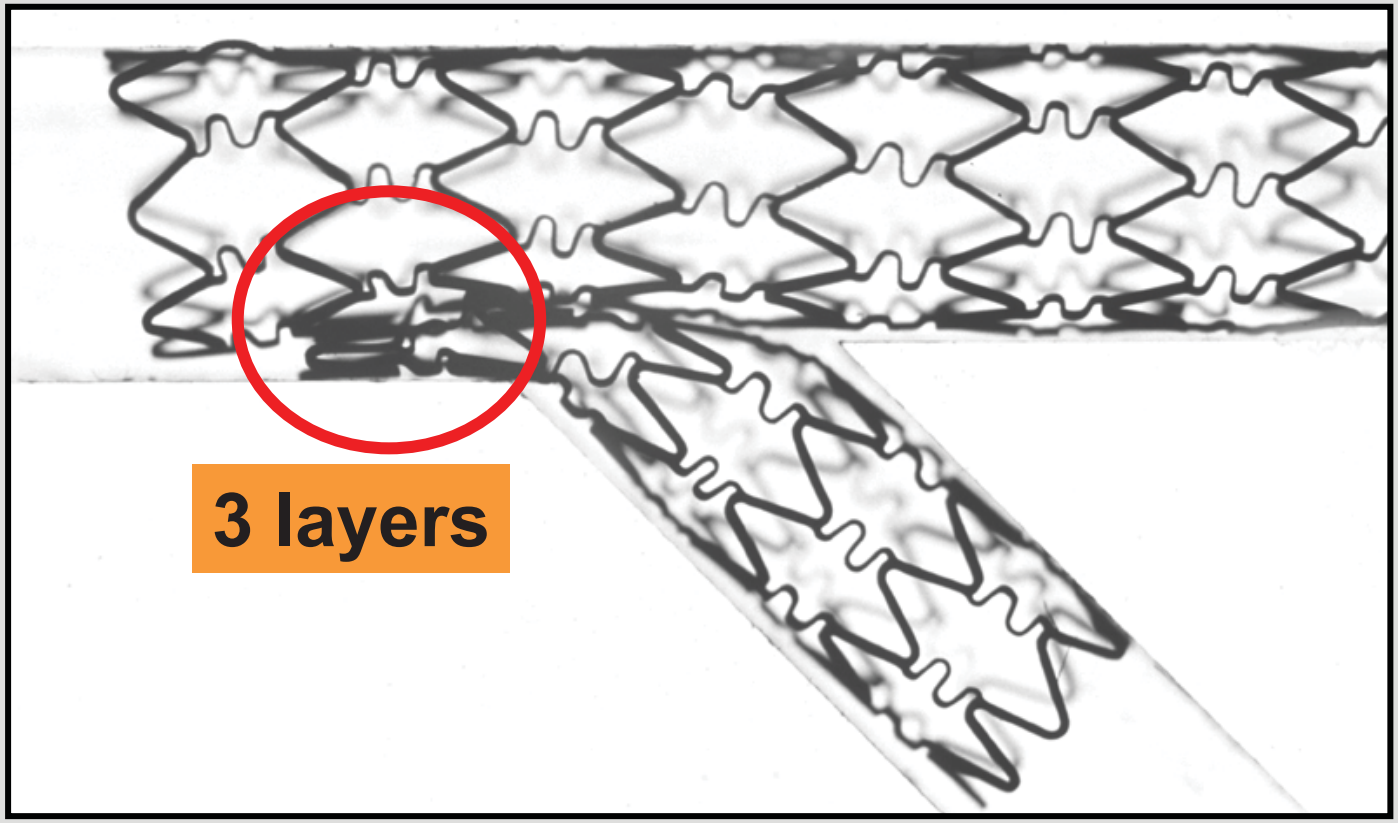
Potential limitations of “Crush”

2. Side-branch is “jailed” by 2 layers of stent limiting subsequent access



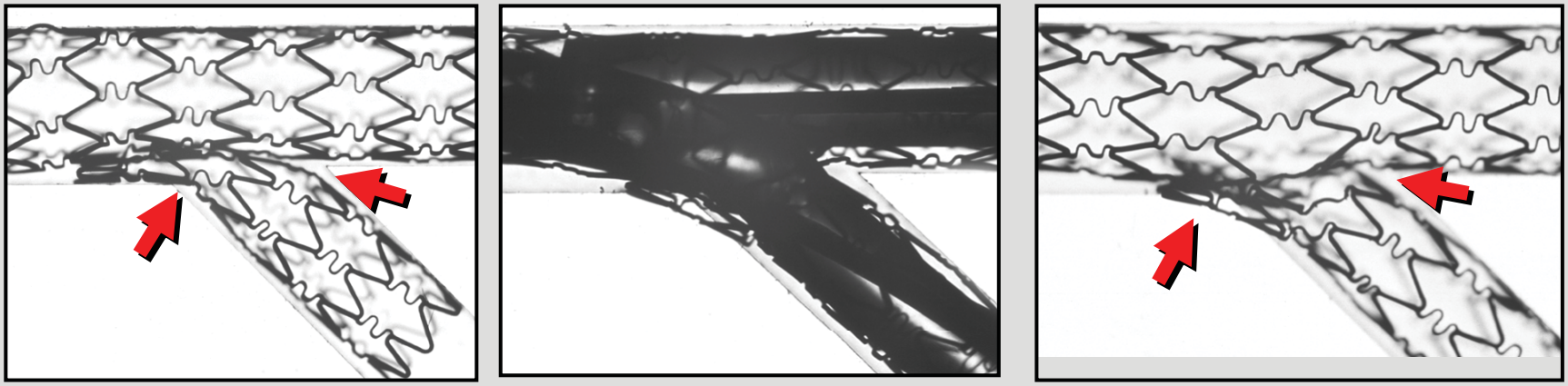
Potential limitations of “Crush”

3. Multiple layers of stent-
?toxicity ?benefit

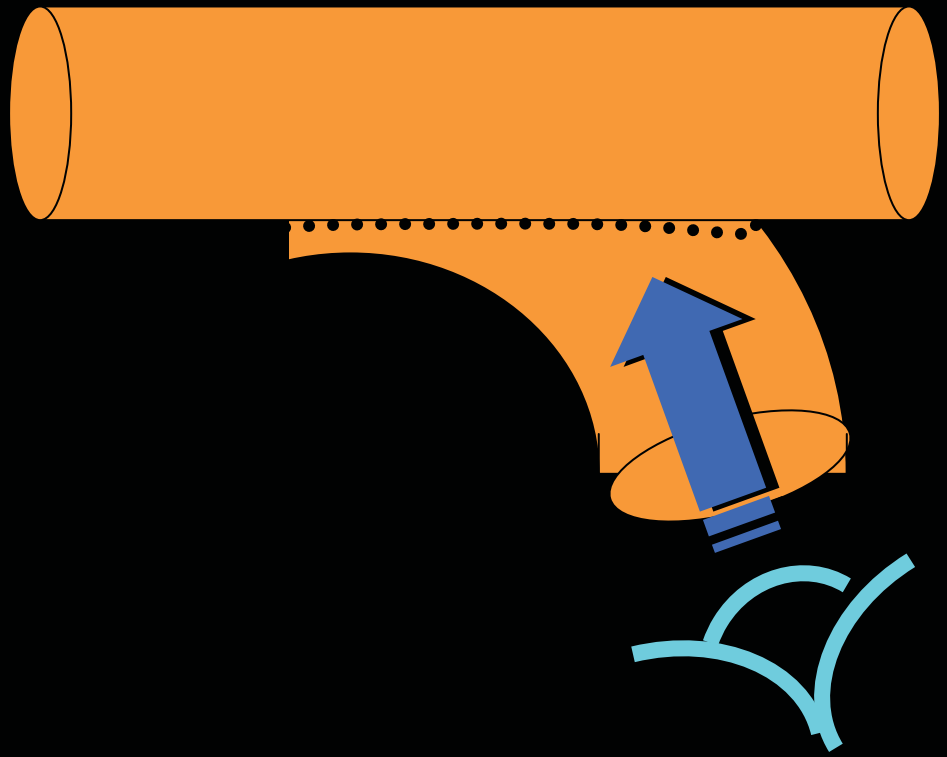


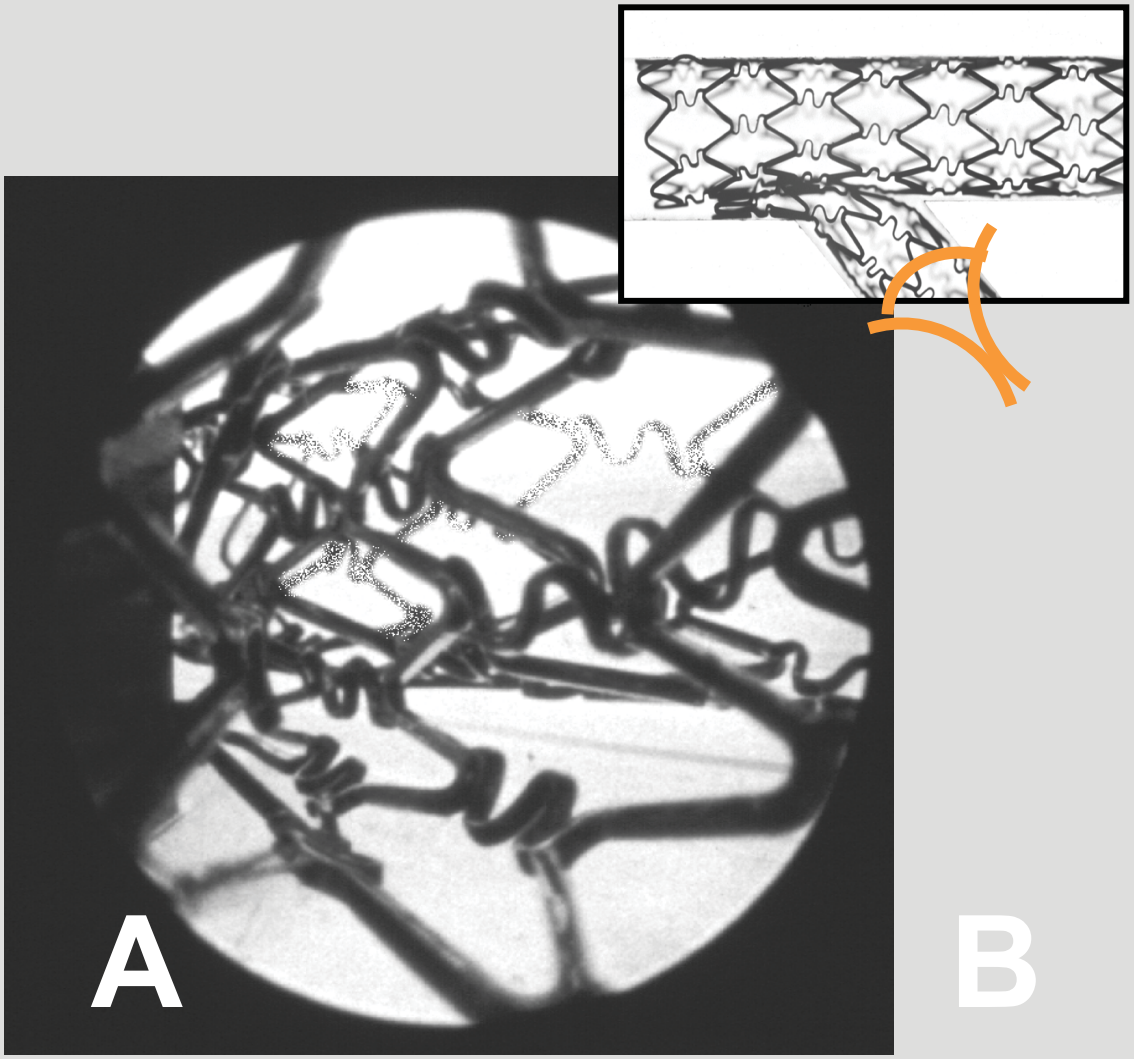
“Kissing Balloon” post-dilatation after “Crush”

- Applies stent struts (and drug) to ostium
- Releases side-branch from “jail”

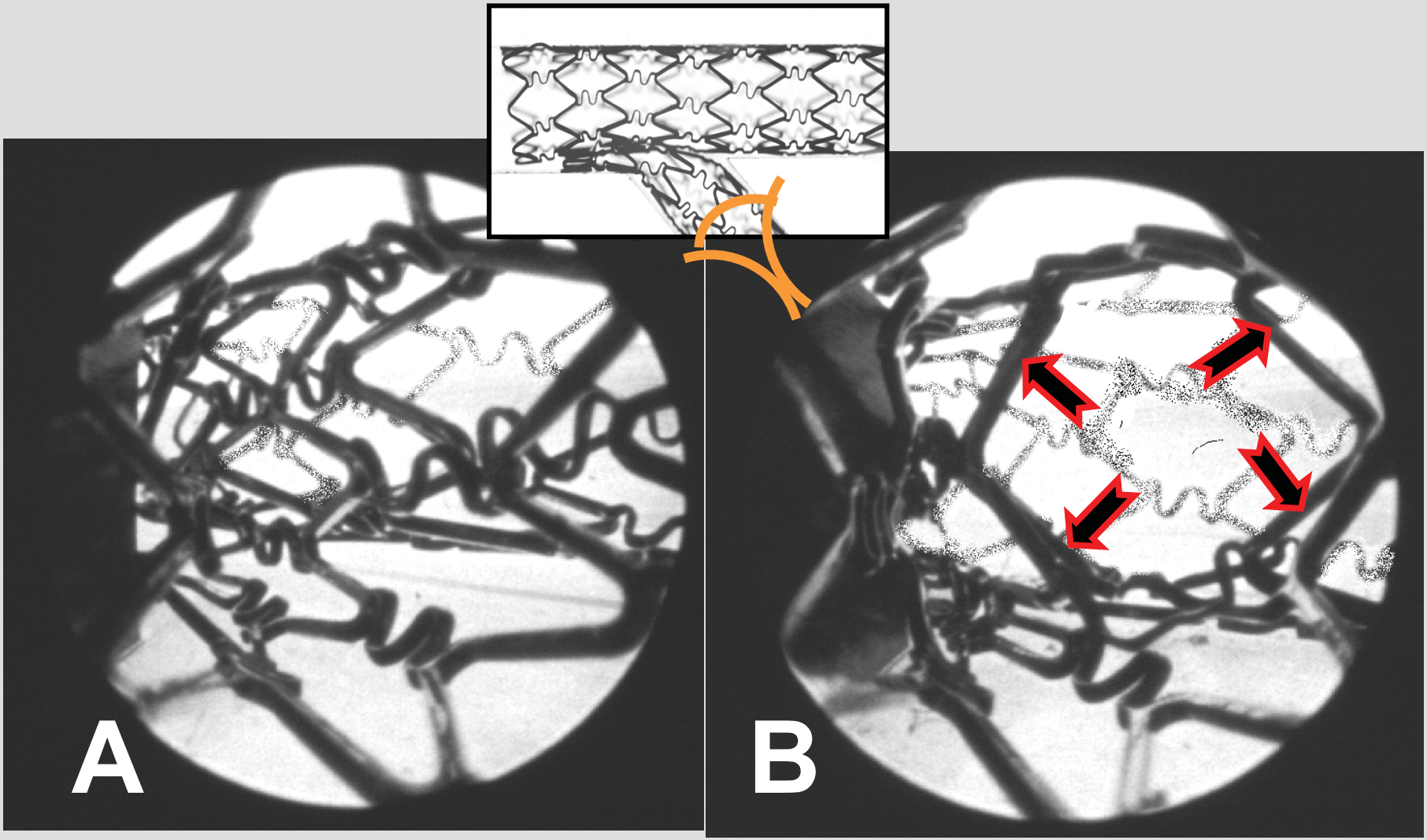


What does a stent look like from the side-branch after “crush”?





After “crush”, 2 layers of stent separate side-br from main br



After “crush”, 2 layers of stent separate side-br from main br

After “Kissing” the side-br is released from jail

Crush is a commitment to two stents, but--

- **Outcomes when only one drug-eluting stent was needed were very good (1).**
- **However, half of those randomized to a single stent strategy crossed over to receive 2 DES (1).**

1. Colombo et al,, "Randomized Trial to Evaluate Sirolimus-eluting Stents in Coronary Bifurcations". Circulation March 2004

If a single stent is deployed there needs to be a reliable safe method of stenting without gaps the side-branch if necessary

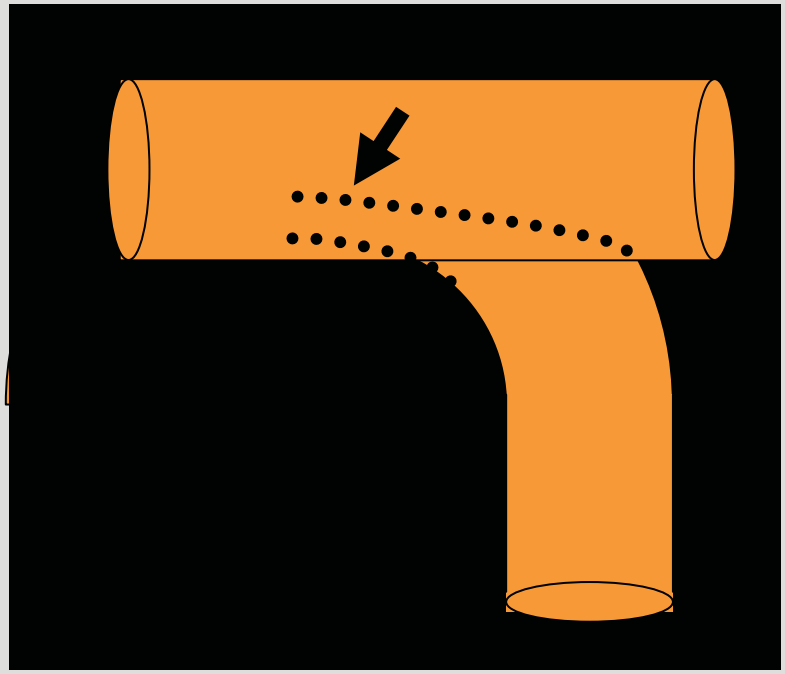
- Provisional “T” stenting has limitations
- “Internal” or “Reverse Crush”
- “Culotte” technique

“Internal” (or “Reverse”) Crush

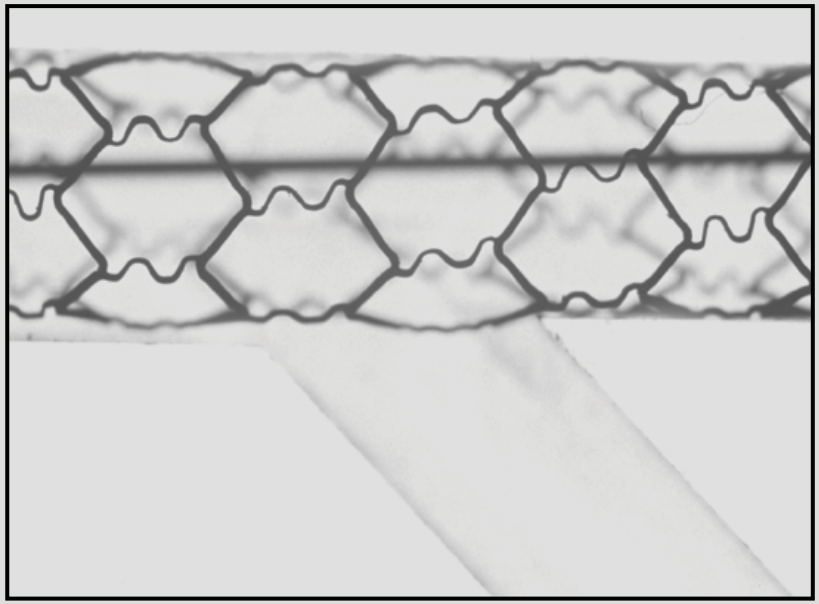
Allows provisional side-br stenting with full ostial coverage

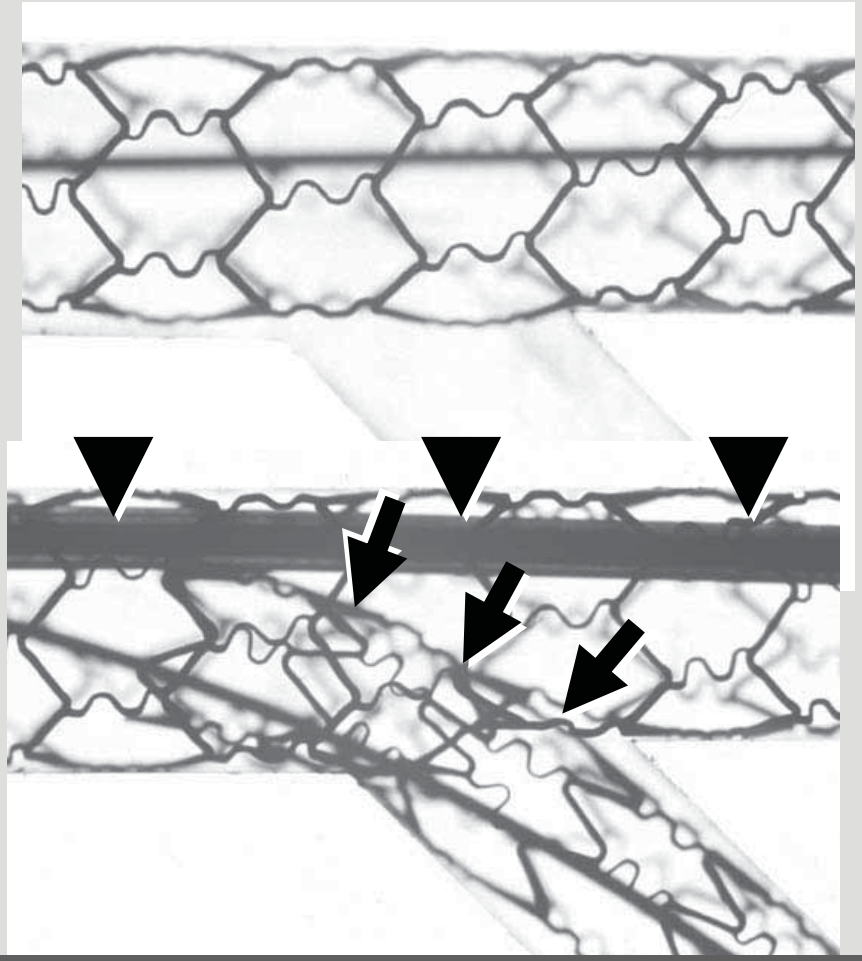
“Internal” Crush – a novel technique

The second stent is deployed and crushed inside the main branch stent



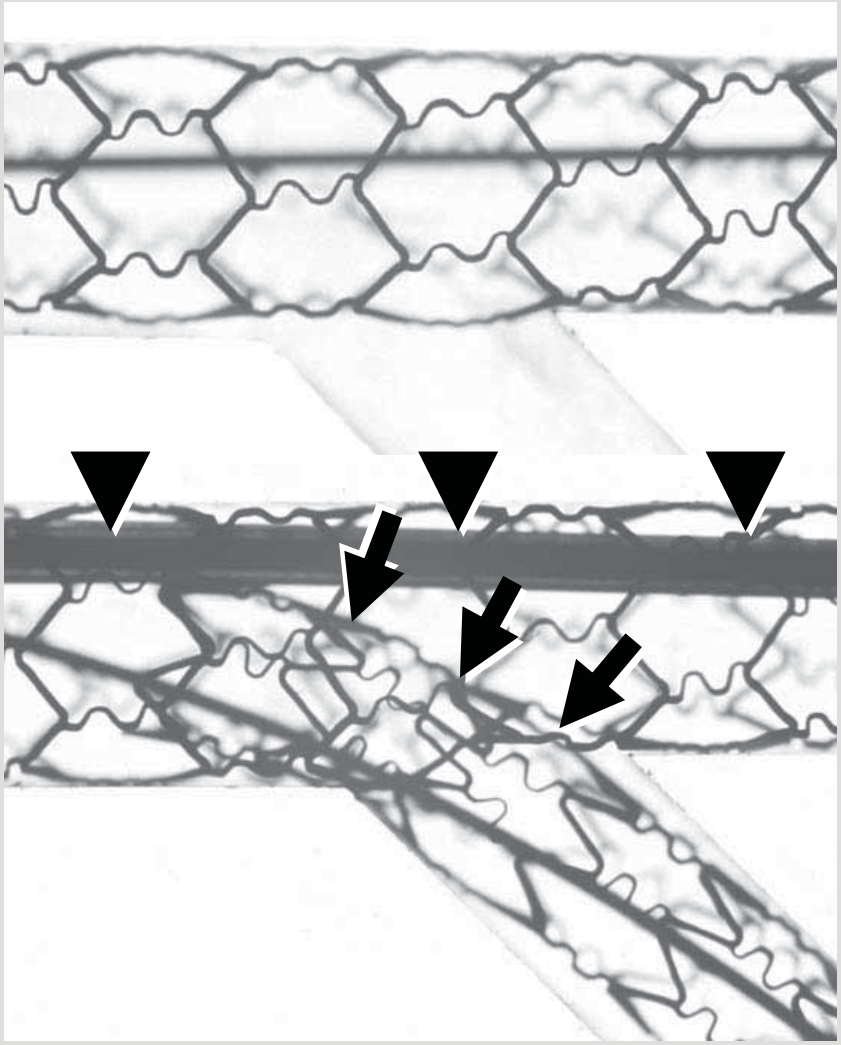
A stent is deployed in the main branch



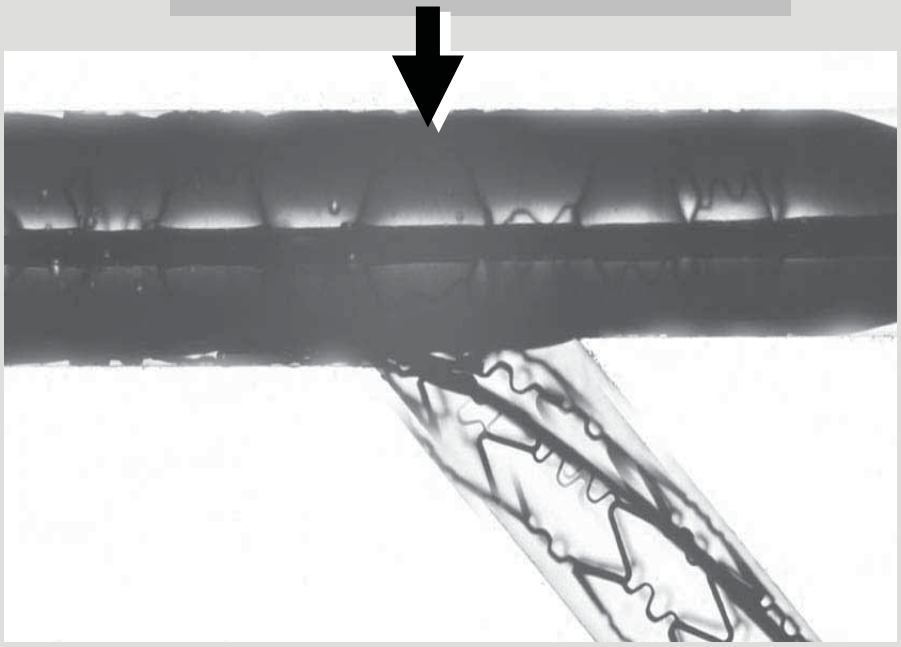


Balloon parked in main br

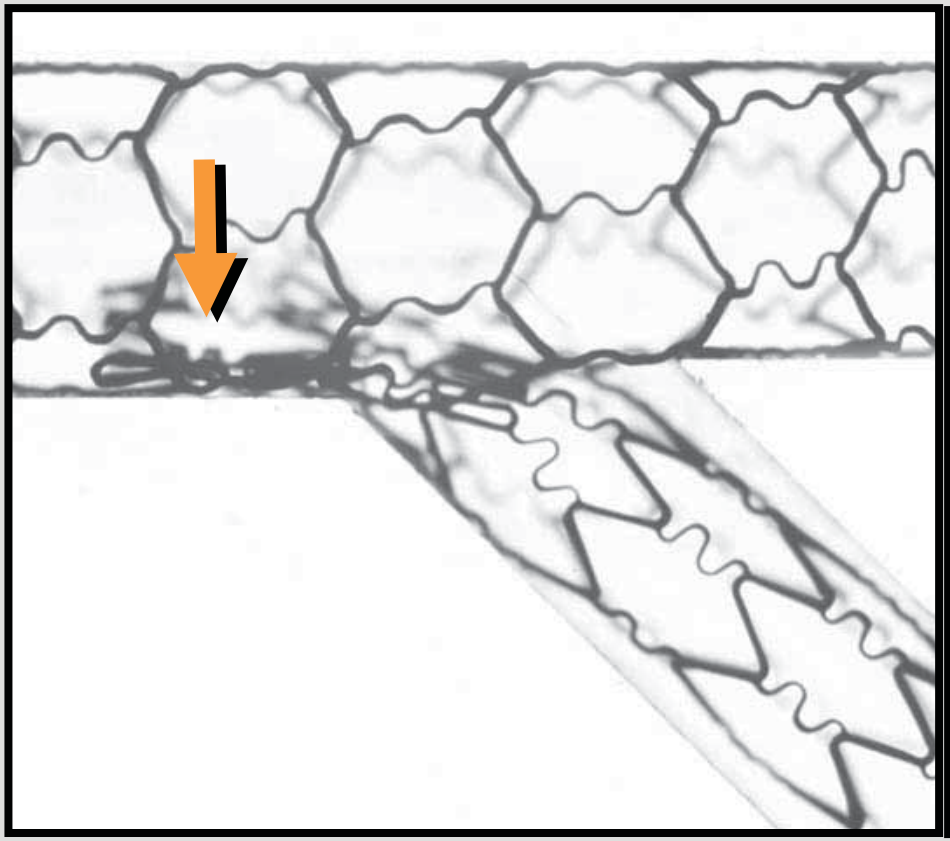
If the side-branch is unsatisfactory, deploy a stent in the side-branch with a balloon parked in the main branch …

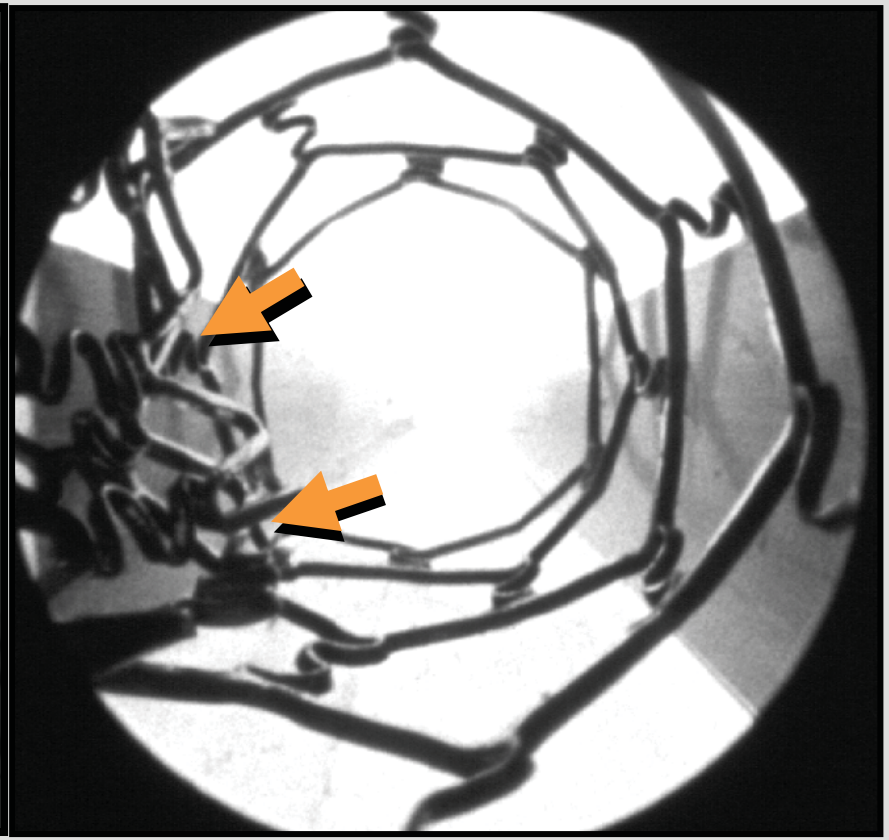


Main br balloon is expanded crushing the side-br stent within the main br stent



The side-br stent is crushed inside the main branch stent. The ostium is covered without gaps





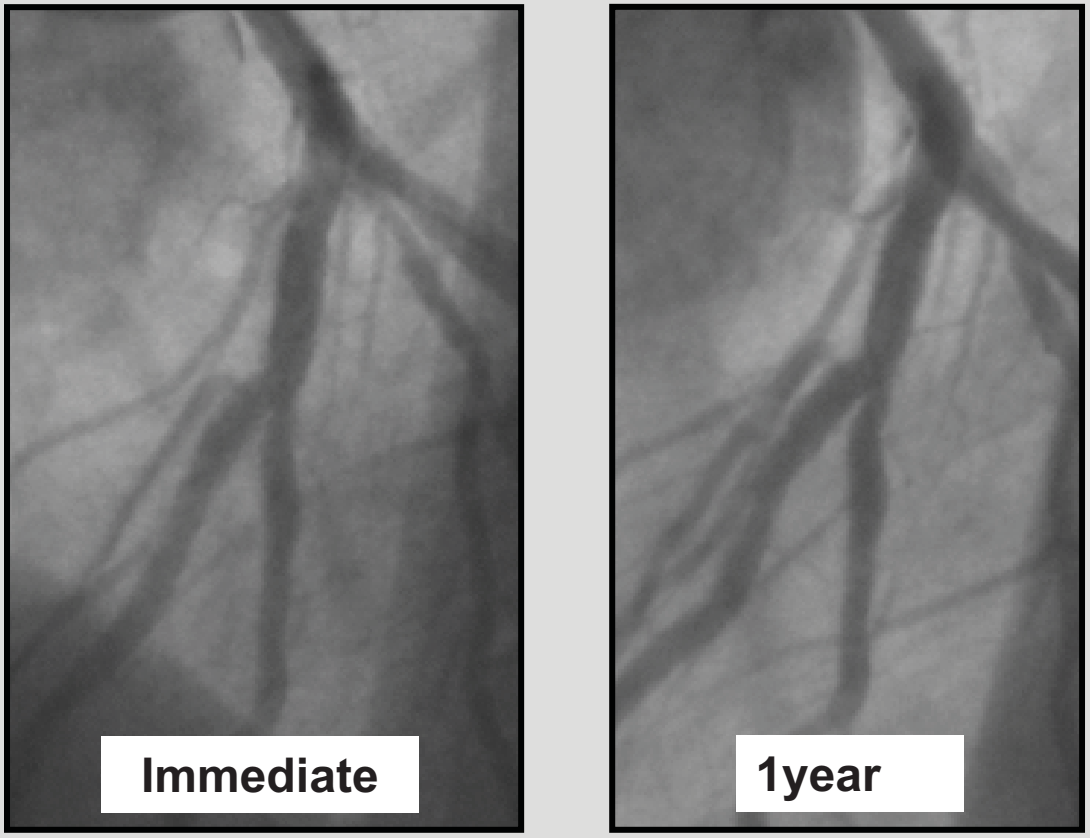
The internal crush technique

- Is a provisional side-branch strategy that covers the side-branch ostium without gaps

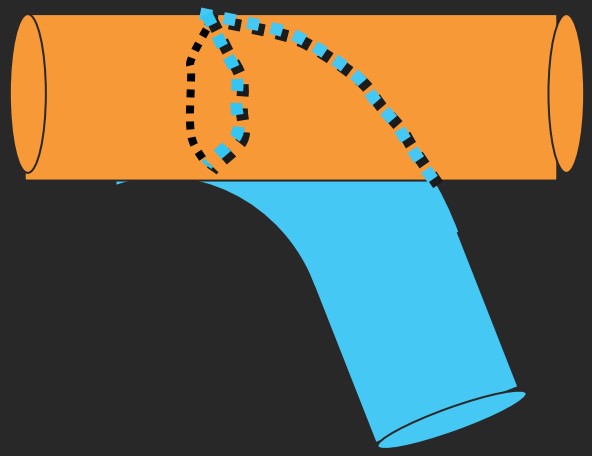
The “internal crush” limitations

- An experimental technique
- Limited experience
- It may be impossible to pass stent to side-branch
- “kissing” distorts
- Side-branch in permanent jail

Immediate and 1 yr angios after “internal crush”

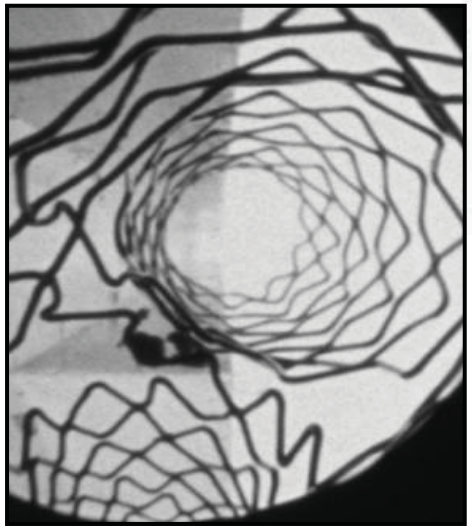


“Culotte” technique is another provisional side-branch stenting strategy for DES

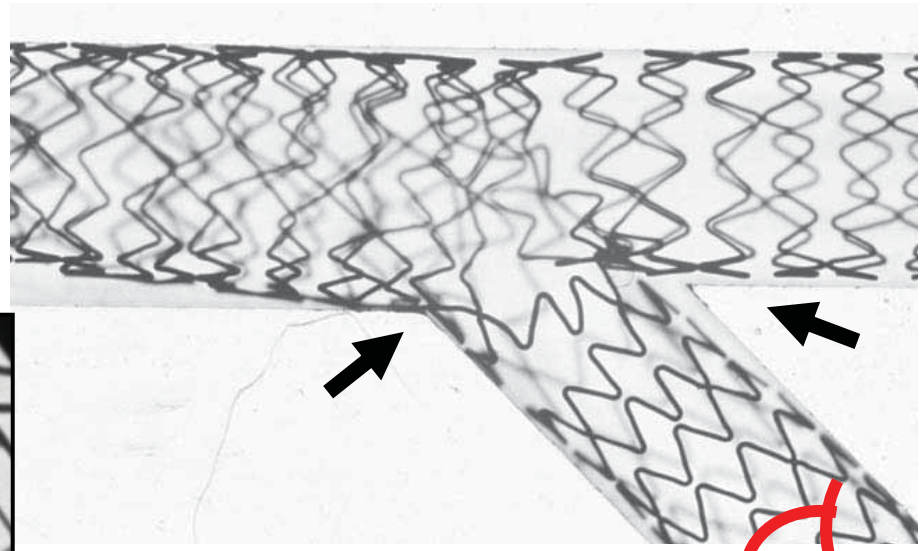


Provisional side- branch stenting

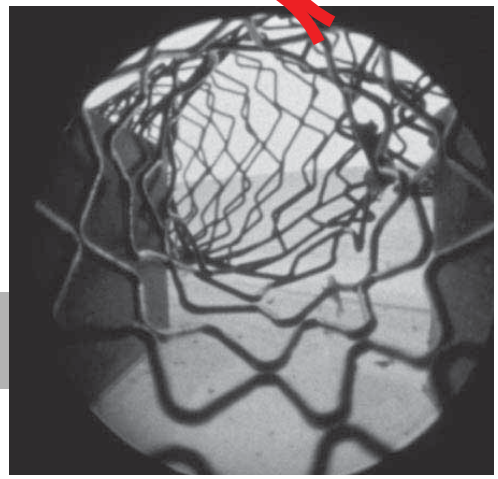
“Culotte” stenting after “kissing”



No distortion,
but gaps



No Jail



Limitations of “Culotte” Provisional Stenting

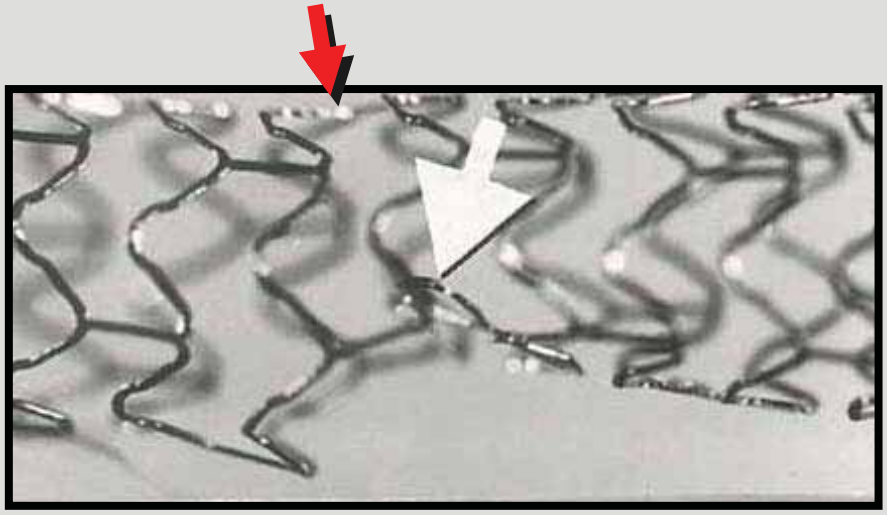
- It may be impossible to cross through the side of main branch stent

Stent Distortion in Bifurcation Stenting

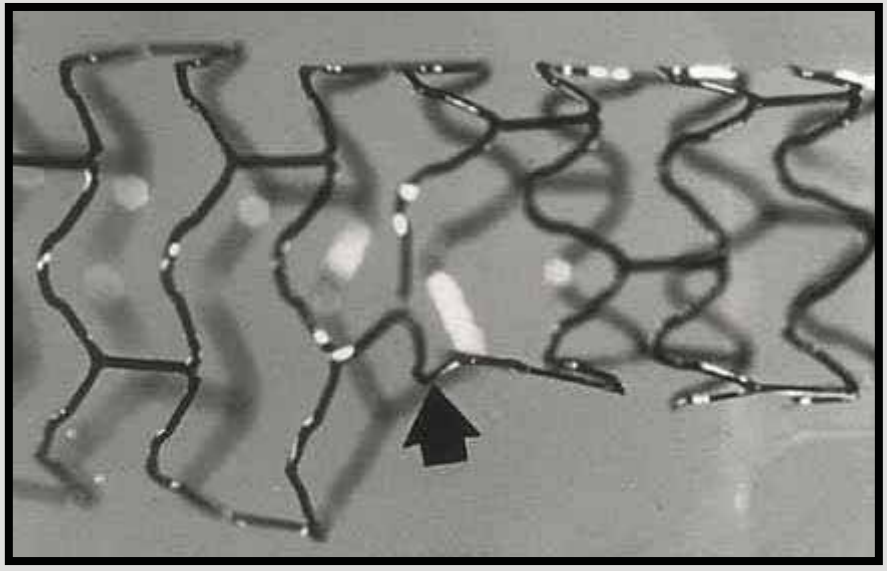
-its prevention and repair

stent distortion may

- predispose to SAT
- predispose to restenosis
- limit subsequent access



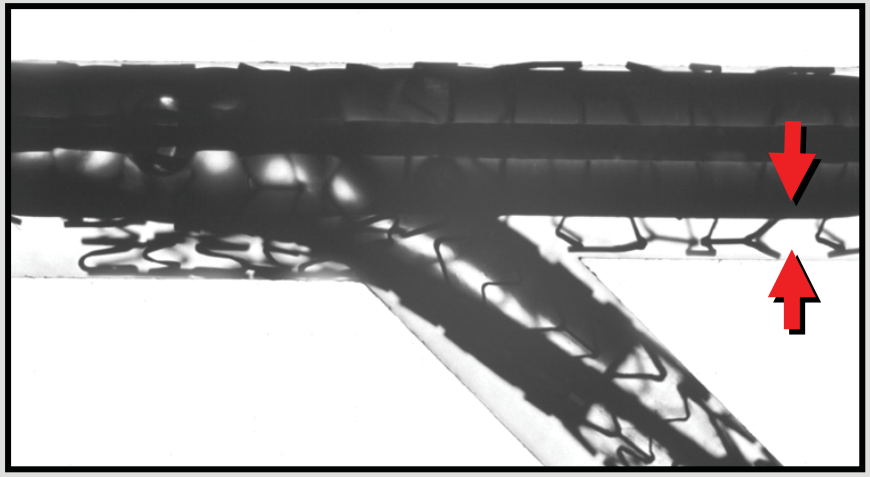
Single stent Distorted by 3mm Side-branch dilatation



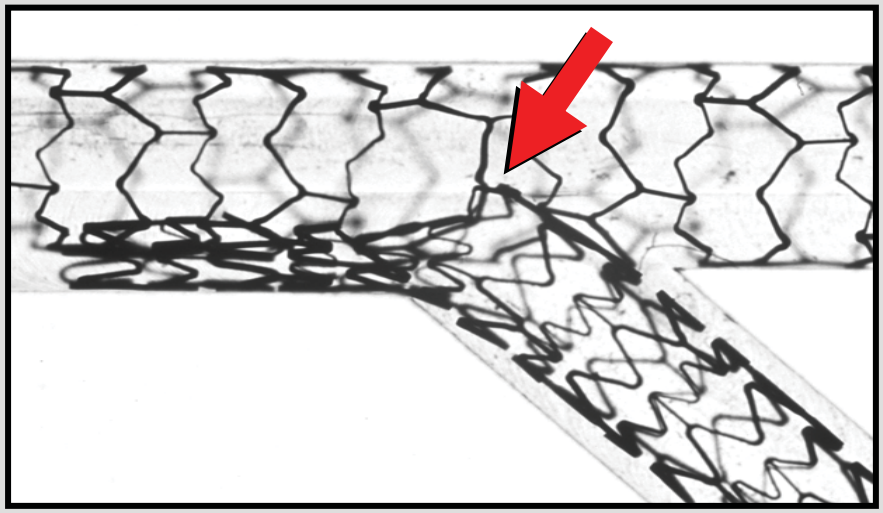
Repaired by "kissing" balloons

Ormiston et al
Cathet Cardiovasc Interv
1999;47:258-264.

Undersized main vessel kissing balloon permits distortion after conventional crush

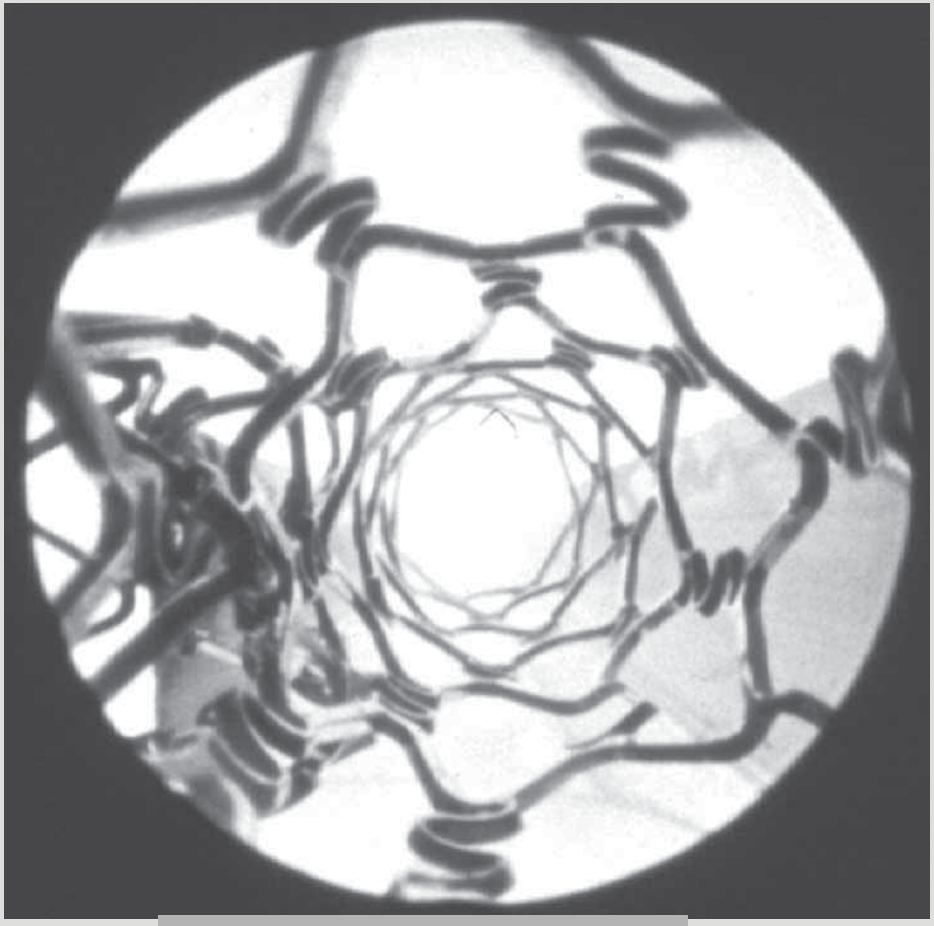


Undersized main vessel balloon

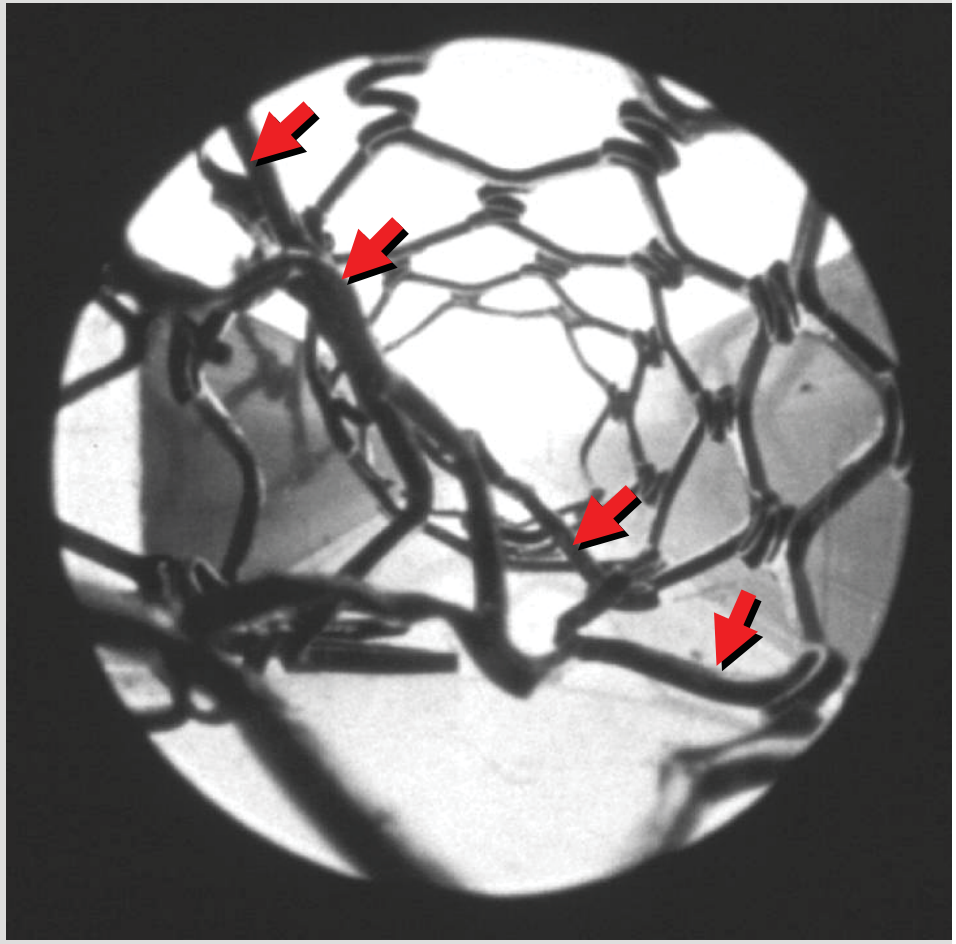


Distortion

Distortion after undersized main branch post-dilatation

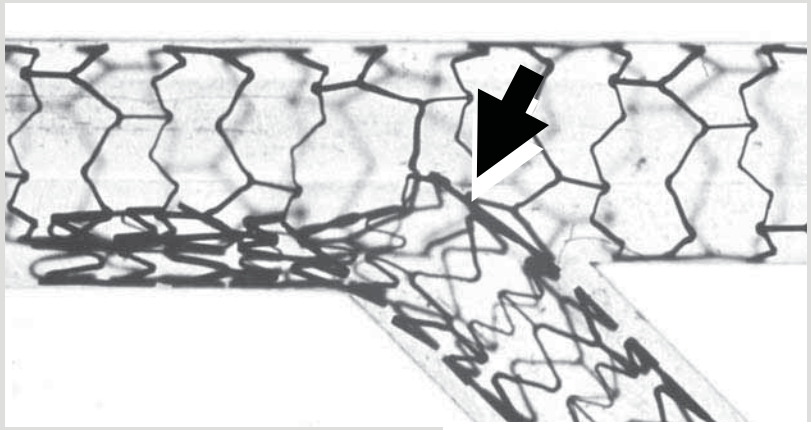


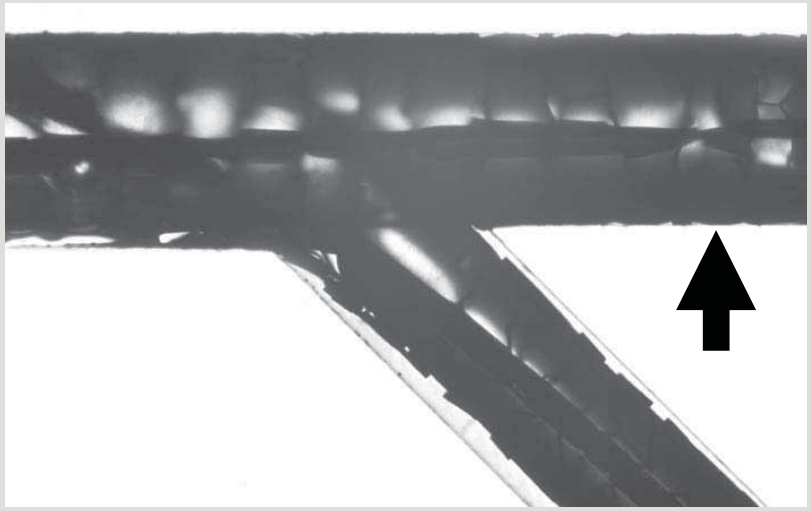
Crush

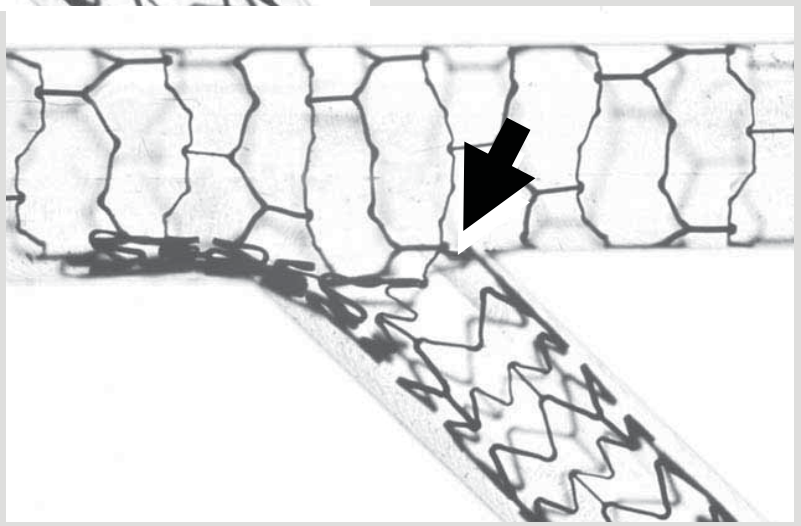


Distortion

Distortion after external "crush" is repaired by an appropriately sized main vessel balloon





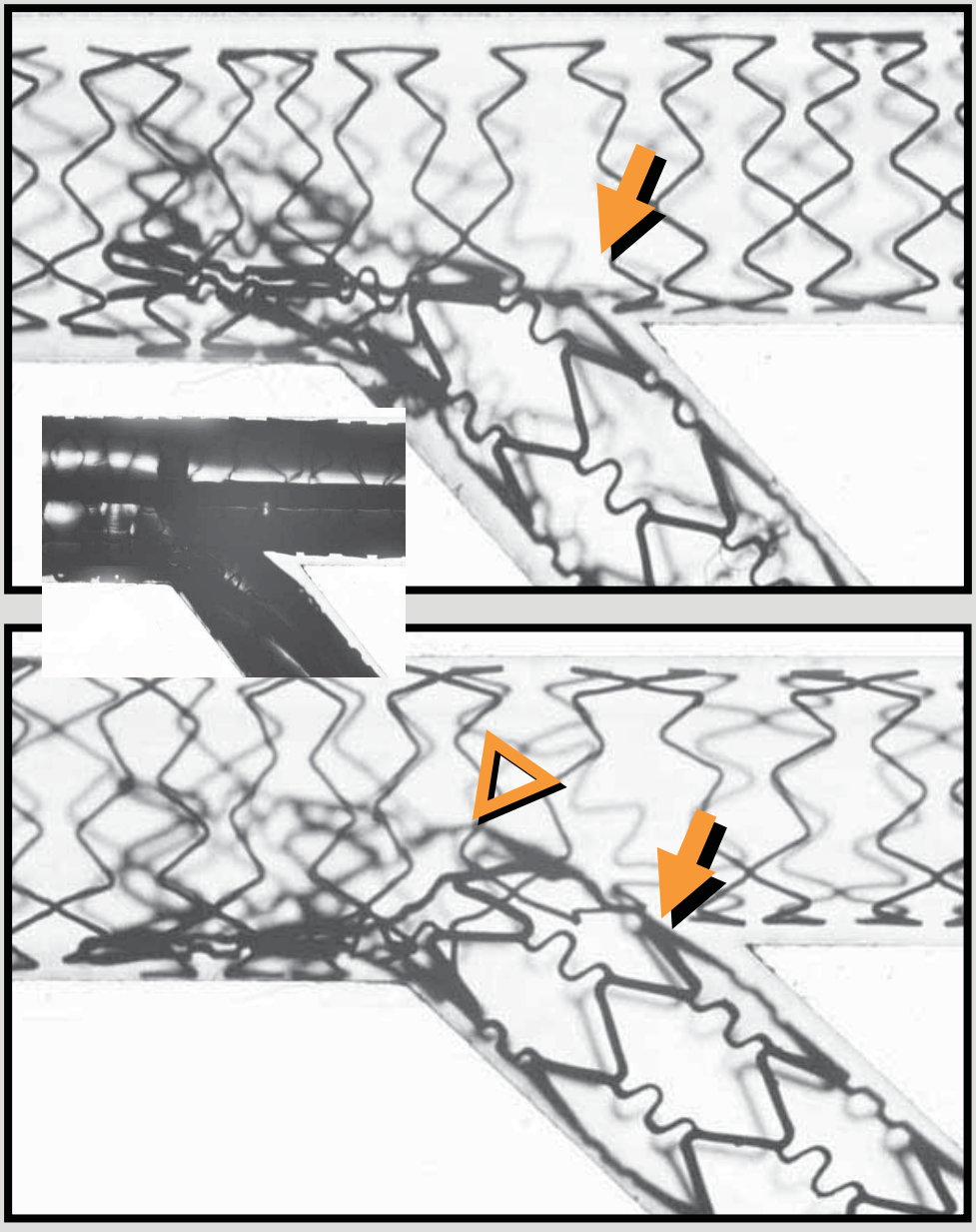


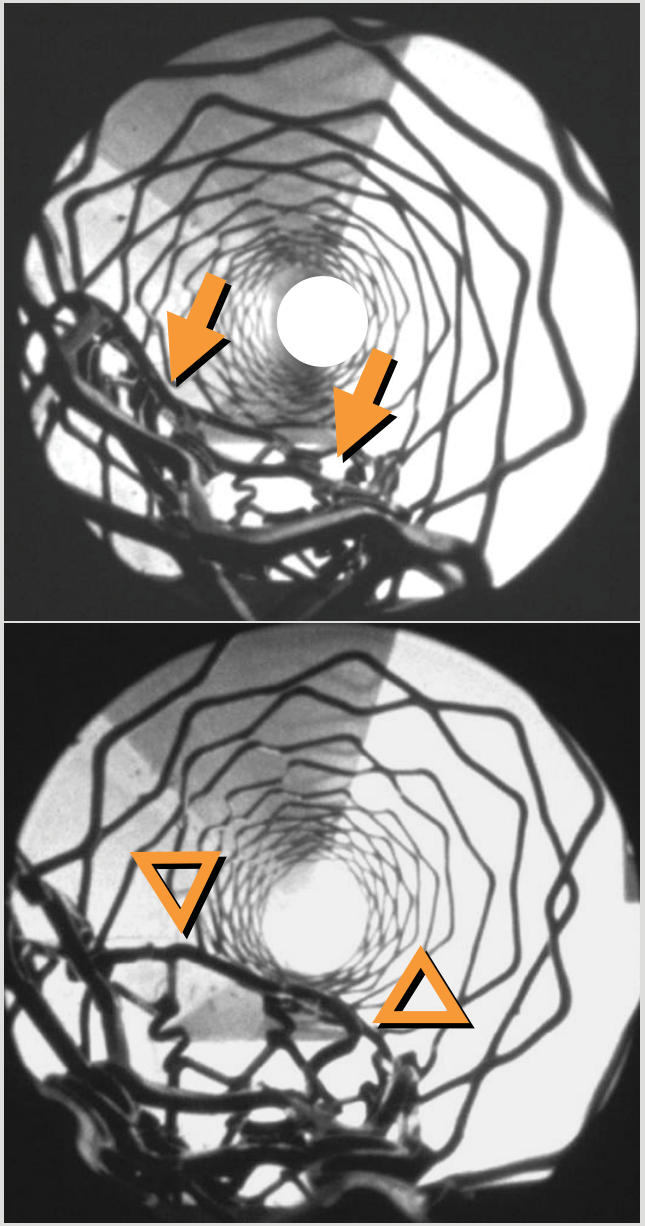
“Kissing” Balloon Post-dilatation

- After “External Crush” corrects distortion

- After “Internal Crush” causes distortion!!

Internal Crush - Before and after Kissing-balloon Post-dilatation





Kissing Balloon Post-dilatation

- After "External Crush" corrects distortion
- After "Internal Crush" causes distortion!!

Summary- Bifurcations with DES

- There is no perfect solution to bifurcation stenting with DES
- The “external crush” technique for bifurcations ensures coverage of the side-branch ostium without gaps
- Kissing balloon post-dilatation after “external crush” ensures best scaffolding and drug application, releases the side-branch from jail, and can correct distortion

Summary

- Provisional side branch stenting strategies that cover the ostium without gaps include “internal crush”, and “culotte” stenting.
- Undersized main branch kissing balloon after “external crush”, “culotte” and “T” stenting causes stent distortion
- After “internal crush” paradoxically any kissing balloon post-dilatation causes distortion