PCI

UNDERSTANDING DEVICES, STRATEGIES, AND COMPLICATIONS

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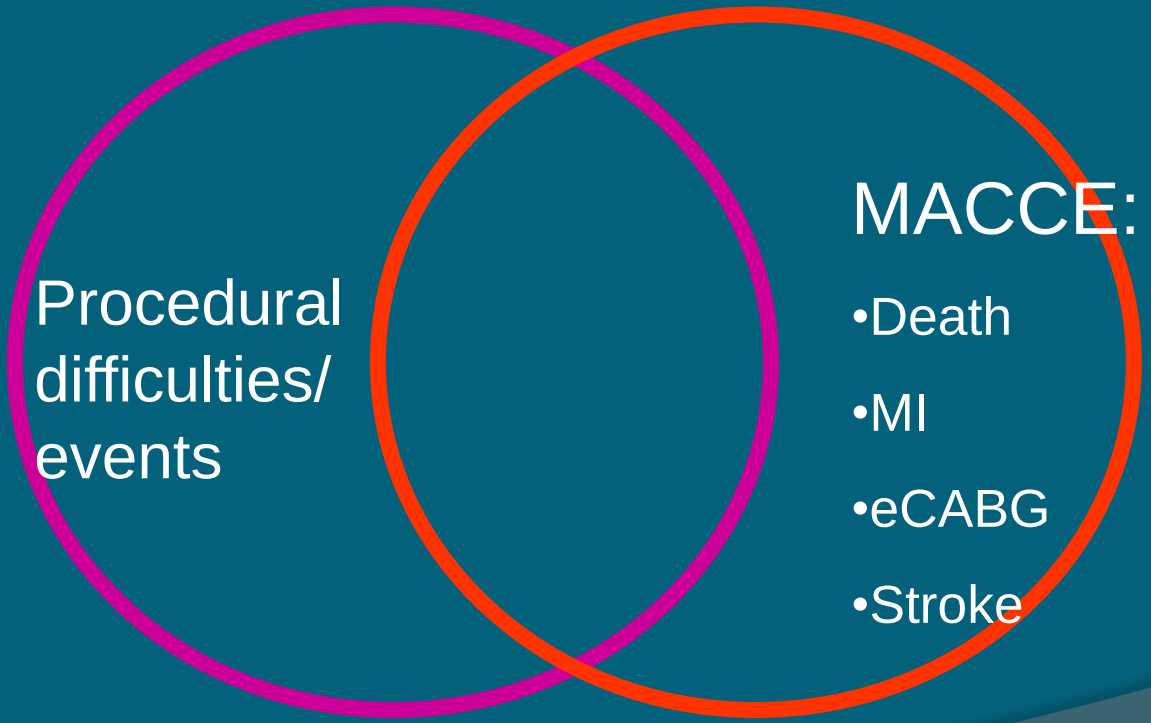
Learning process

- Knowledge & experience
- Judgment & decision
- Formation of treatment strategy
- Technical execution
- Outcome

PCI complications:

Problem base learning

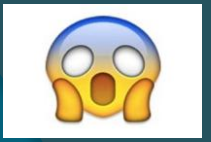
- Complications 
- Salvage 
- Mechanism 
- Prevention strategy 


Procedural difficulties/ events
MACCE:
•Death
•MI
•eCABG
•Stroke


Columbia


Columbia

Immediately life threatening



- Abrupt closure of a major coronary artery
- Cardiac tamponade from perforation
- Equipment related situations:
  - Entrapment
  - Breakage

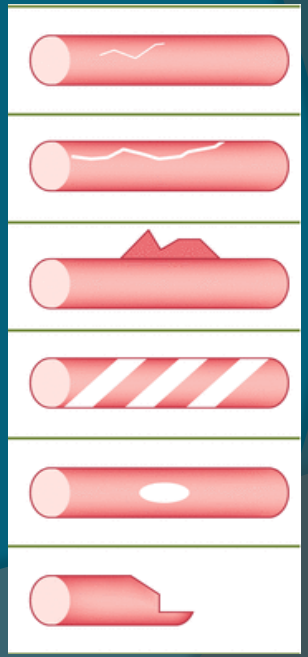
Acute closure (TIMI 0/I)

DDx:

- Dissection
- Thrombus
- Micro-embolization
- Spasm
- Air lock
- Psuedo-lesions (accordion effect)

Coronary dissection: NHLBI classification

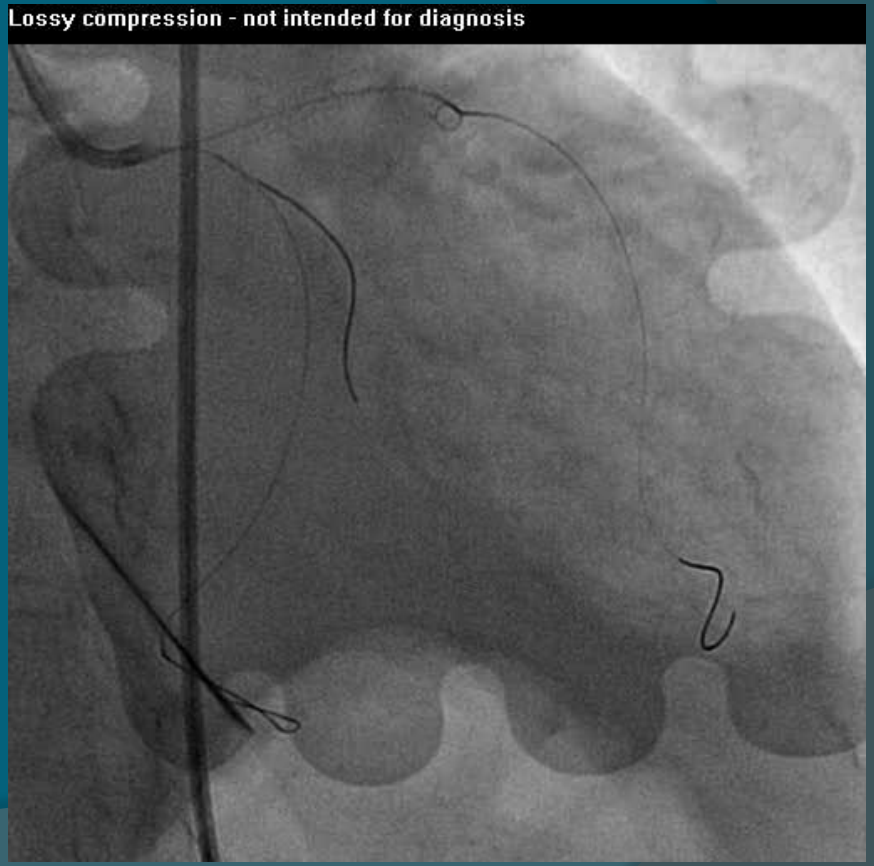
- A: Haziness within the vessel
- B: Linear dissection or intimal flap
- C: Dissection cap with contrast staining
- D: Spiral dissection
- E: Dissection with reduced flow
- F: Dissection with abrupt closure



Equipment and dissection

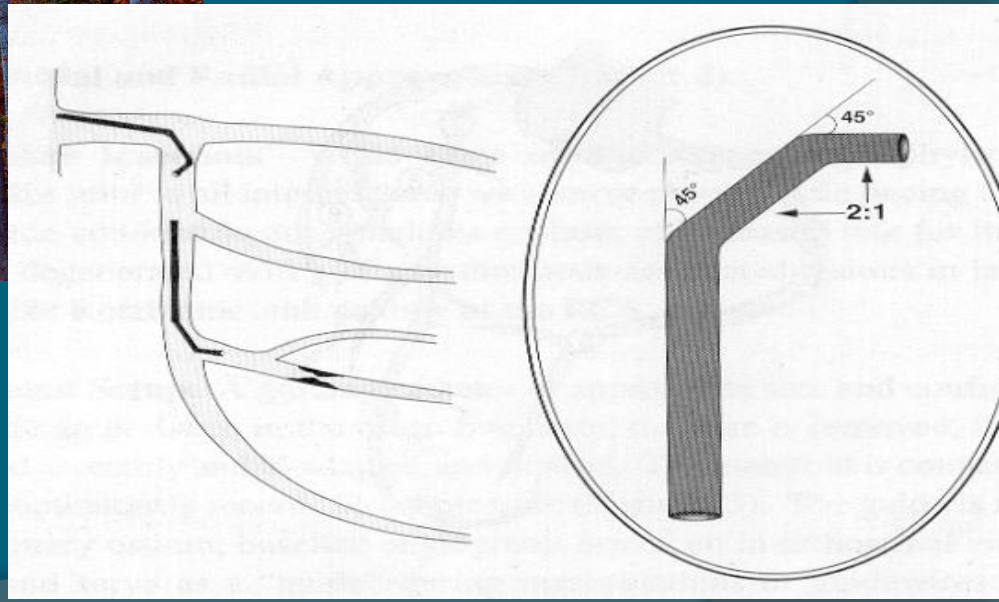
- Guidewires: stiff/ sharp tip, torturous vessel, subtotal occlusions, forcing knuckle
- Guiding catheters: off co-axial, pressure damping, forceful injection
- Balloons/ stents: B/A ratio
- Bulky devices force through torturous vessels

GW dissection



Guidewire passage

Turn & glide

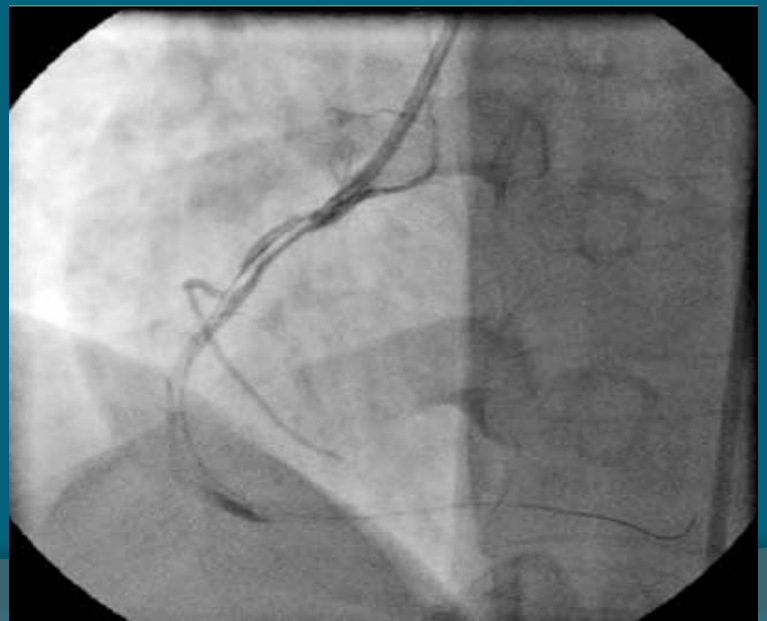


Guidewire control

- 0.014” wire circumference = 3.14x0.014” = 0.044” = 1.11mm
- Use a torquer!
- Familiarize with 2 to 3 workhorse wires for their responses (tactile and visual)
- Don’t do excessive spinning
- Avoid knuckling unless very sure

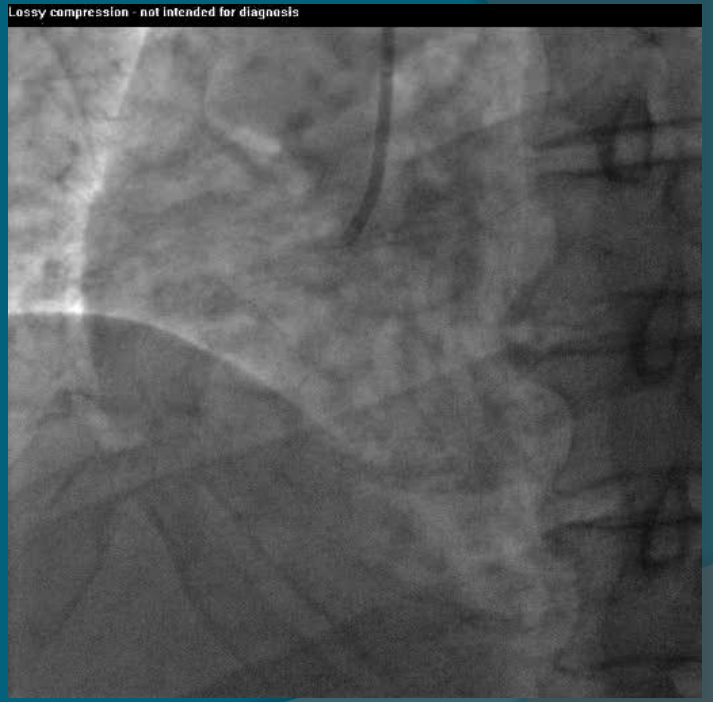
Guiding catheter injury

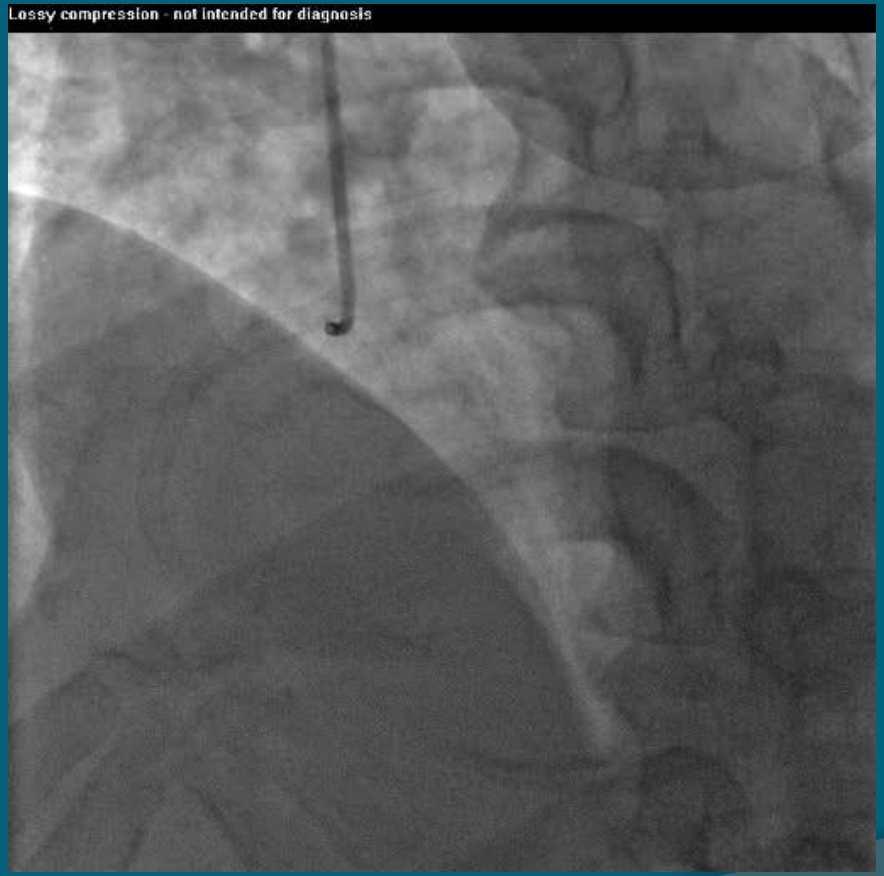
- Ostial dissection
  - Forward extension: threaten closure
  - Backward extension: aortic dissection



Ostial dissection

- Stop injection immediately
- Review angiogram to study the proper GW passage to avoid extension of the dissection
- May need a second guiding catheter for wiring
- May need IVUS to be certain
- May need to stent the ostium 1st

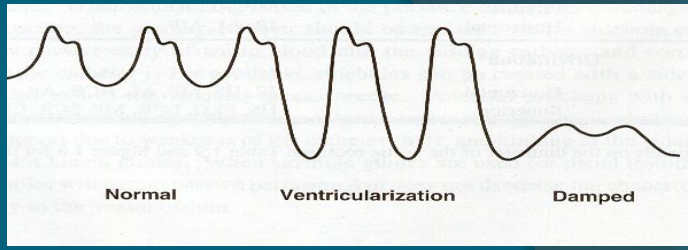



Lossy compression - not intended for diagnosis

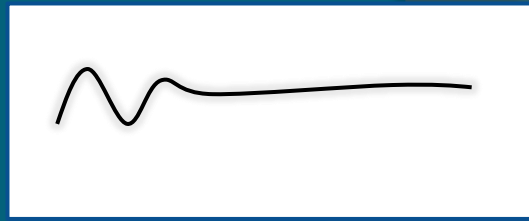
Ostial dissection

- Catheter tip damage to a plaque
- Subsequent forceful contrast injection
- Force guidewire passage

Ostial dissection

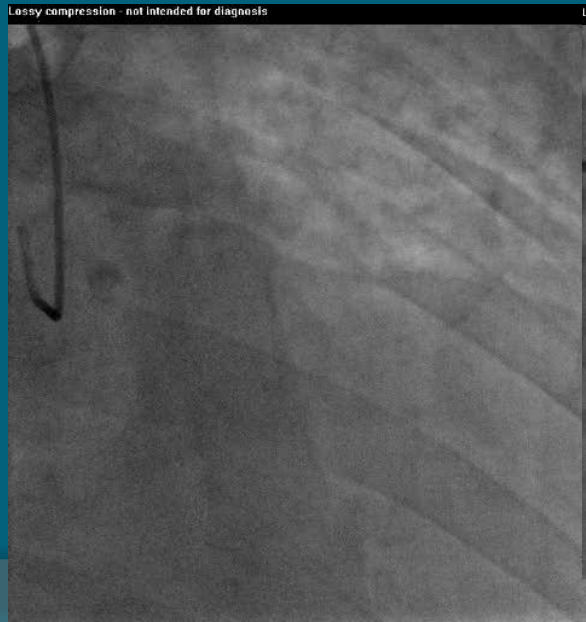


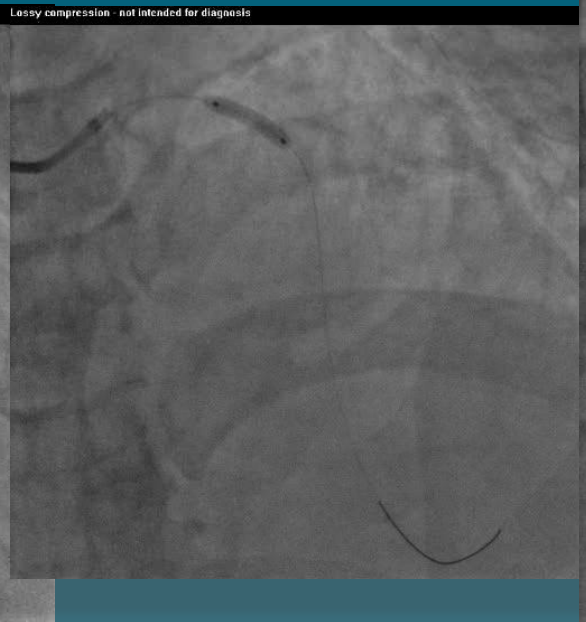
- Choice of GC:
  - risk of ostial damage vs support needed
  - Side-hole useful??
- Careful engagement with GW ready within for quick access
- Use GW to control the depth of GC
- Watch the pressure before injection



Side branch occlusion

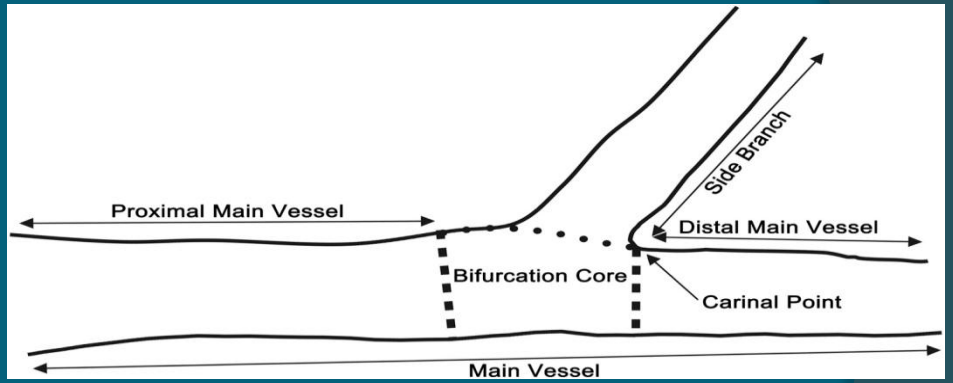
- Common cause of peri-procedural MI
- Could be fatal though rare





Risk of closure

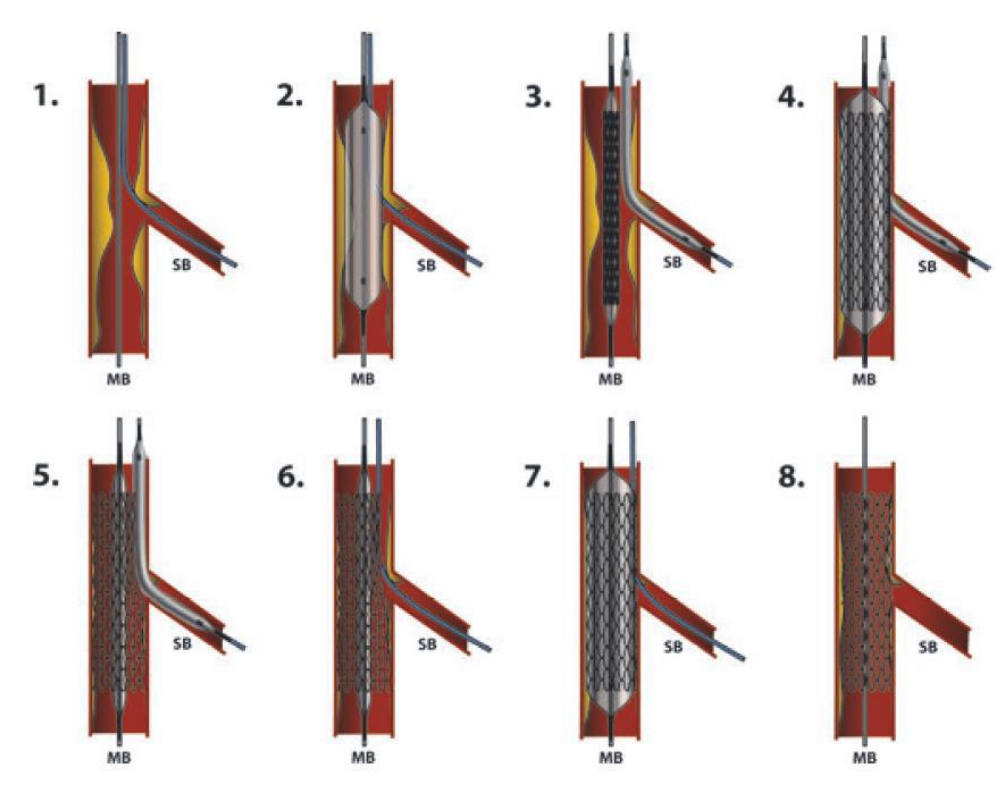
- Plaque volume and distribution
  - MV stenosis
  - SB os stenosis
  - TIMI flow in MV/SB
- Bifurcation angle
- Relative size



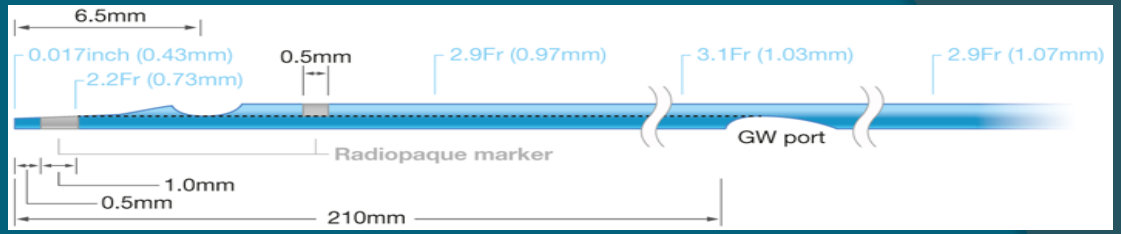
Side-branch preservation

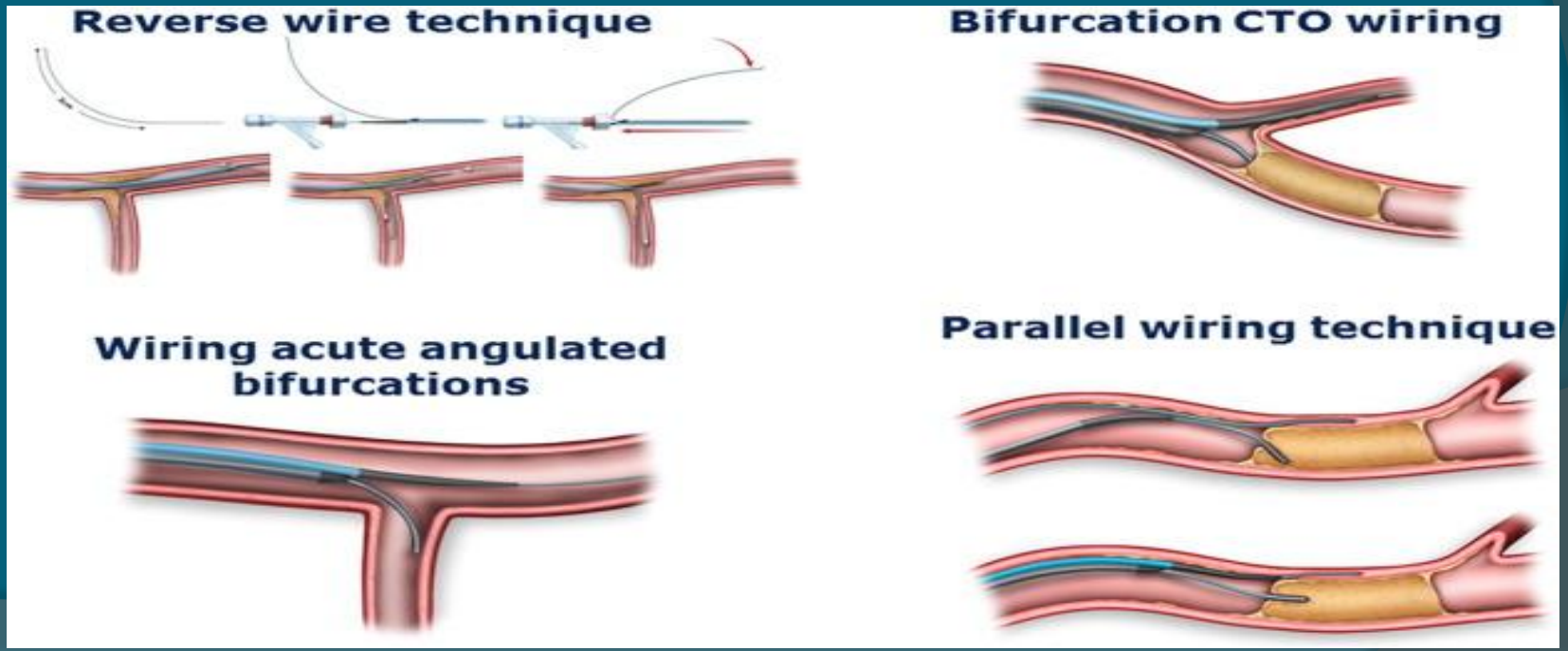
- All bifurcation strategy: KIO to complex 2-stents approach
- Protection of SB and re-access:
  - Jailed wire
  - Jailed balloon, Corsair
- Get a wire into the SB branch first!

Jailed balloon

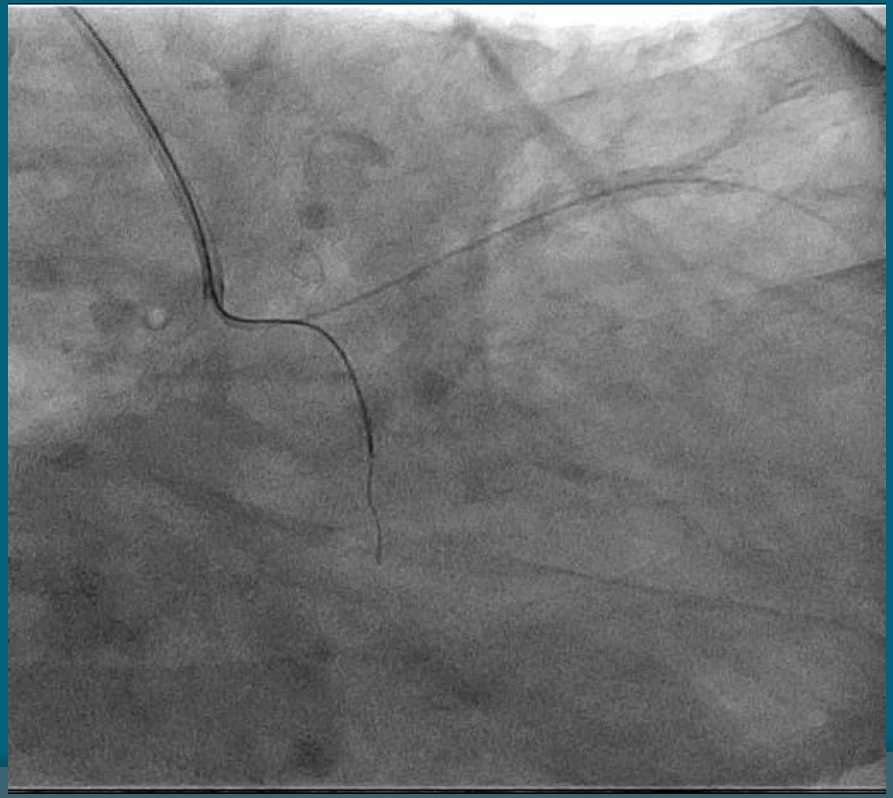


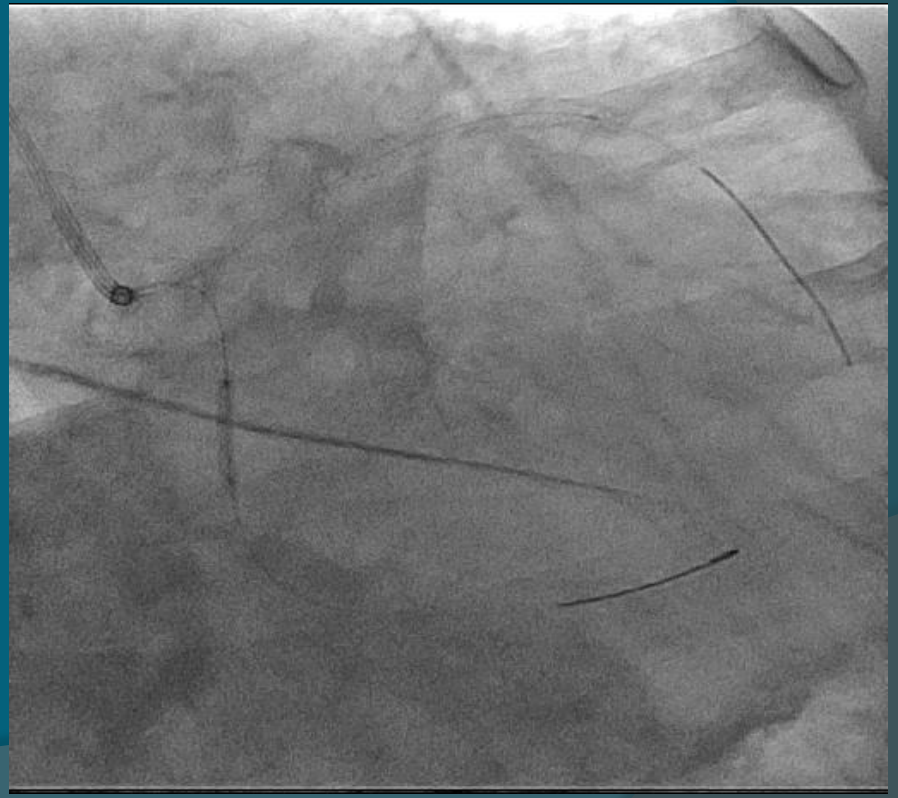
Double lumen catheter



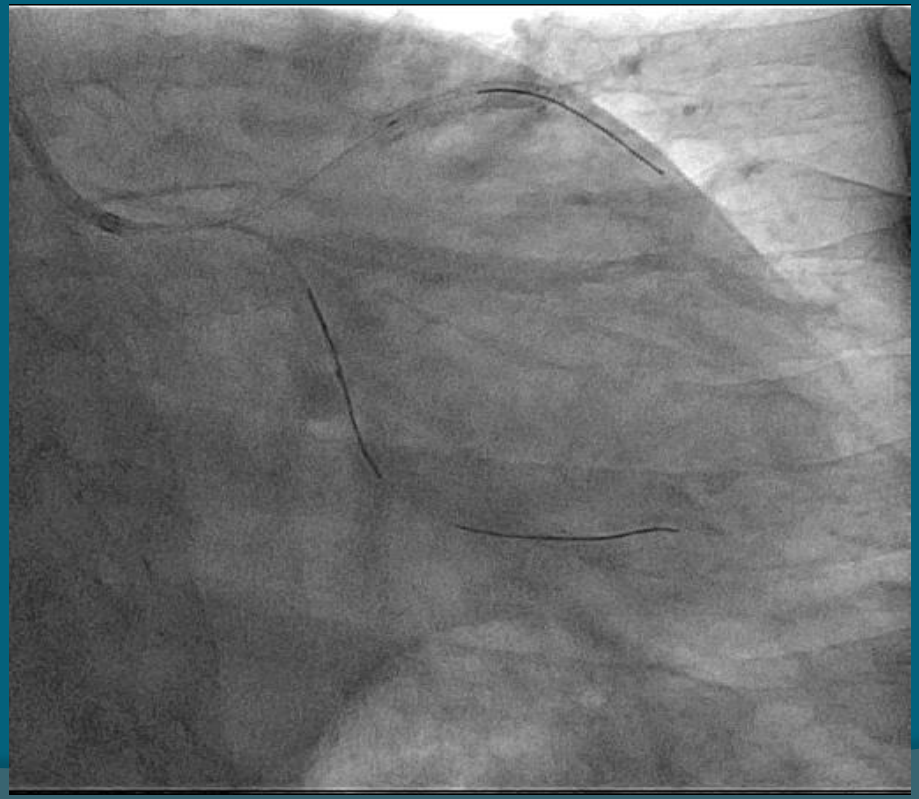


Reverse wiring

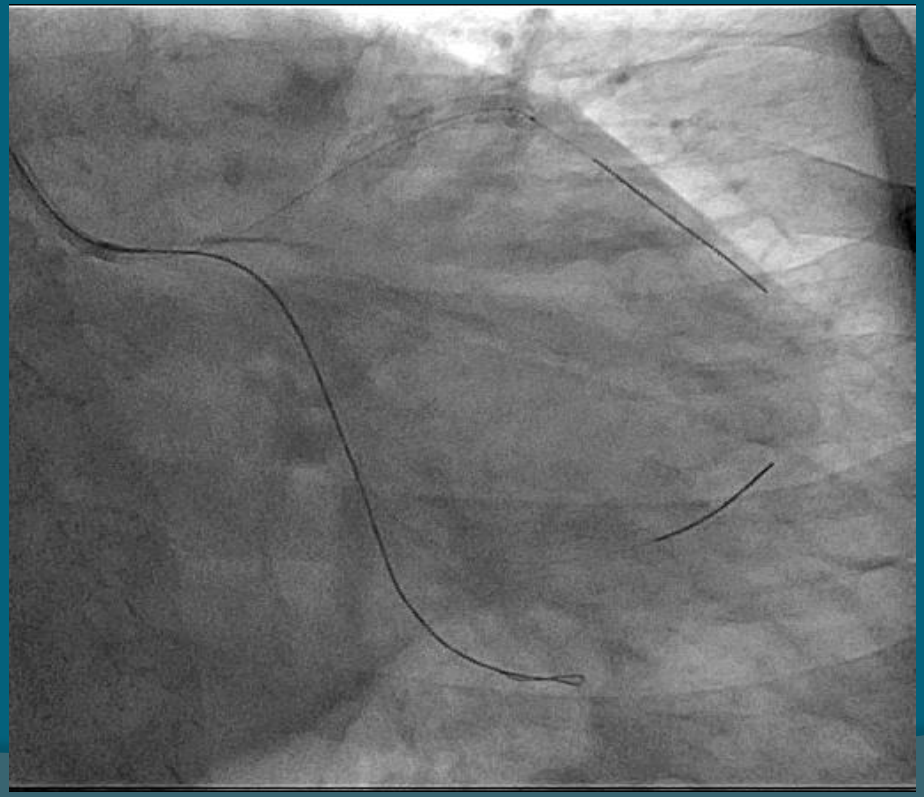




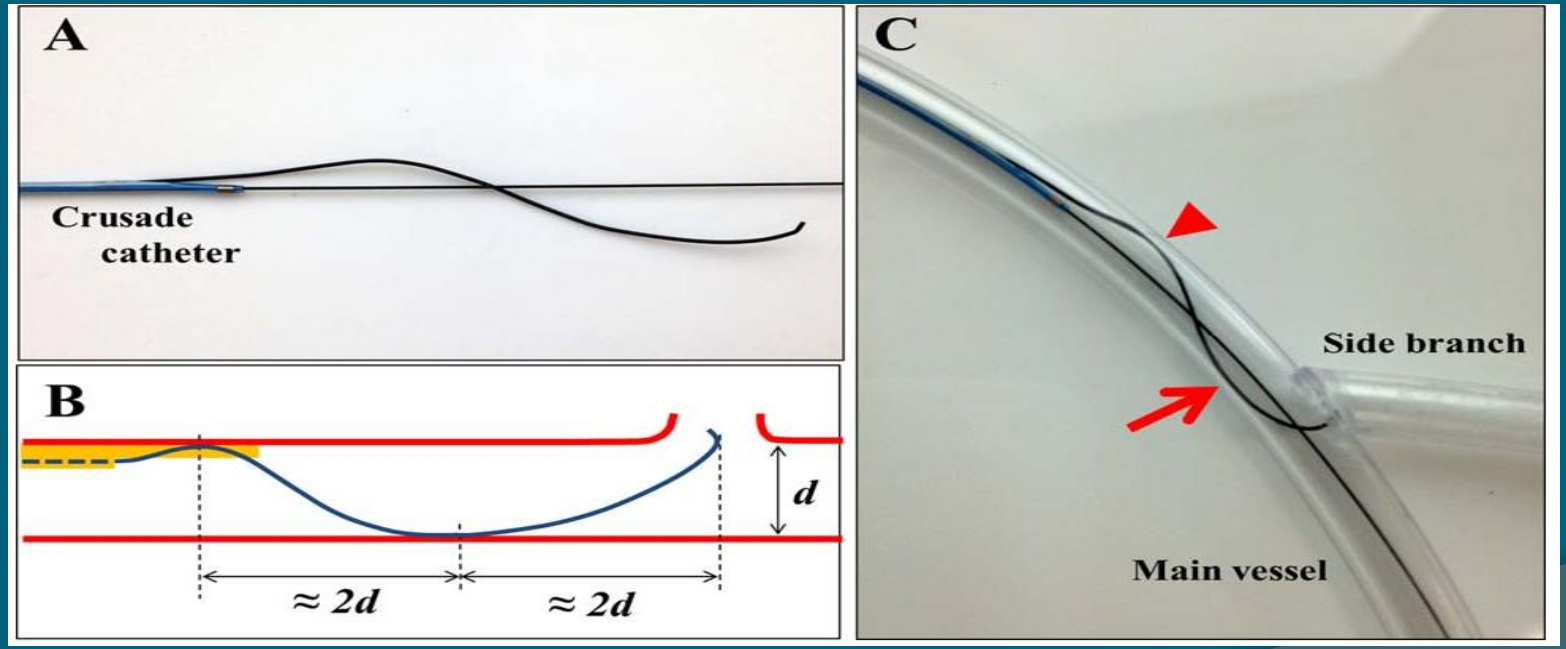
Reverse wiring 2



Reverse wiring 3

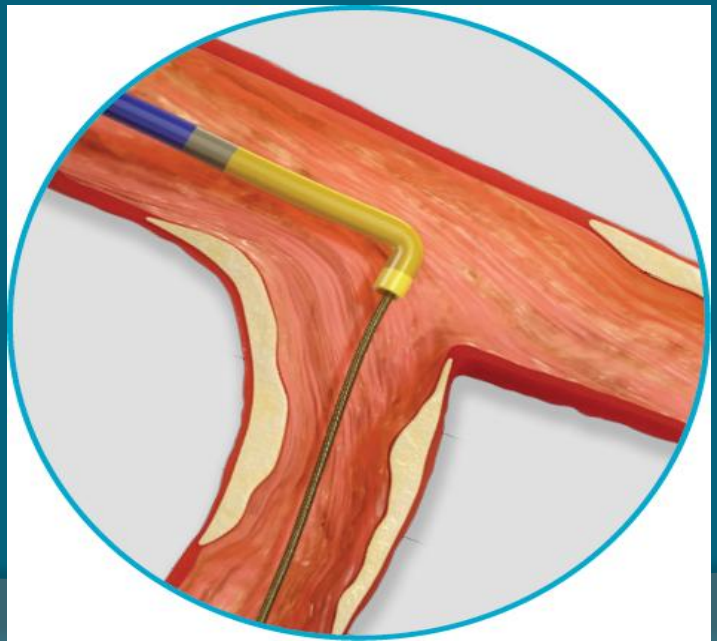


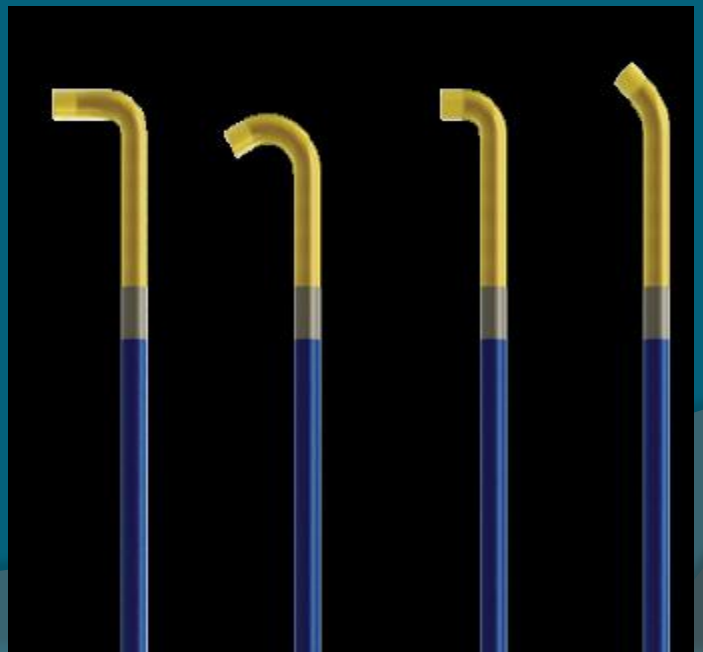
Reverse bent wire



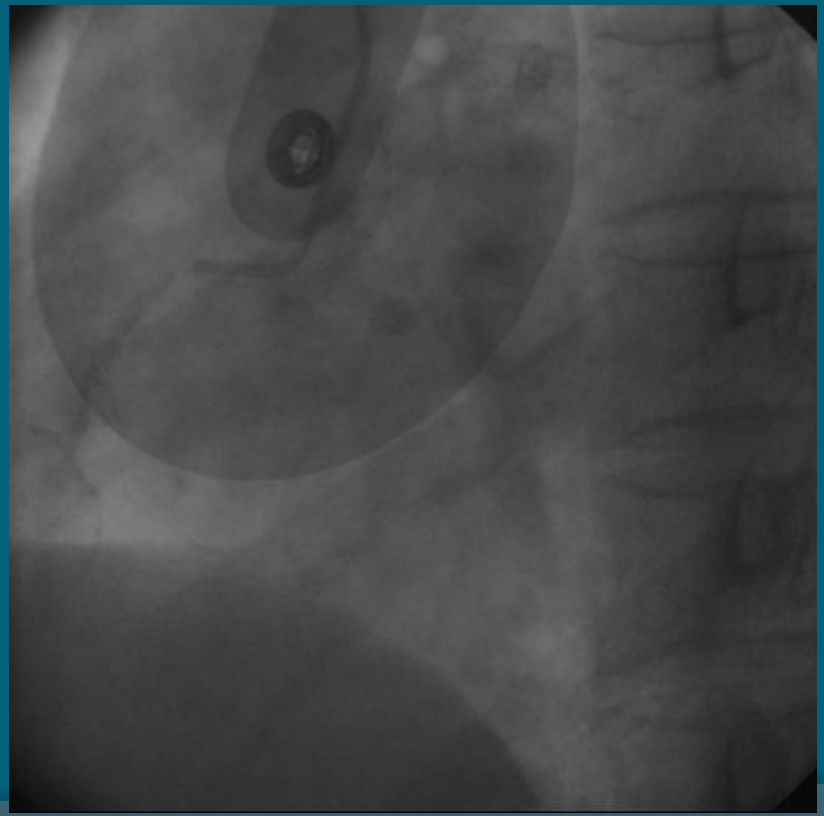
Nomura T, et al. Catheter Cardiovasc Interv. 2016 Apr;87(5):920-5

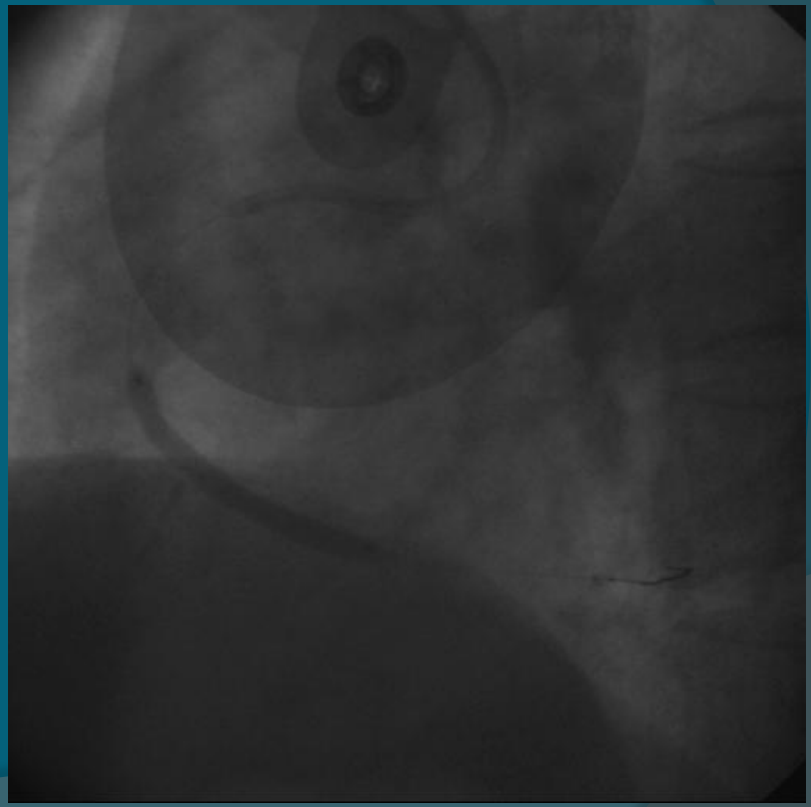
Supercross microcatheter

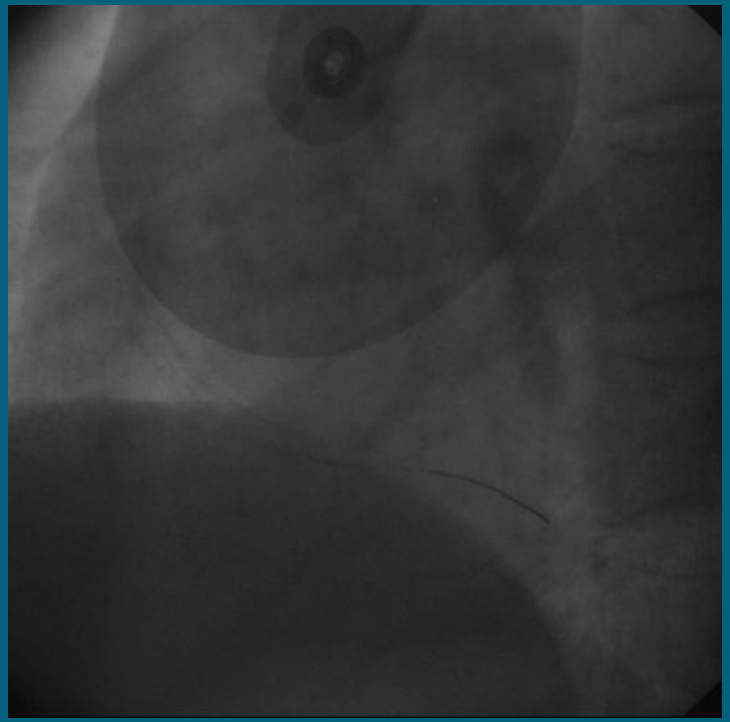


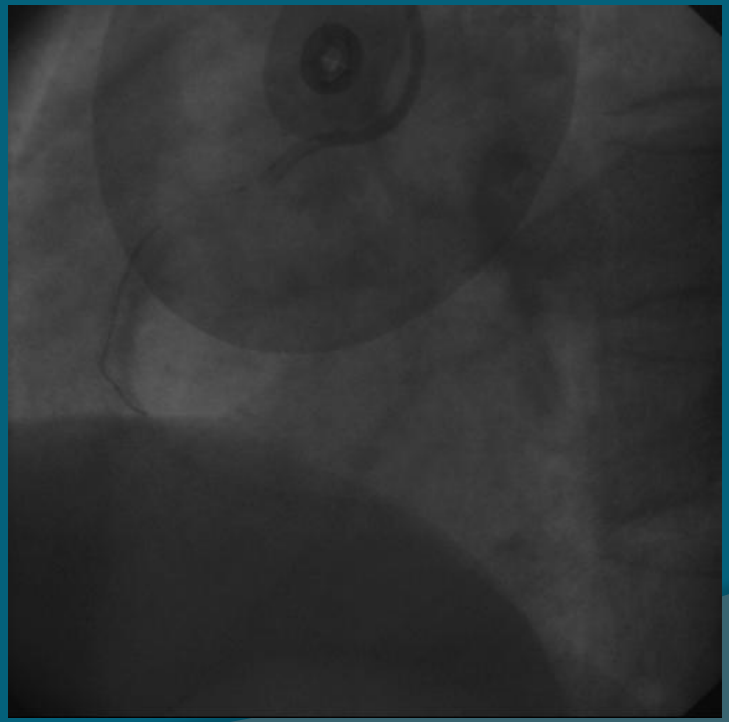


1o PCI









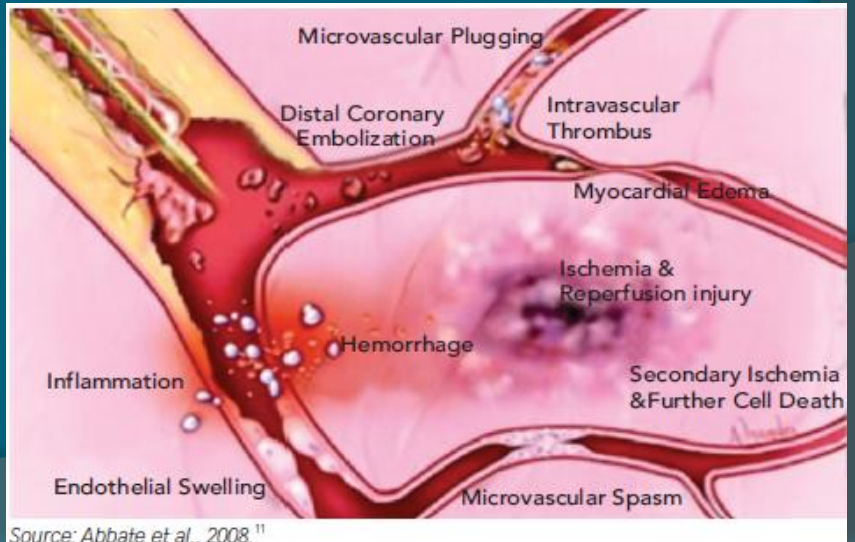
No reflow or slow flow

Microembolization

- Atheromatous debris
- Clot: fibrin, platelets
- High risk lesions: SVG, ACS culprit, large plaque burden
- Rotablation with rapid passes

Late reperfusion in AMI

- Tissue edema
- Endothelial damage



Source: Abbate et al., 2008.[11]

Management of no-reflow

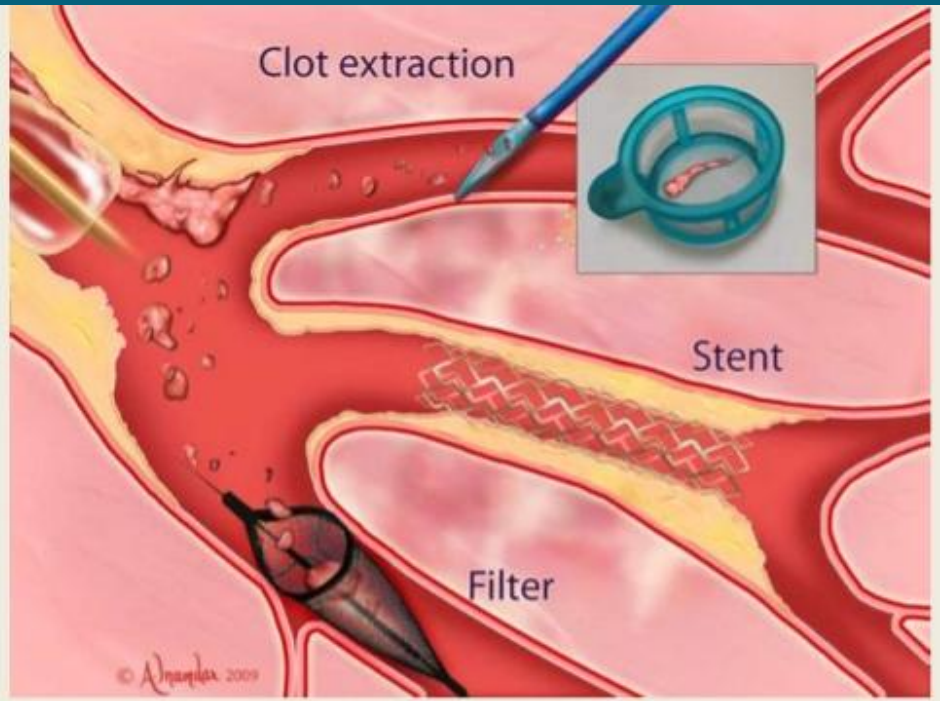
Support BP:

- Inotropes
- IABP

Drugs:

- TNG not useful
- Vasodilators: nitroprusside, adenosine, CCB, adrenaline
- Via microcatheter
- Anti-thrombotics: GP2b3a inhibitors

Device strategies to prevent no-reflow

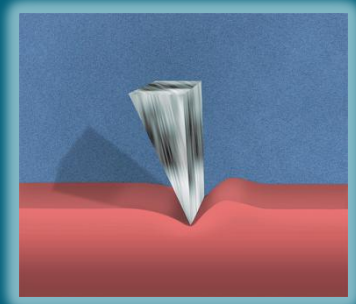


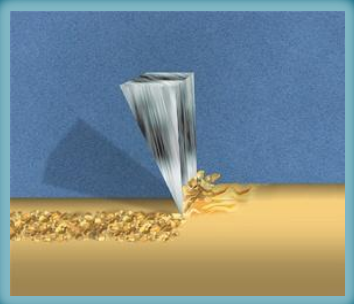
Jaffe et al. JACC Cardiovasc Interv. 2010 Jul;3(7):695-704

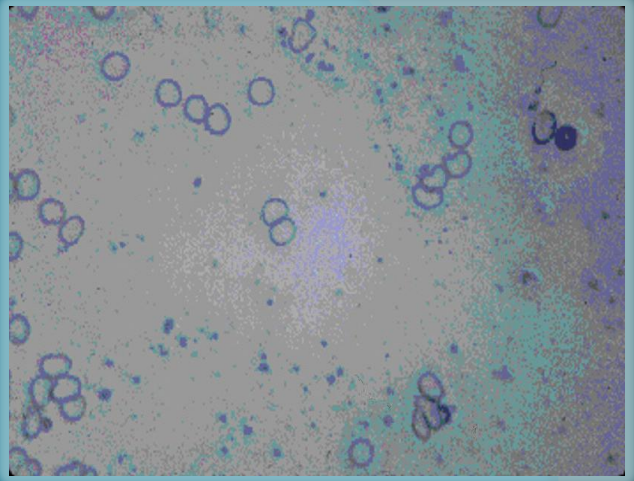
Prevention of no-reflow

- SVG: use distal protection device
- ACS: antiplatelets, GP 2b3a inhibitors
- Thrombectomy in bulky clot
- Rotablator: cocktail infusion, pecking on resistant lesions

Rotablator








Rotablator
Console
Foot Pedal
Advancer


1.25 mm
1.5 mm
1.75 mm
2.0 mm

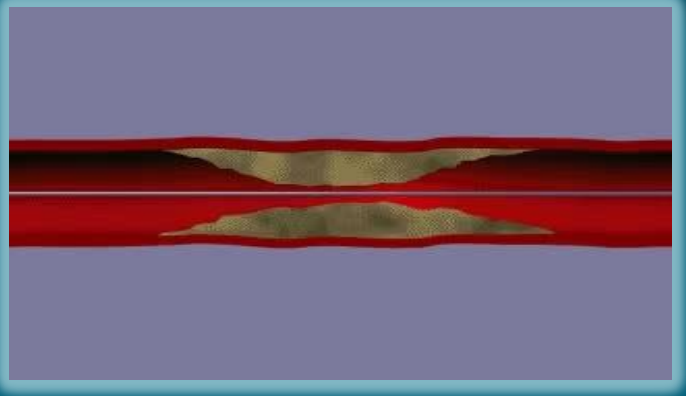
Rotational atherectomy

Equipment setting

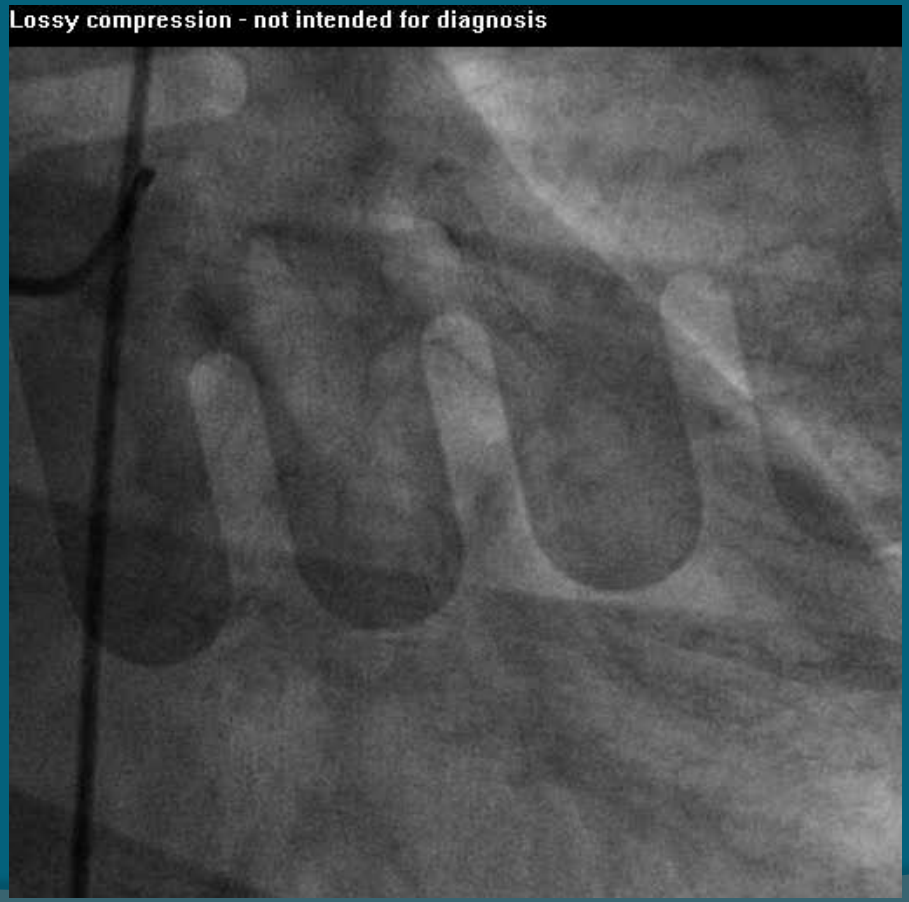
- Burr-to-artery ratio of 0.5 to 0.6
- Rotational speed of 140,000 to 150,000 rpm

Burr technique

- Gradual advancement with pecking motion
- Short runs of 15 – 20 sec
- Avoidance of decelerations > 5,000 rpm
- Intermittent check of blood flow and BP
- Final polishing run



Tomey, et al. Current Status of Rotational Atherectomy. 2014. JACC Cardiovasc Int.


Lossy compression - not intended for diagnosis


Lossy compression - not intended for diagnosis

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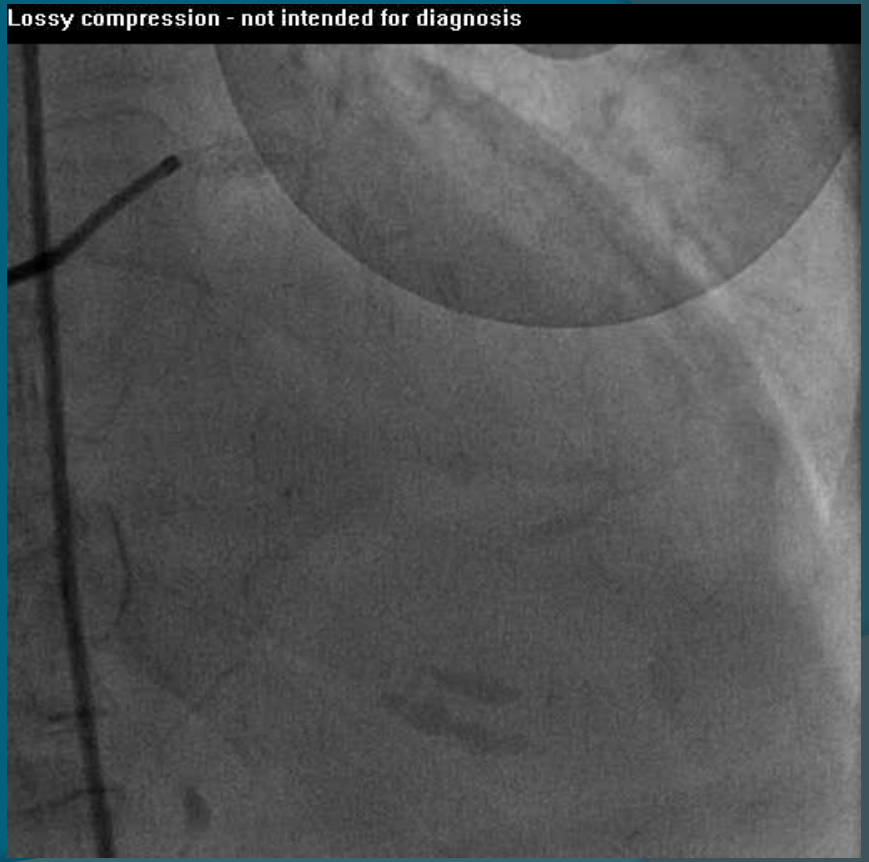
Air embolism

- Small amount well tolerated
- Larger amount causes “air-lock” abrupt cut-off
- Triad of chest pain, hypotension and brady-cardia
- ECG: ischaemic change



Air embolism management

Supportive treatment:

- 100% O2
- Atropine
- Inotropes
- IABP

Possible measures:

- Active flushing, with blood/ saline
- Balloon inflation to dissipate the air column
- Aspiration
- Intracoronary drugs as no-reflow

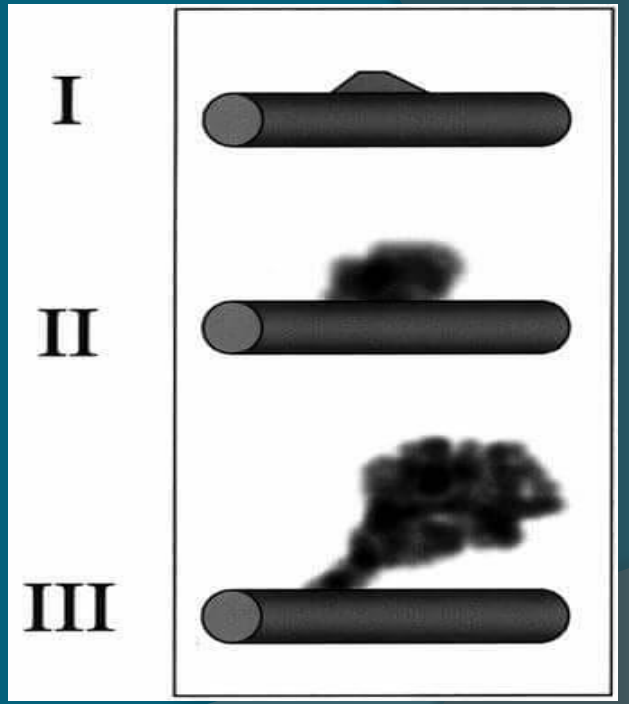
Air embolus prevention

- Often from manifold
- Poorly prepared devices, e.g. IVUS sheath
- Entrained during insertion or removal of bulky devices, e.g. aspiration catheter, trapping balloon
- Higher chances in
  - Hypotensive patients
  - Deep seated guiding

Perforation

Classification (Ellis)

- Type I: extraluminal crater without extravasation (contained)
- Type II: pericardial or myocardial blush without contrast jet extravasation
- Type III: Extravasation through frank (> 1mm) perforation → tamponade
- Type III Cavity spilling usually benign



SG Ellis et al Circ 1994; 90:2725-30

Perforation

Clinical outcome of 62/12900 procedures (0.5%)

Type	N	Death %	eCABG %	Q-MI	Tamp%
I	13	0	15	0	8
II	31	0	10	0	13
III	16	19	63	15	63
III (CS)	2	0	0	0	0

SG Ellis et al Circ 1994; 90:2725-30

Perforation Incidence

- 84/5728 patients (1.5%) in Milan Stankovic Circ 2002;19:2210

POBA		45 pt (53.6%)
DCA	8	(9.5)
Rotablator	3	(3.6)
Cutting balloon	2	(2.4)
Guidewire	23	(27.4)

- Atheroablative procedure 2.4% vs 1.3%
- Complex lesions 1.9% vs 0.5%
- CTO 9.9% Shiga Med Ctr Nakamra Circ 2002;19:2209

Wire Perforation

- Often associated with hydrophilic / stiff wires. Not only in CTO.
- May be slow to be recognized.
- Tamponade may occur out of the lab hrs later, final shots must be long enough!

Management of perforation

Immediate actions

- Don’t panic!
- Inflate the balloon
- Call people to help

Support BP

- IV fluid
- Inotropes

Promote clotting

- Protamine
- Platelet transfusion?

Treat tamponade

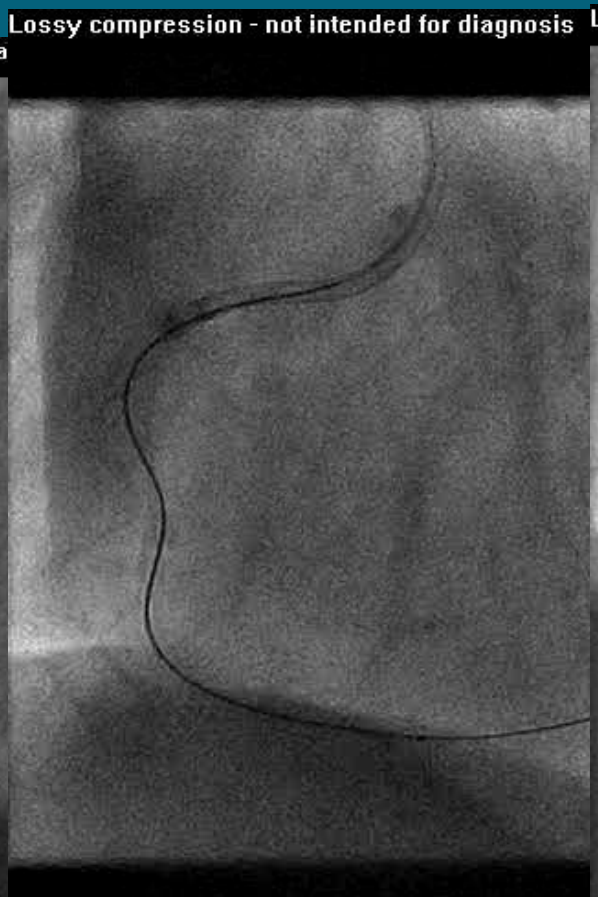
- Pericardial drain
- Echo / Fluoro- guide

Management of perforation

- Prolonged inflation for small leak
- Capillary / small branch leak, close the feeding vessels by:
  - Prolonged aspiration by microcatheter
  - Embolisation: coil, gel foam, blood clot, fat
- Large leak may need stent graft. Same GC vs 2nd GC
- Surgical consultation
- Follow up echo

RCA CTO


Lossy compression - not intended for dia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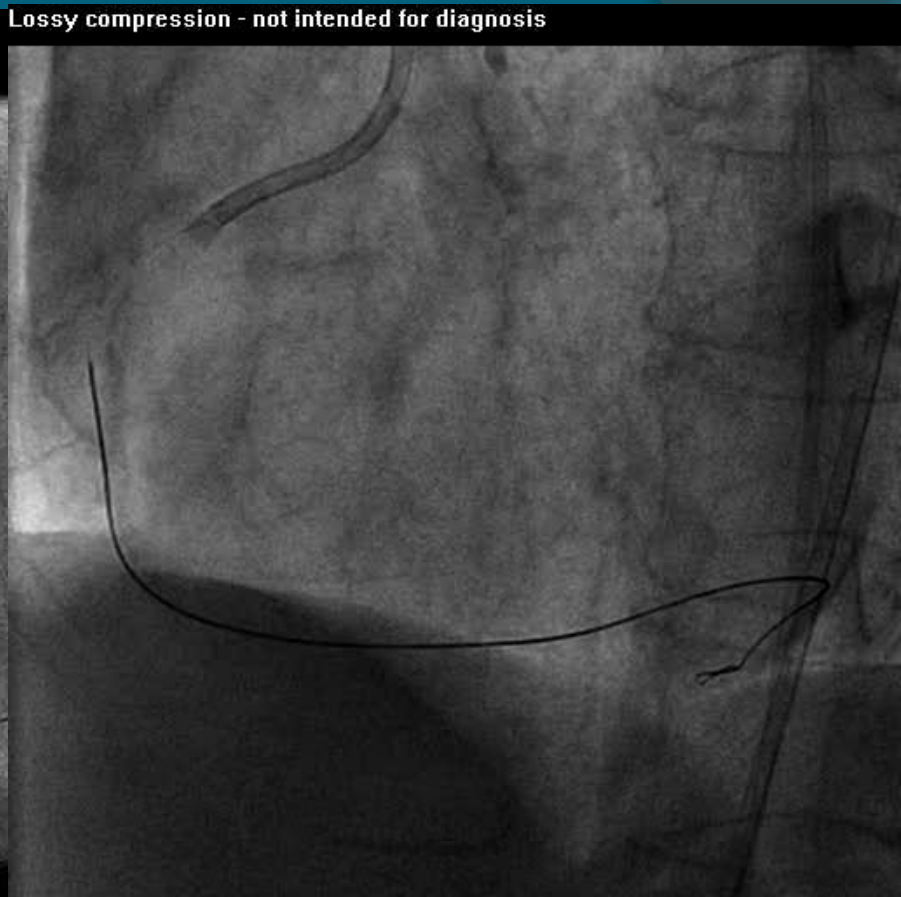
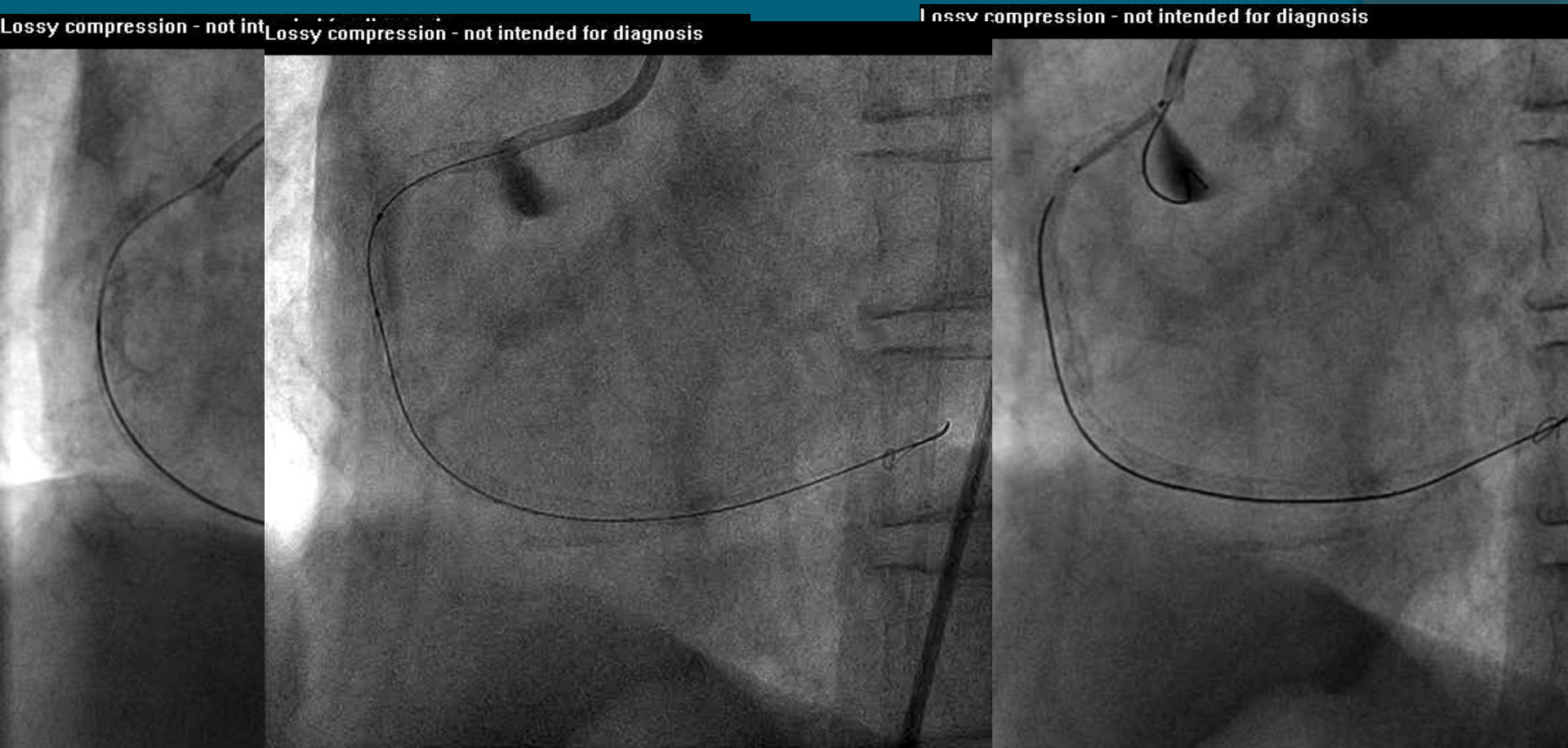
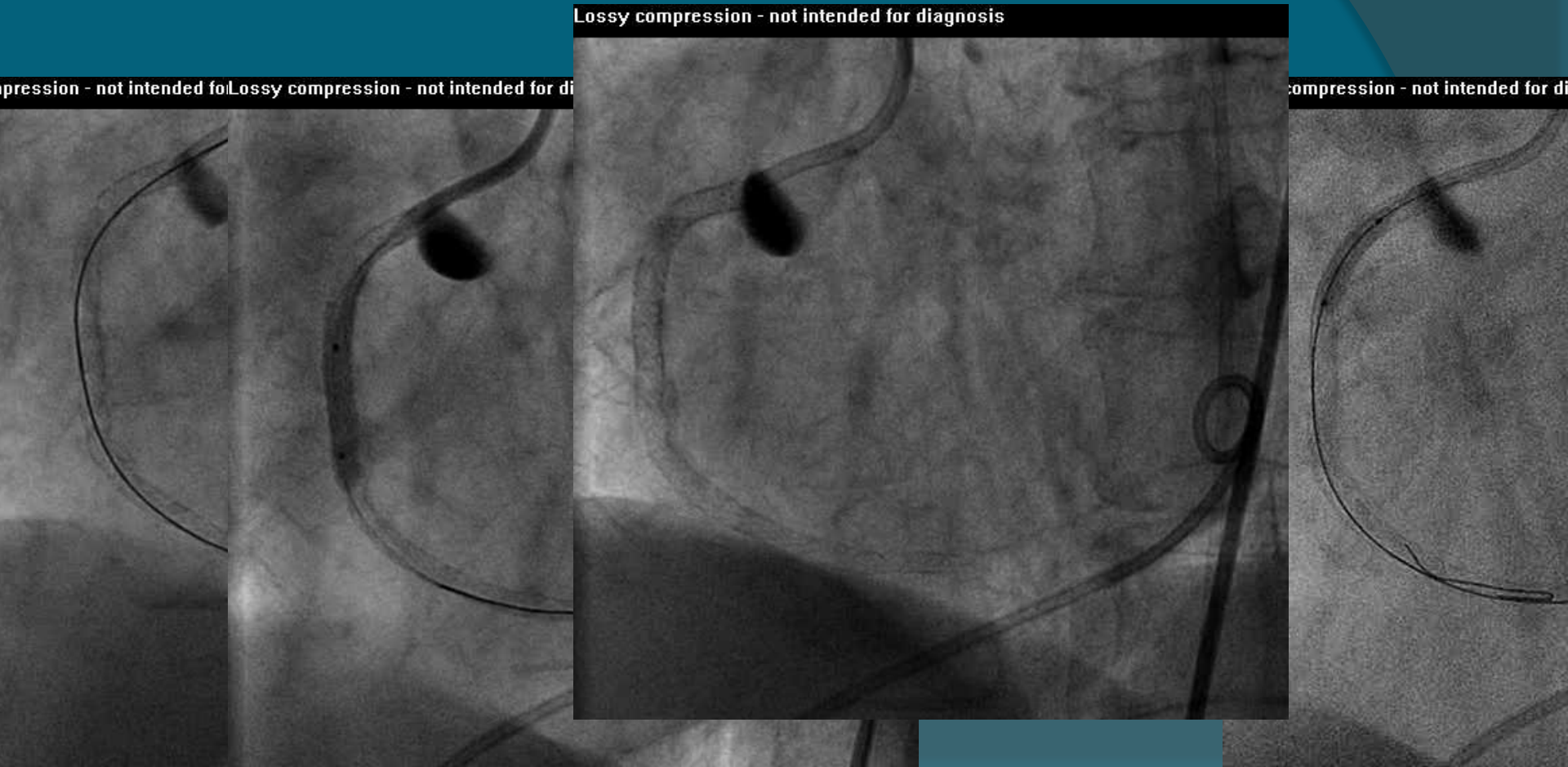

Lossy compression - not intended for diagnosis

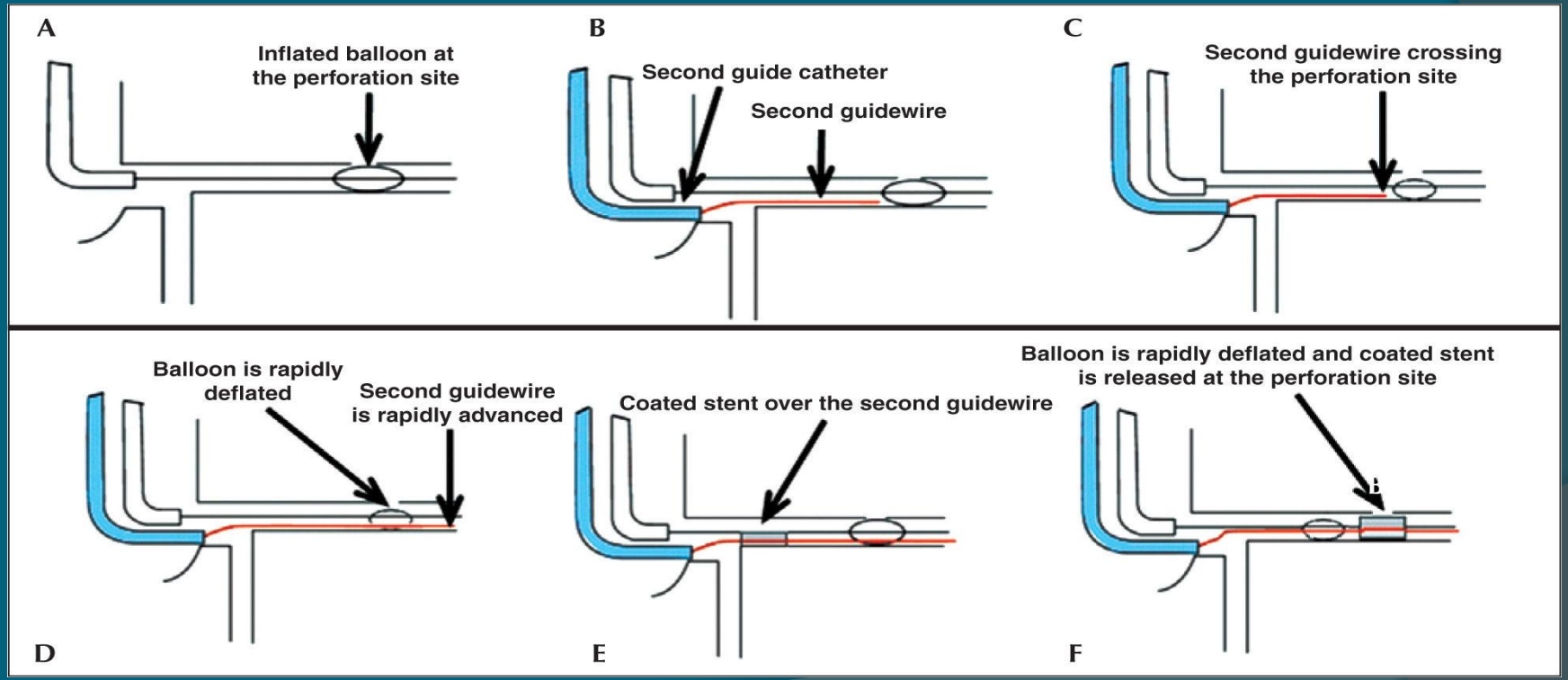
Difficult tornus retraction



It never rains

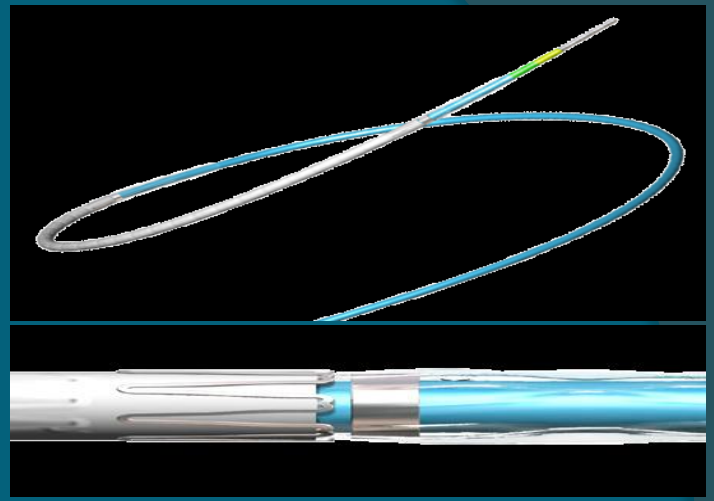


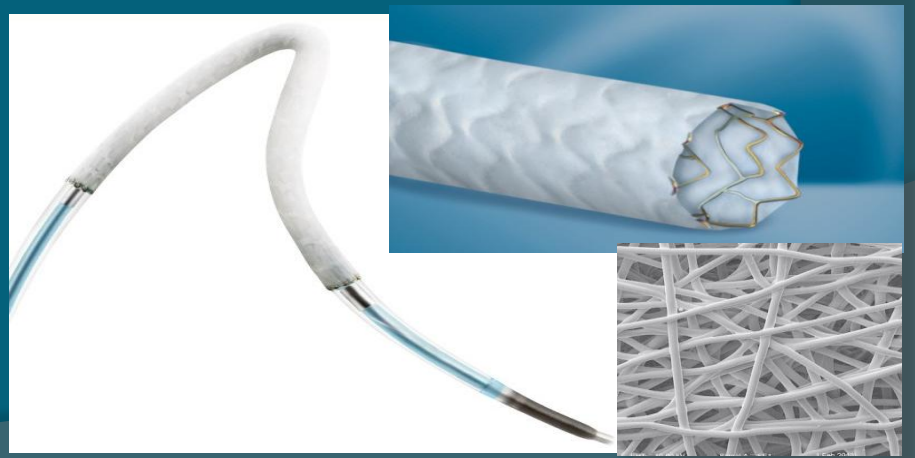
2 GC for stent-graft implantation



Stent-grafts

- Relatively bulky and delivery could be difficult
- Still need good post-dilatation to ensure sealing of leakage
- Longer duration of DAPT then usual BMS





Perforation risk

- Elderly, women
- Interaction between lesions and devices
- CTO especially long length, especially sub-intimal passage of wires
- Calcified vessels with uneven expansion
- Atheroablation in torturous vessels
- High balloon (device)/ artery (diameter) ratio

When perforation risk is high ……

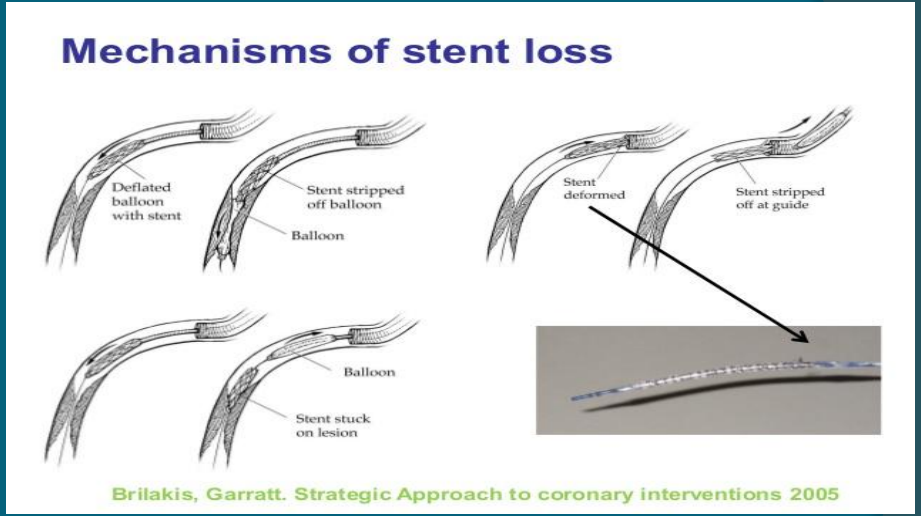
- Be conservative
- Better is the enemy of good!

Equipment problems

- Stent dislodgement
- Device entrapment
- Broken devices

Stent dislodgement

- Detaching from stent balloon
- Balloon went in but the stent lag behind
- Forward displacement or backward displacement



Failed delivery to the target site is the prime cause of stent dislodgement.

Possible scenarios

- Balloon still partially attached to the stent
- Balloon is completely separated from the stent but wire still across it
- The stent is completely detached from external link
  - Whole stent within the vessel
  - Part of the stent sticking out to the aorta

Management option: if attached

- Deploy the stent in situ if feasible
- Back out the GC / stent to aorta if still attached, keep wire in the target artery. Finish up the PCI with new access then retrieve the stent.

Management option: if detached

- Pass a small balloon through the stent, inflate the balloon to lock the stent and back out the system.
- Pass additional wire(s) across the stent, lock them in one torquer and turn to produce distal floppy part entanglement to trap the stent for retrieval.
- Crush the stent into the vessel by another stent.

Failed delivery

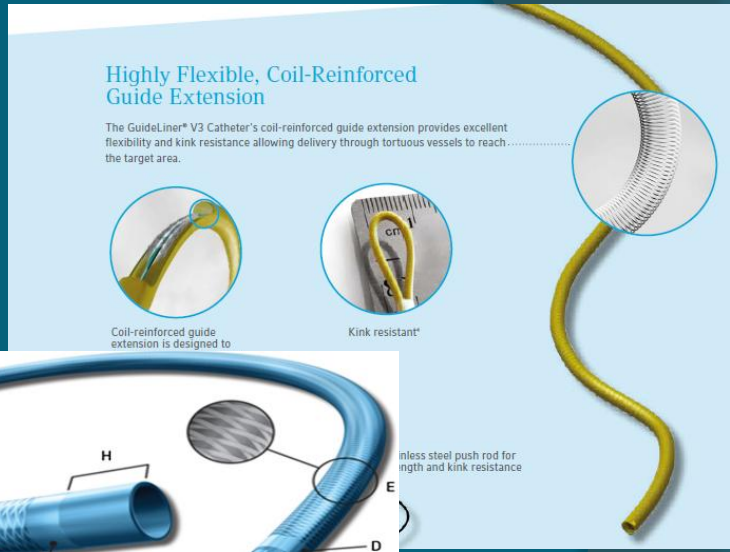
- Suboptimal guiding catheter support
- Inadequate guide wire support
- Inadequate lesion preparation
- Proximal disease, calcification, torturous course, angulation, and vessel rigidity

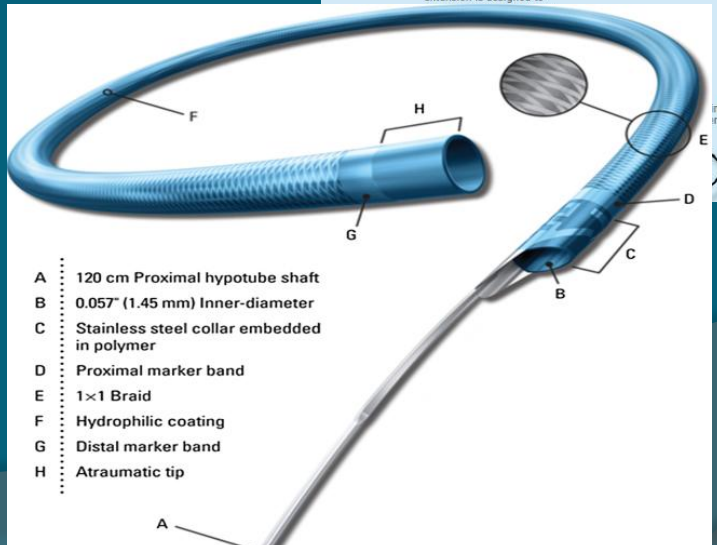
Preparation for stenting

- Starts from the basic: choice of GC and wire according to estimated difficulty
- Adequate lesion preparartion: predilatation, rotablation for lesions with significant Ca^{++}
- Try the passage of a minimally inflated balloon to estimate the resistance

Strengthen the support

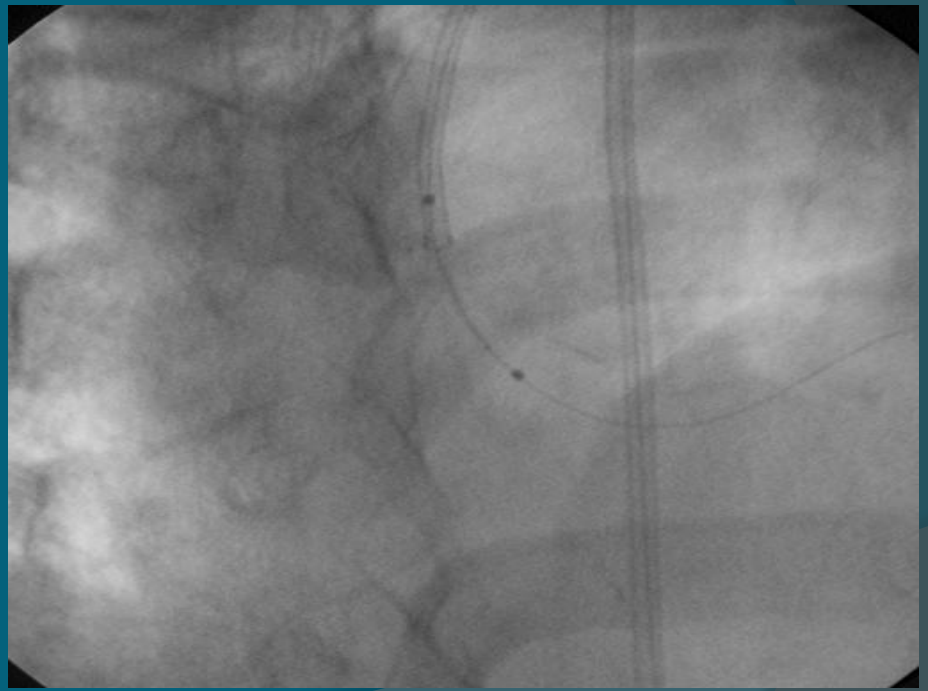
- Buddy wire
- Anchoring wire/ balloon
- GC deep seating
- GC extension: Guideliner, Guidezilla



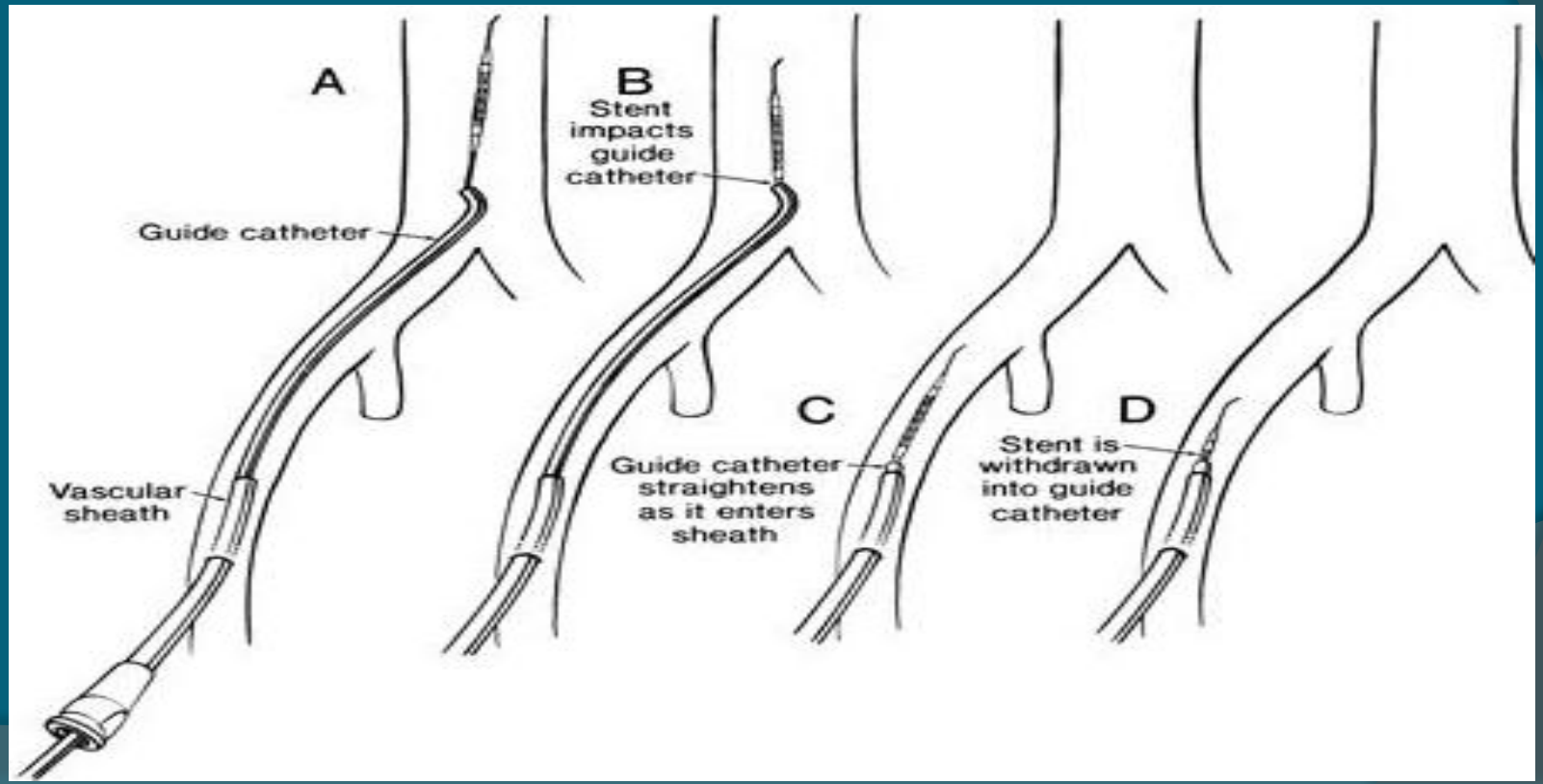


Retract stent outside coronary

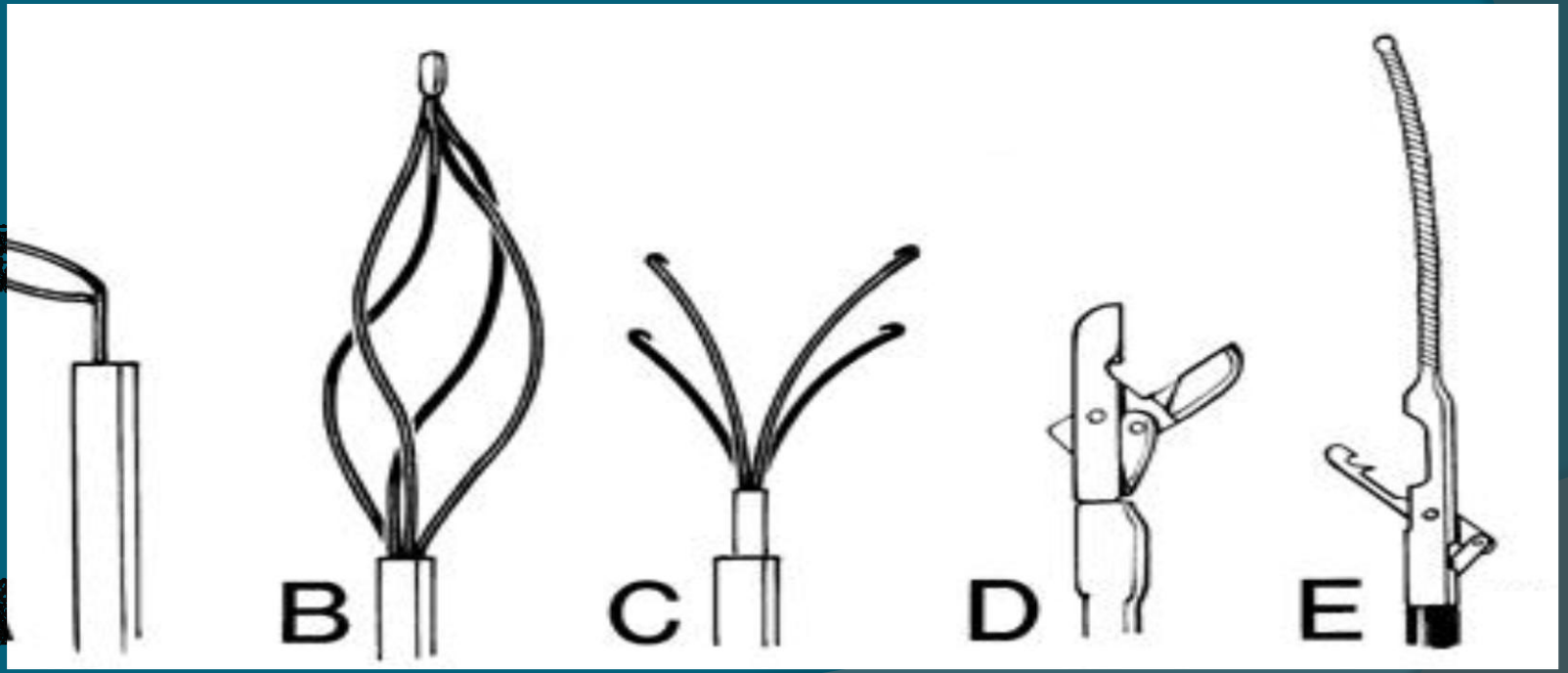
- Better still in descending Ao
- Minimize the angulation
- Embolization in peripheral arteries usually have no sequel



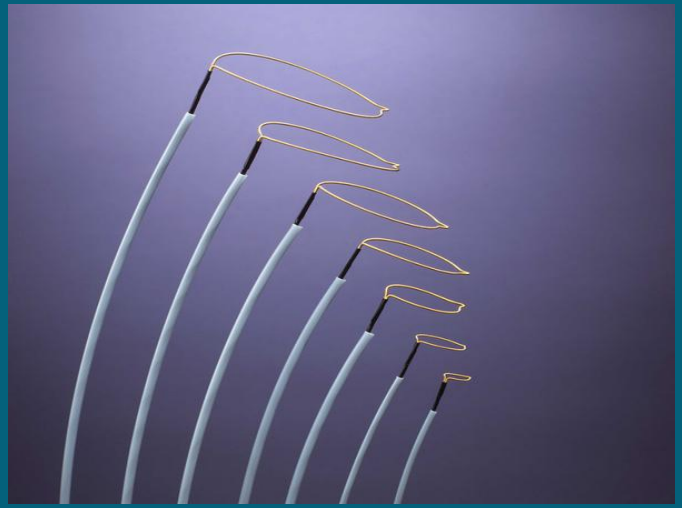
Withdraw as one piece

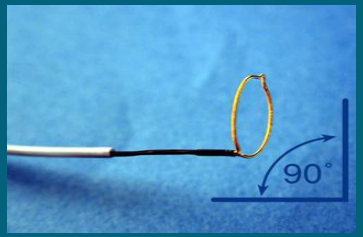


Various retrieval devices



Snares





GooseNeck® Snare and Microsnare

Amplatz GooseNeck® Snare Kit (kit includes Snare, Snare Catheter)

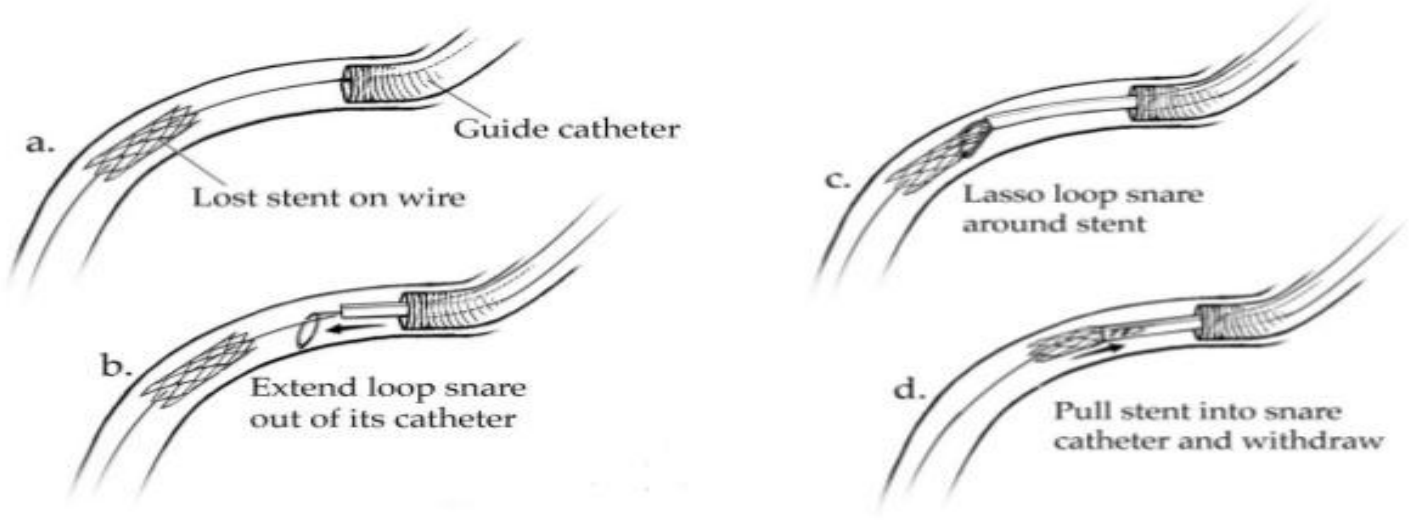
Model No.	Loop Diameter (mm)	Snare Length (cm)	Catheter Size (F)	Catheter Length (cm)
GN500	5	120	4	102
GN1000	10	120	4	102
GN1500	15	120	6	102
GN2000	20	120	6	102
GN2500	25	120	6	102
GN3000	30	120	6	102
GN3500	35	120	6	102

Microsnares: 2,4,7mm loop, 150cm catheters

Ensnare from MERIT MEDICAL

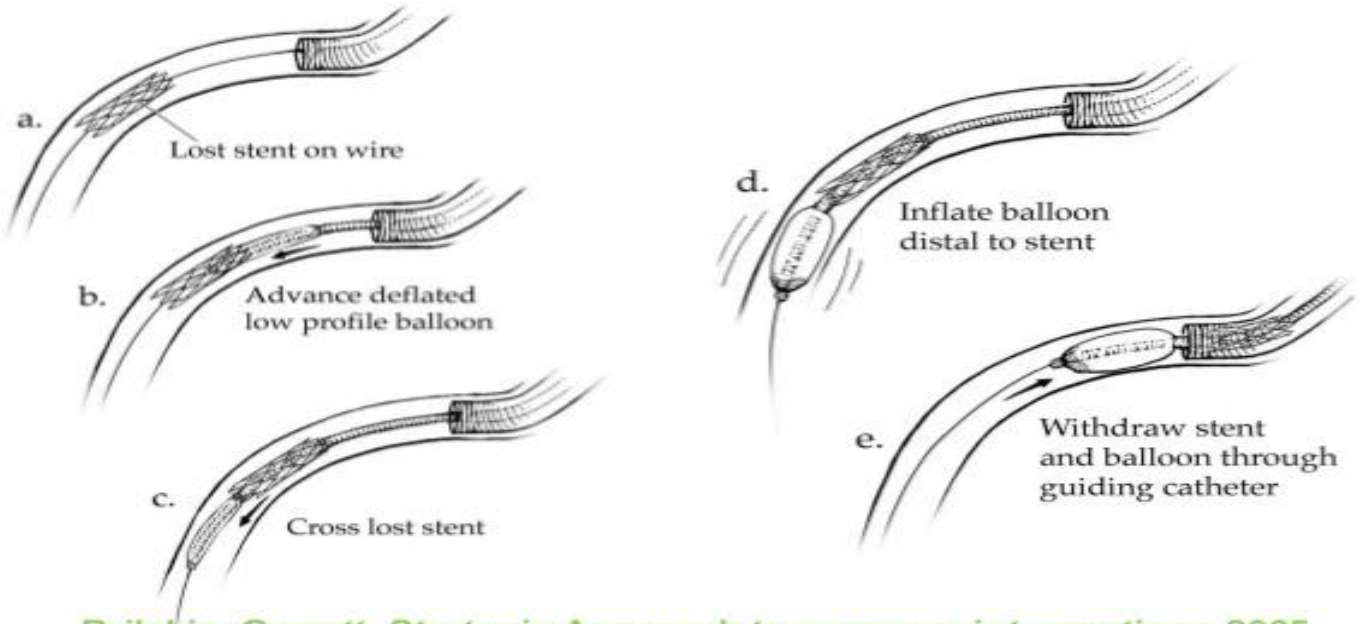
Catalog Number	Working Diameter	Snare Length	French Size	Snare Catheter Length
EN1003004 Mini	2-4mm	175cm	3.2F	150cm
EN1003008 Mini	4-8mm	175cm	3.2F	150cm
EN2006010 Standard	6-10mm	120cm	6F	100cm
EN2006015 Standard	9-15mm	120cm	6F	100cm
EN2006020 Standard	12-20mm	120cm	6F	100cm
EN2007030 Standard	18-30mm	120cm	7F	100cm
EN2007045 Standard	27-45mm	120cm	7F	100cm

Stent retrieval: loop snare



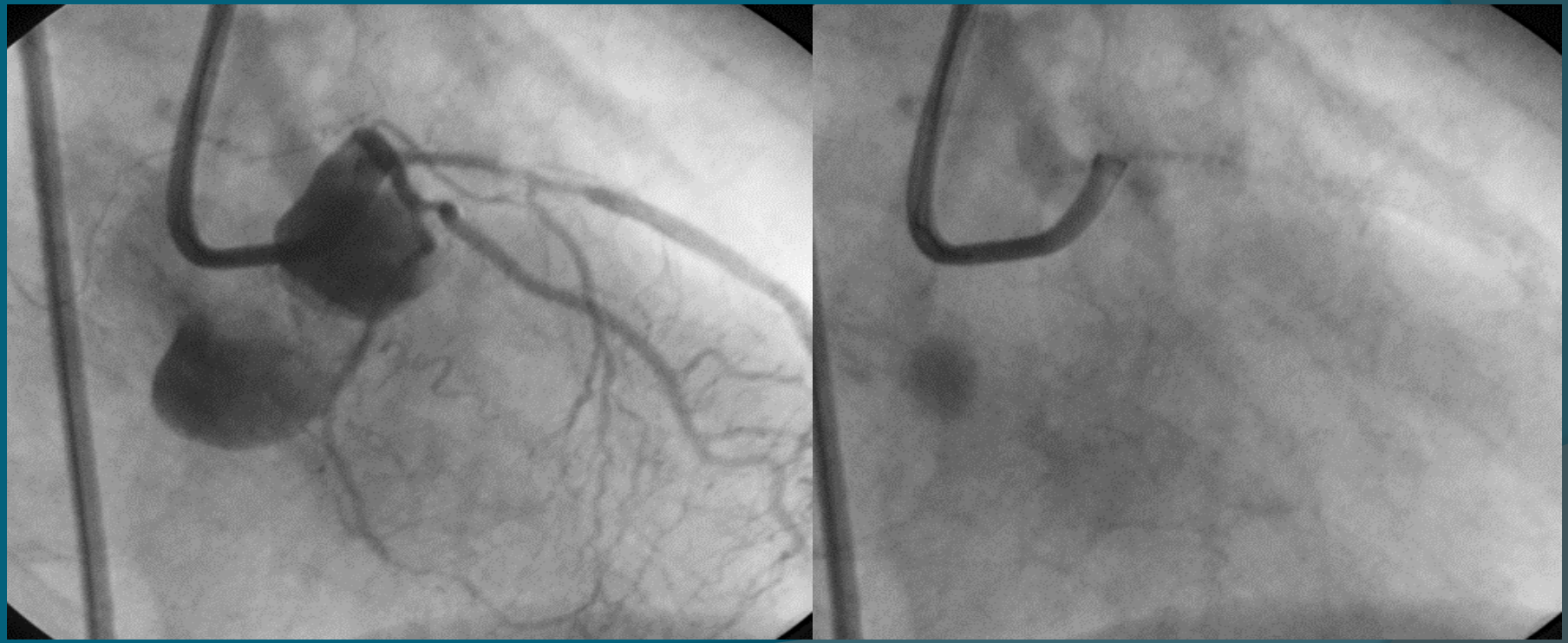
Brilakis, Garratt. Strategic Approach to coronary interventions 2005

Stent retrieval: small balloon technique

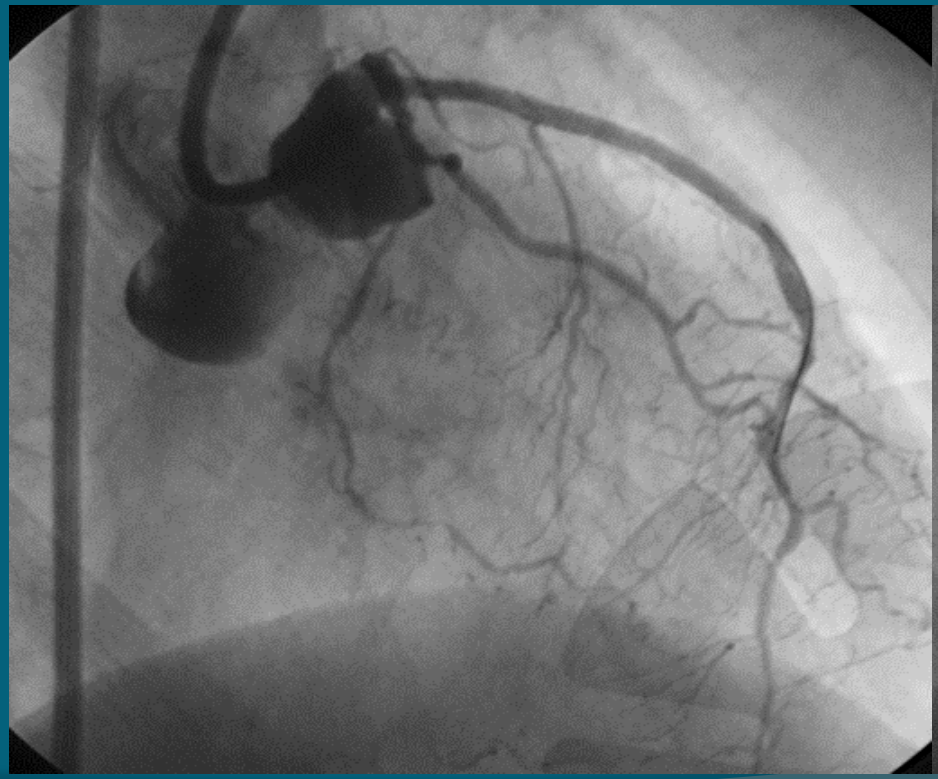


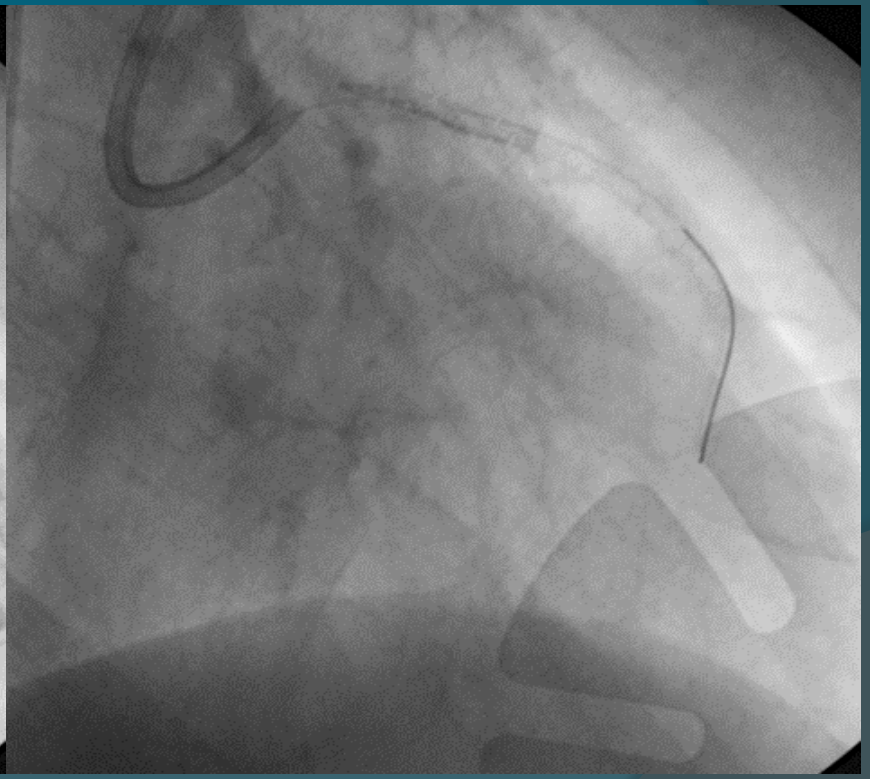
Brilakis, Garratt. Strategic Approach to coronary interventions 2005

Crushed dislodged stent



Crushed dislodged stent





Entrapment of equipment

- Entrapment by stents in bifurcation:
- Jailed GW
- IVUS to side branch
- Rotablation to SB
- Extruded SB stent
- Small balloon to negotiate a passage

- Entrapment along the stent:
- IVUS catheter/ sheath
- Distal protection device

Entrapment of equipments

- Entrapment by coronary calcification especially in tortuous anatomy
- Guidewires
- Balloons: especially after burst
- Microcatheters: e.g. Corsair, Tornus
- Rotablator burr
- Difficult to get in => difficult to get out!

Equipment defects

- Balloon leak/ burst
- Balloon non-deflation
- Fragmentation: wire, balloon/stent shaft

Prevention of complications

- Optimize patient's condition
- Set objectives for the procedure
- Systematic preparation and post-PCI care by protocol
- "Pre-flight" and post-op checklists
- Meticulous intra-operative monitoring
- Study the CAG to estimate the difficulties
- Plan your procedure/ equipment
- Judicious use of contrast
- Plan B
- Learn some salvage techniques

Wisdoms

- Anything that can happen, it will!
- Better is the enemy of good.
- Good judgement comes from experience, and experience comes from bad judgement.

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- Anything that can happen, it will!
- Better is the enemy of good.
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- Good preparation can minimize many unnecessary mistakes.
- Set treatment goal at the start, be realistic!
- To make the most positive gain out of a bad case is to learn from it. To share the learning is even better.