

TCTAP 2021 Virtual

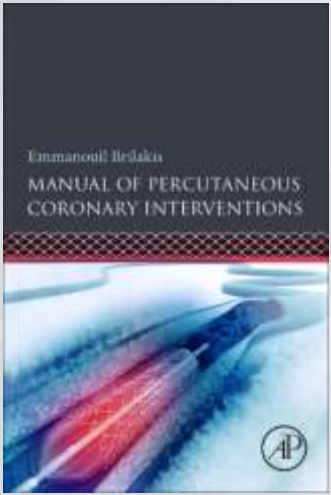
Perforation During CTO-PCI: Mechanism and Management

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Disclosures

- **Consulting/speaker honoraria: Abbott Vascular, American Heart Association (associate editor Circulation), Amgen, Biotronik, Boston Scientific, Cardiovascular Innovations Foundation (Board of Directors), ControlRad, CSI, Ebix, Elsevier, GE Healthcare, InfraRedx, Siemens, Teleflex, Medtronic**
- **Research support: Regeneron, Siemens**
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Acute Complications of PCI

Cardiac

Non-cardiac

Coronary

Non-coronary

Acute vessel closure

1. Dissection
 - Coronary
 - Aortocoronary
2. Thrombosis
3. Embolization
 - Thrombus
 - Plaque
 - Air
4. Side branch occlusion
5. Spasm
6. Pseudolesion
7. Equipment entrapment
8. Intramural hematoma
9. Aortic dissection

Perforation

- main vessel
- distal vessel
- collateral

Equipment loss/entrapment

1. Hypotension
2. Myocardial infarction
3. Arrhythmias
4. Tamponade

1. Vascular access complications
2. Thromboembolic complications
3. Contrast-related complications (nephropathy, allergies)
4. Radiation injury

CTO-ARC perforation classification

Coronary vessel injury resulting in bleeding through the vessel wall

Part 1

Mechanism – location

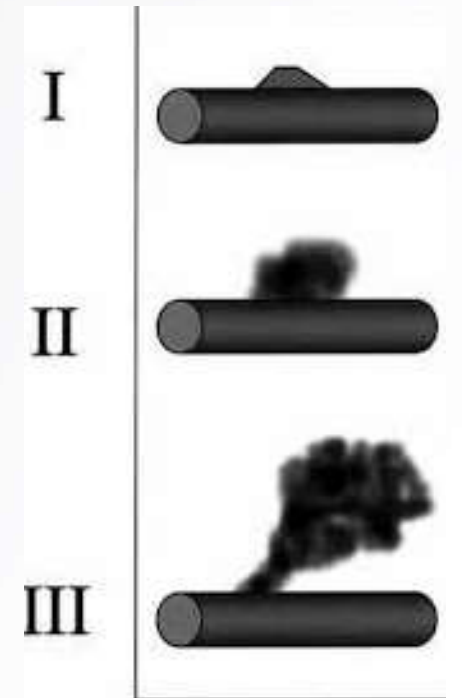
1. Large vessel
2. Distal vessel
3. Collateral septal
4. Collateral epicardial

Part 2

Severity

1. Ellis 1
2. Ellis 2
3. Ellis 3

Ellis 4 – cavity spilling



Ybarra LF et al. Circulation. 2021;143:479–500

Types of coronary perforation mechanism

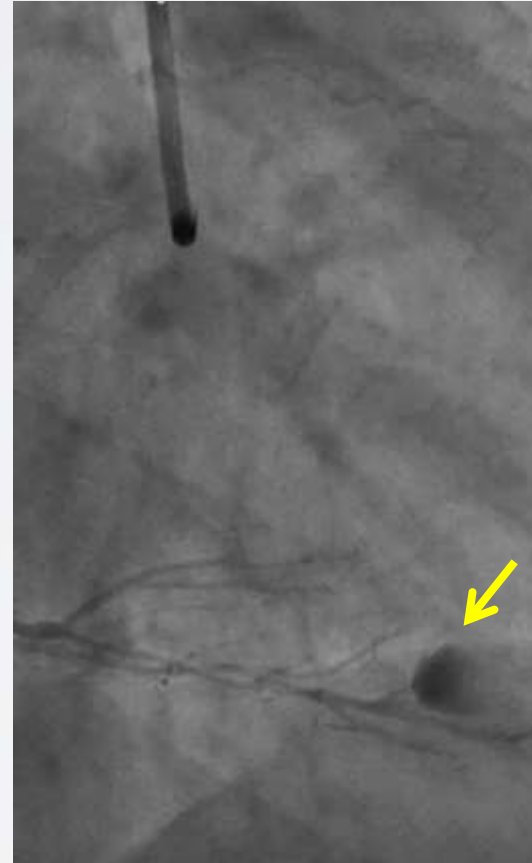
**Large Vessel
perforation**



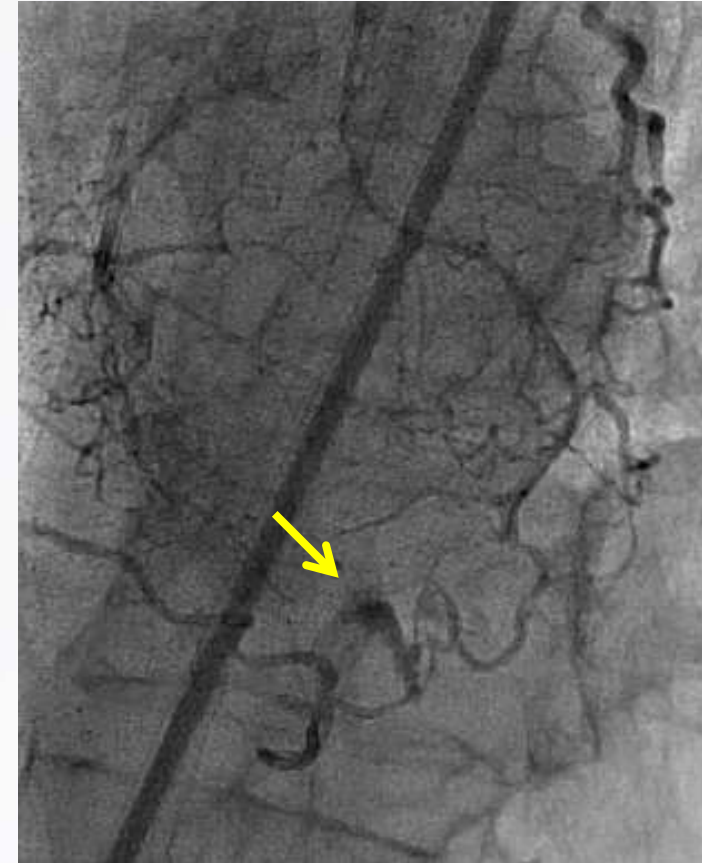
**Distal Vessel
perforation**



**Collateral
perforation
septal**



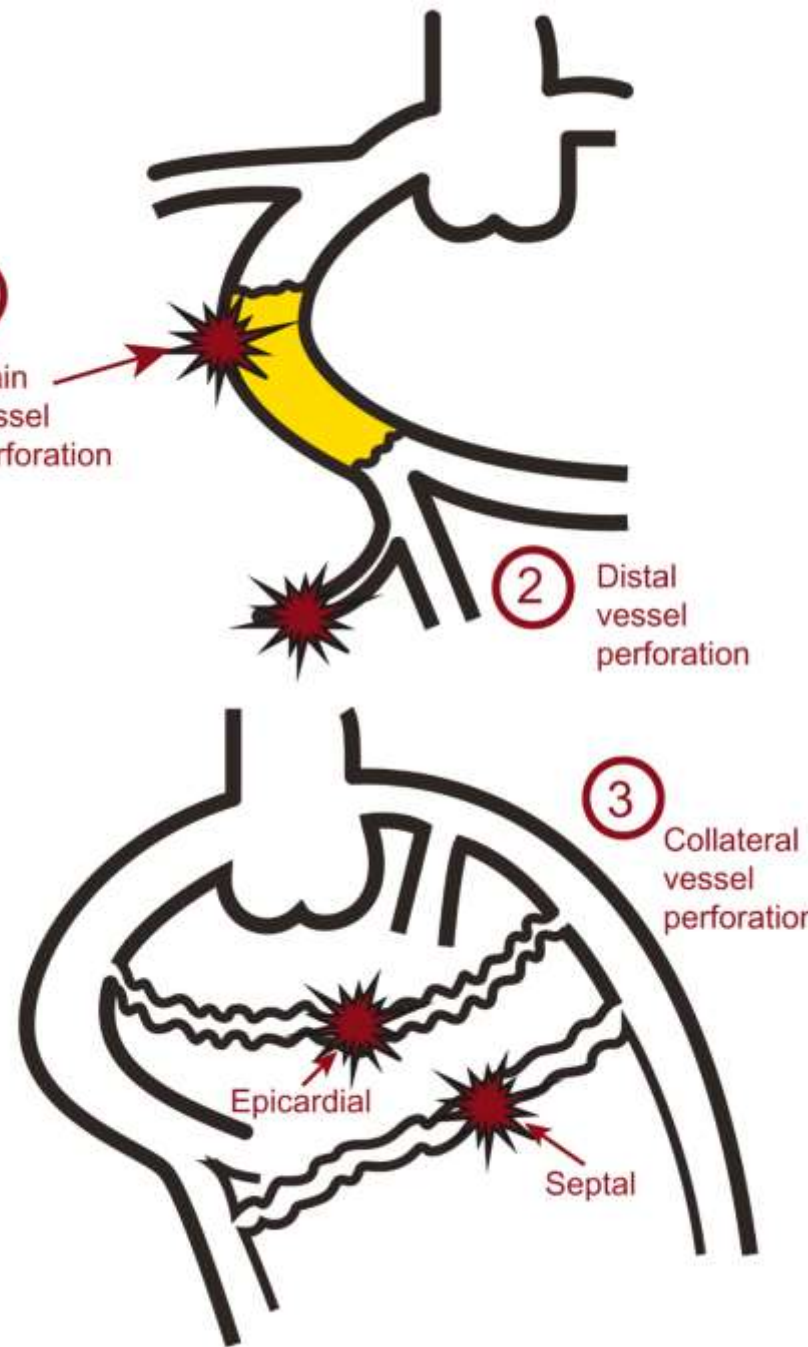
**Collateral perforation
epicardial**



75%

①

Main vessel perforation



②

Distal vessel perforation

③

Collateral vessel perforation

Epicardial

Septal

25%

Large vessel perforation

Causes

1. Oversized stents/balloons
2. High pressure inflations
3. Severe calcification
4. Balloon rupture
5. Atherectomy
6. Wire + microcatheter/balloon exit

Treatment

1. Prolonged balloon inflation
 - Block+deliver
 - Ping pong guide
2. Covered stent
3. Dissection techniques
4. Surgery

1. Inflate balloon to occlude vessel

2. Intravenous fluids / vasopressors

**3. Pericardiocentesis if hypotension –
? autotransfusion**

4. Notify surgeons

**“Universal” Algorithm for
Coronary Perforations**

Persistent extravasation?

no

Monitor patient

yes

Treat the cause

Large vessel perforation

- 1. Covered stent**
- 2. Prolonged balloon inflations**
- 3. Dissection techniques**

Distal vessel perforation

- 1. Embolization (fat, coils, etc)**
- 2. Covered stent over perforated branch origin**

**Type-specific
Treatment**

Continued extravasation?

yes

Reverse anticoagulation

failure

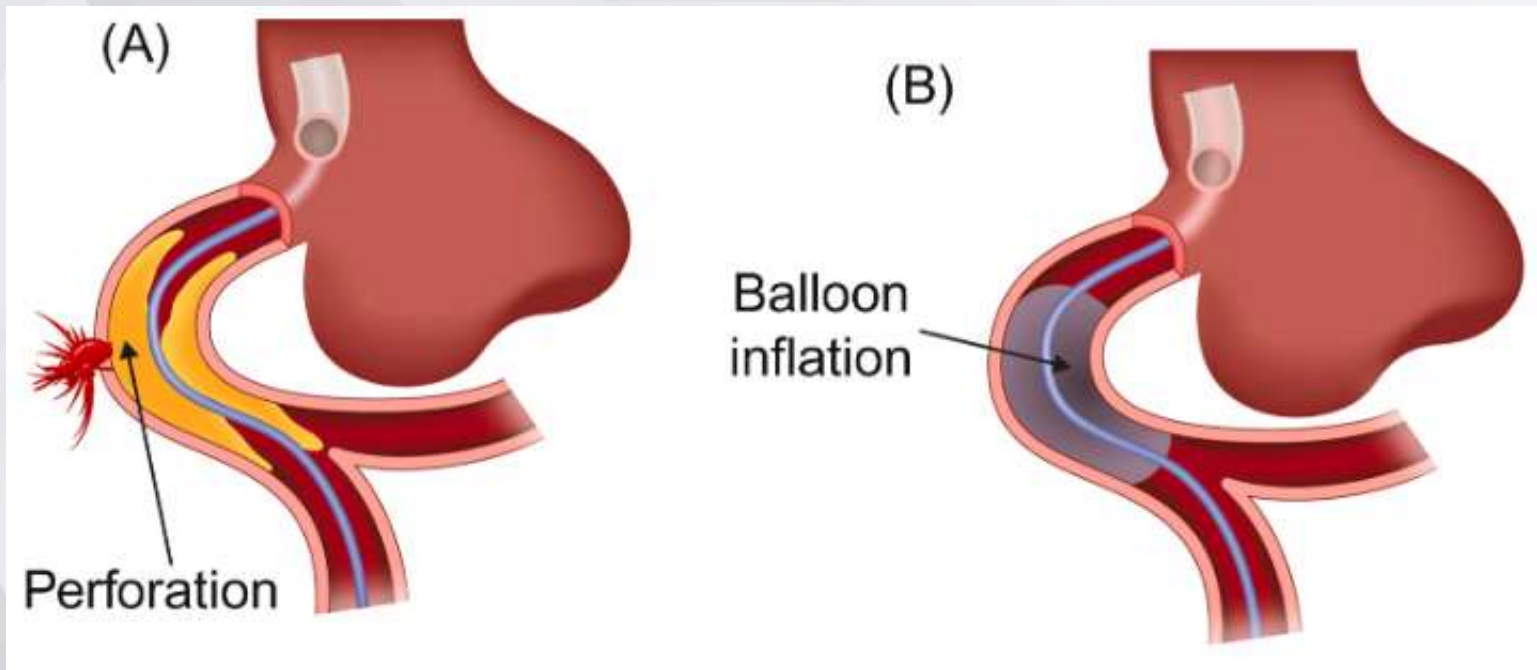
Surgery

1. Inflate balloon to occlude vessel

IMMEDIATELY!!!



“Universal” Algorithm for Coronary Perforations



1. Inflate balloon to occlude vessel

2. Intravenous fluids / vasopressors

**“Universal” Algorithm for
Coronary Perforations**

**Type-specific
Treatment**

Medication classes

1. Sedatives - Analgesics
2. Vasodilators
3. Contrast media
4. Anticoagulants
5. Antiplatelets
6. Vasopressors - Inotropes
7. Antiarrhythmics

- **Pure vasopressors**

Phenylephrine

50–100 mcg IV bolus

infusion at 0.5–1.4 mcg/kg/min

Vasopressin

0.03 – 0.1 U/min IV infusion

- **Vasopressors/inotropes**

Norepinephrine (Levophed)

0.1–0.5 mcg/kg/min IV infusion

Dopamine

10–20 mcg/kg/min

1. Inflate balloon to occlude vessel

2. Intravenous fluids / vasopressors

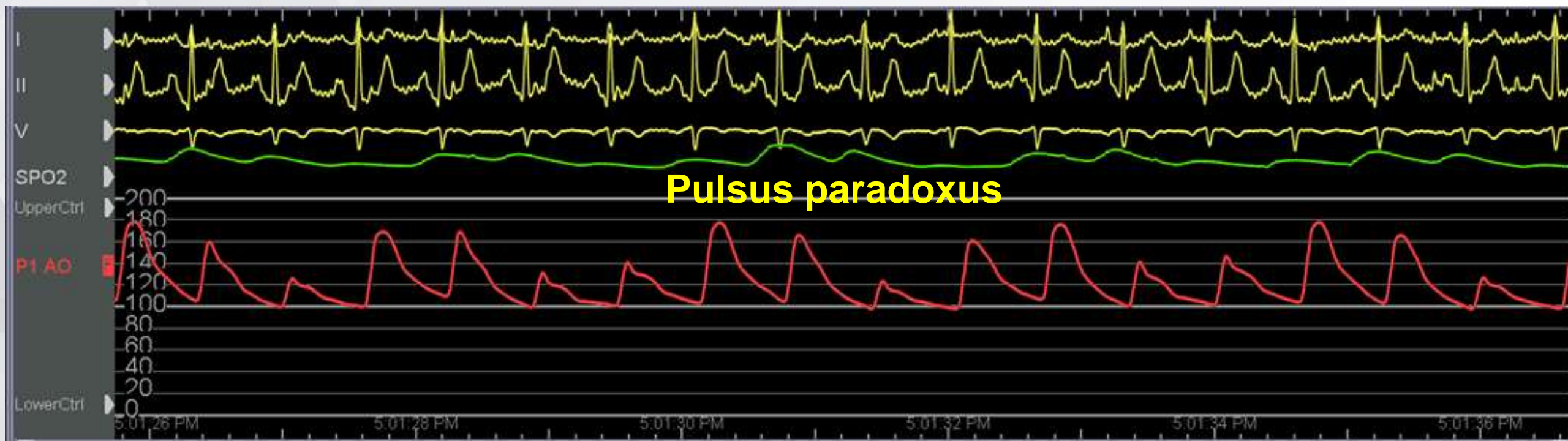
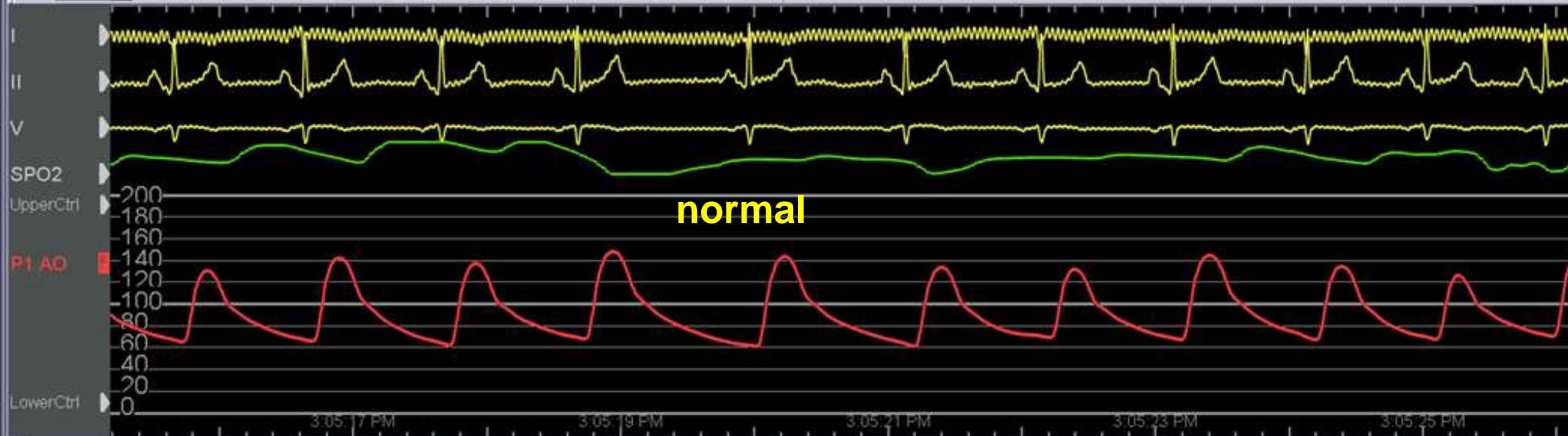
**3. Pericardiocentesis if hypotension –
? autotransfusion**



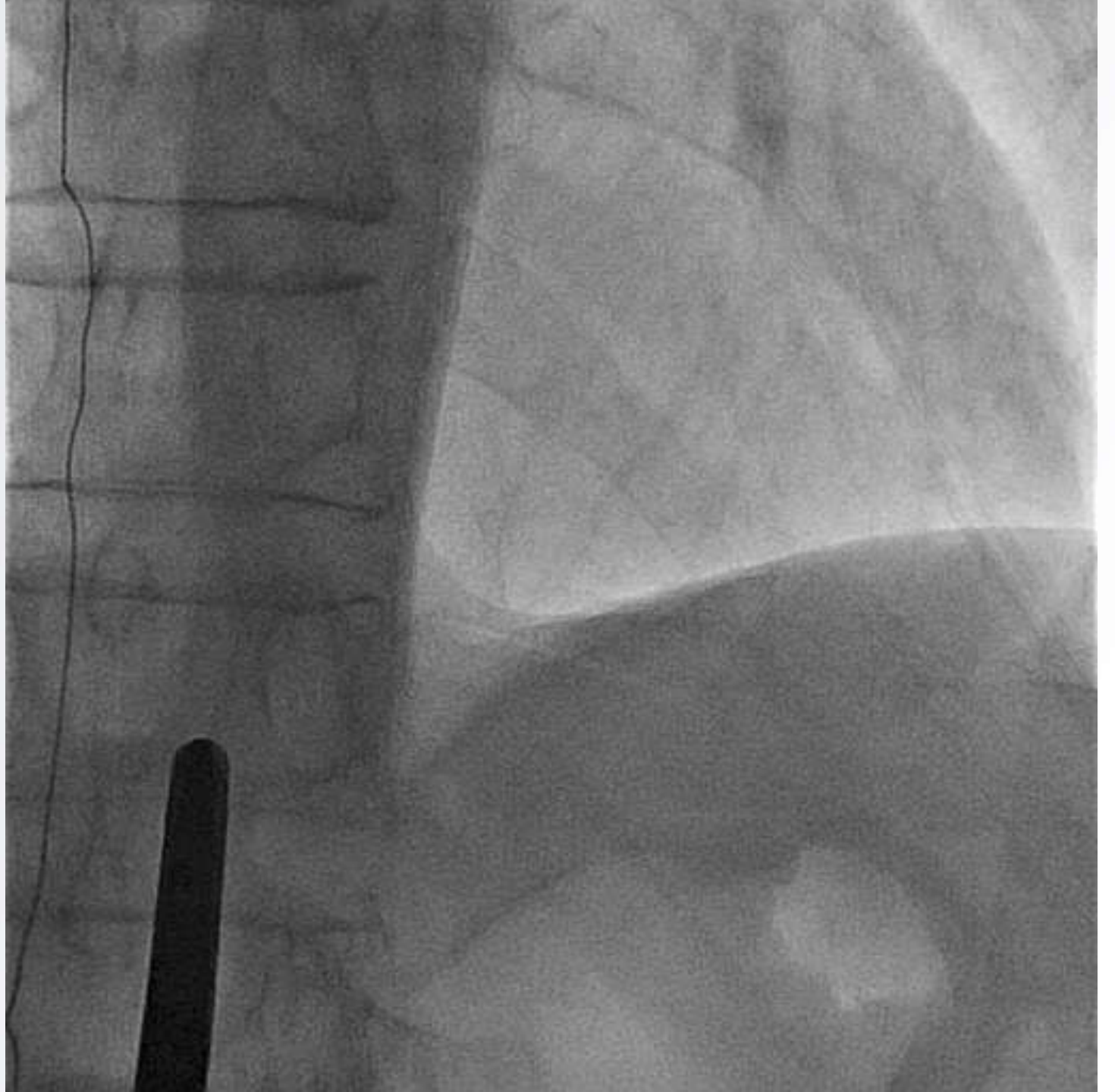
**“Universal” Algorithm for
Coronary Perforations**



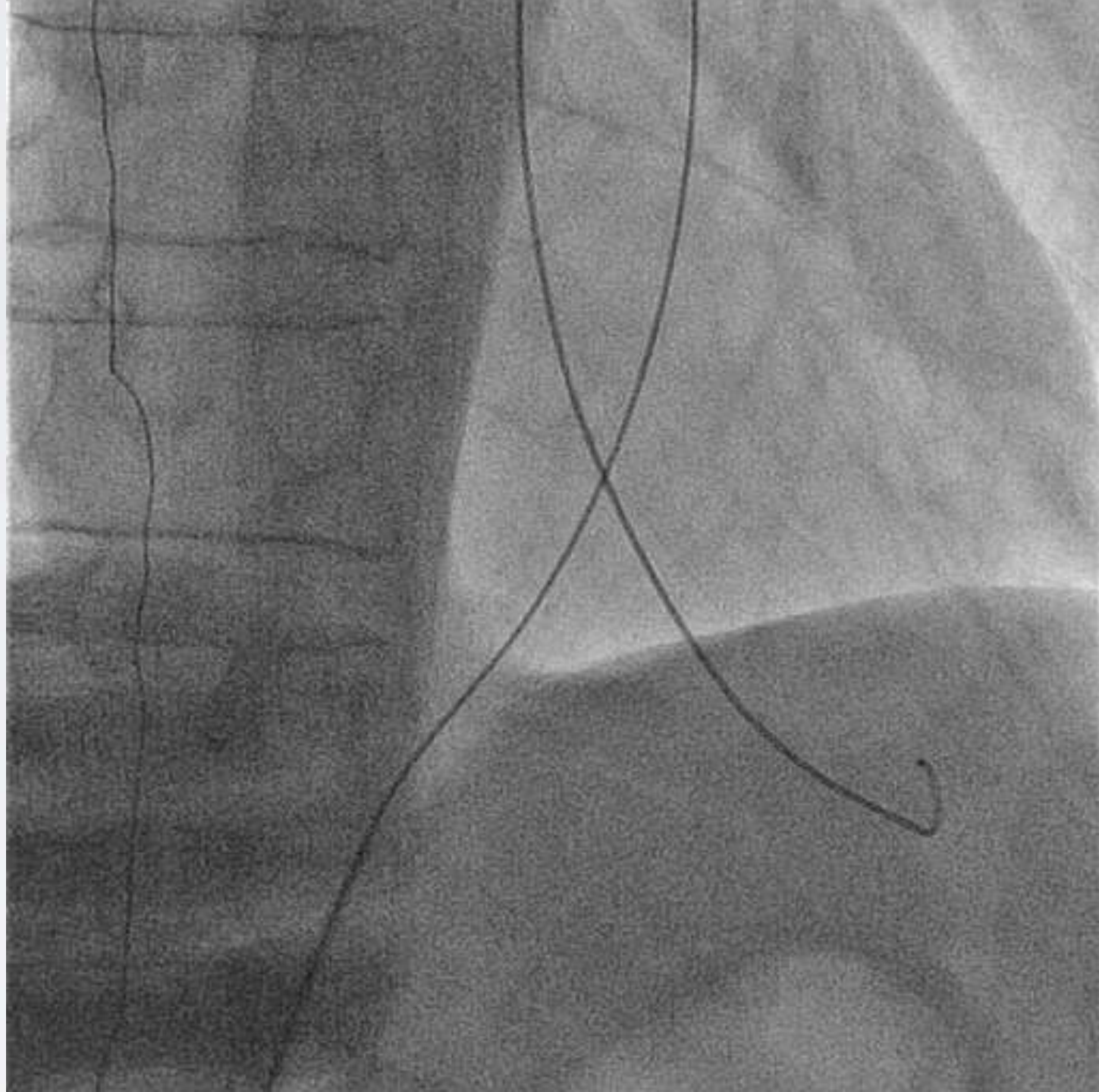
**Type-specific
Treatment**



Fluoroscopy-guided pericardiocentesis



Tapping the effusion



1. Inflate balloon to occlude vessel

2. Intravenous fluids / vasopressors

**3. Pericardiocentesis if hypotension –
? autotransfusion**

4. Notify surgeons

**“Universal” Algorithm for
Coronary Perforations**

**Type-specific
Treatment**

1. Inflate balloon to occlude vessel

2. Intravenous fluids / vasopressors

**3. Pericardiocentesis if hypotension –
? autotransfusion**

4. Notify surgeons

**“Universal” Algorithm for
Coronary Perforations**

Persistent extravasation?

no

Monitor patient

yes

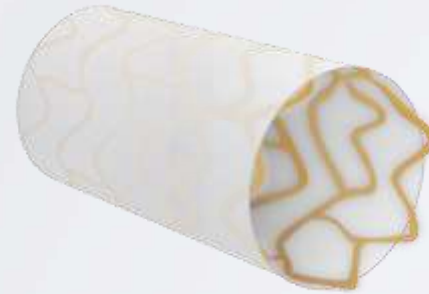
Treat the cause

Large vessel perforation

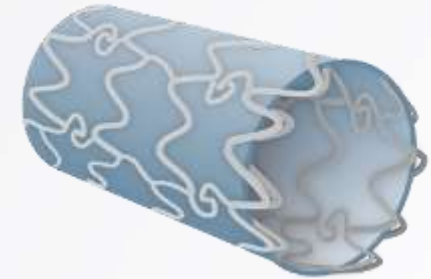
- 1. Covered stent**
- 2. Prolonged balloon inflations**
- 3. Dissection techniques**

**Type-specific
Treatment**

FDA approved covered stents



PK Papyrus



GRAFTMASTER

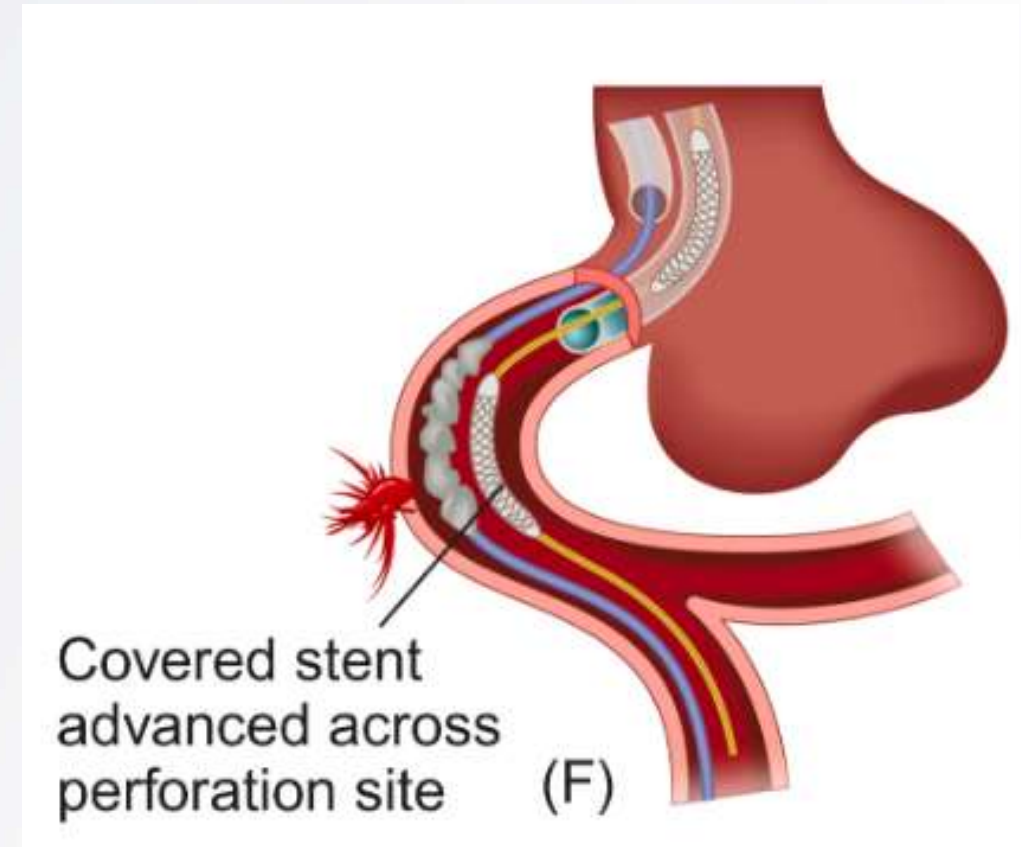
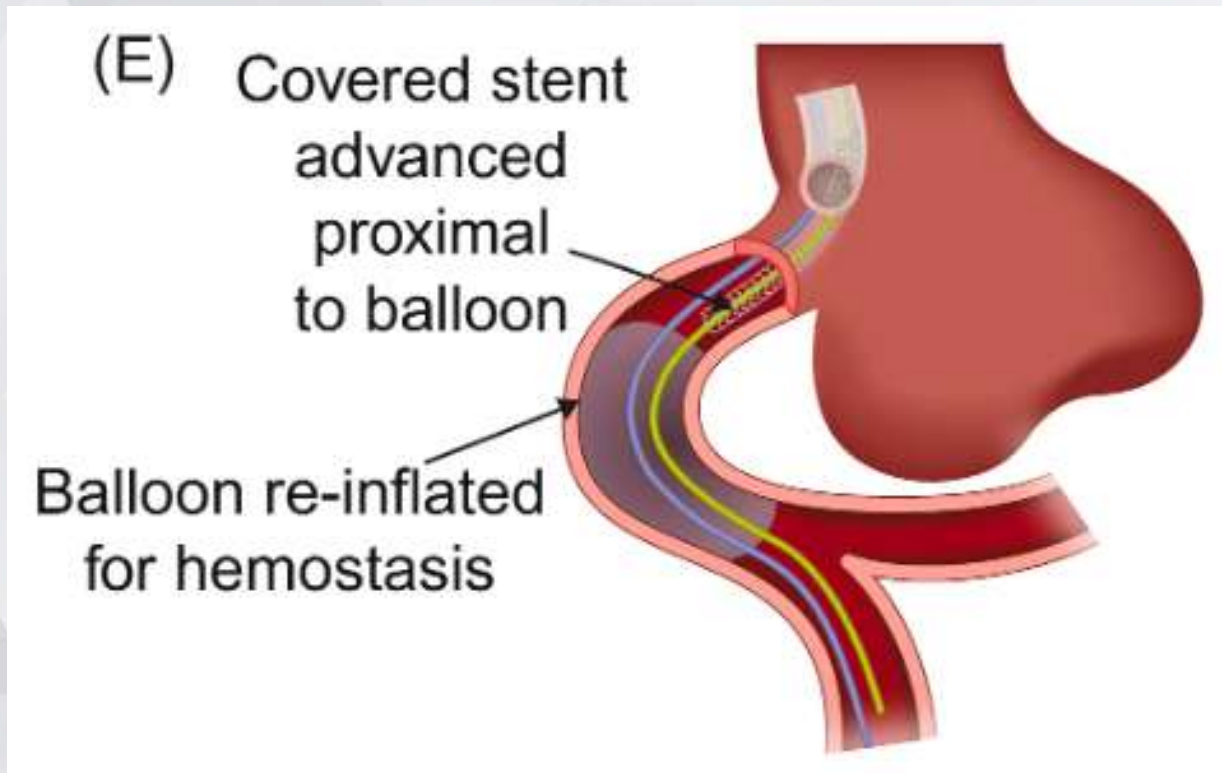


		Single Stent Design	Sandwich Stent Design
Cover material		Polyurethane	ePTFE
Guide catheter		5F	6F
Available sizes (mm)	Length	15, 20, 26	16, 19, 26
	Diameter	2.5, 3.0, 3.5, 4.0, 4.5, 5.0 (6 French)	2.8, 3.5, 4.0, 4.5, 4.8 (7 French)

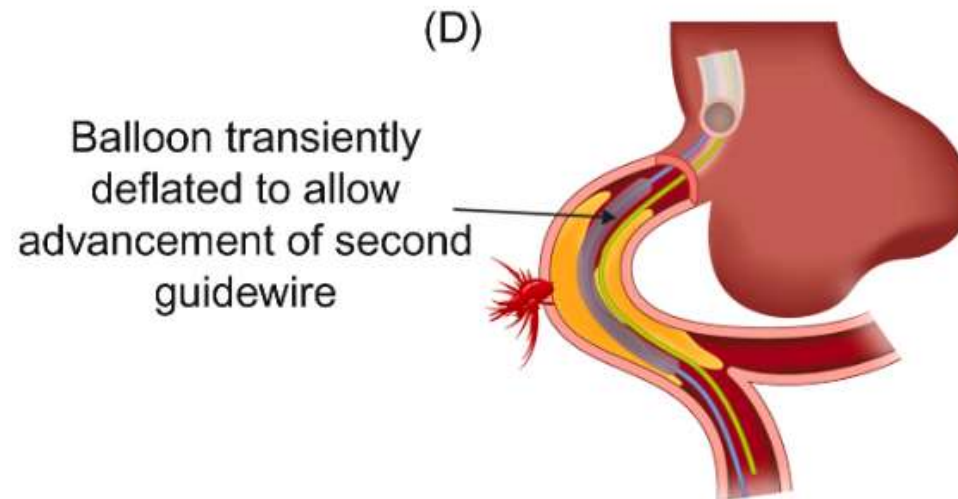
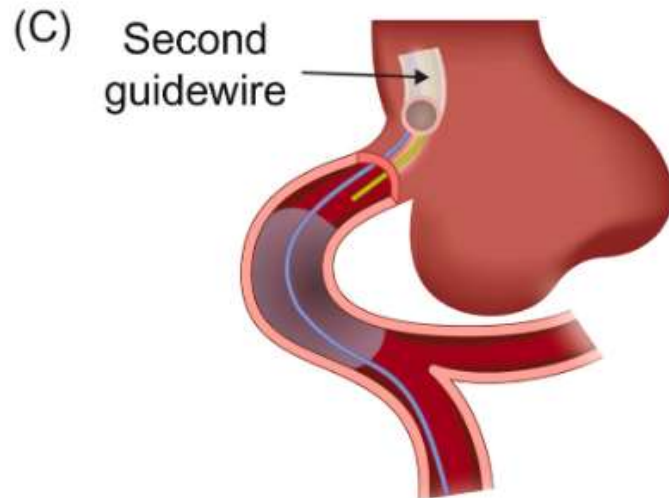
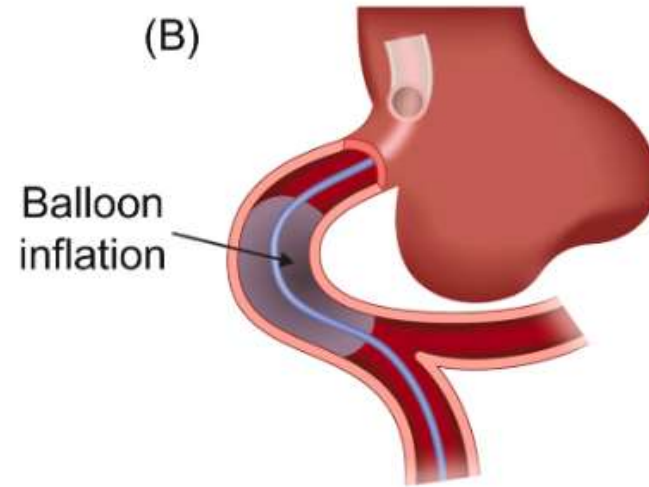
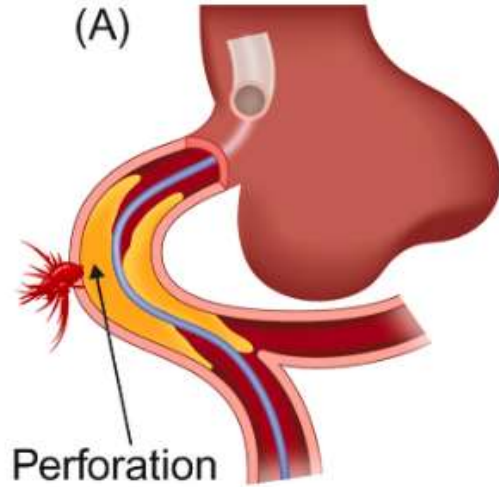
Covered stent delivery

**Block and deliver
(single guide)**

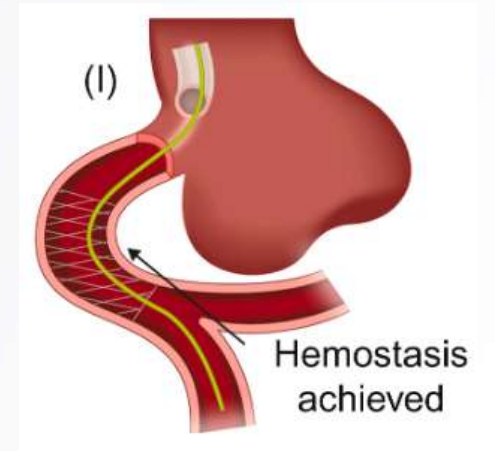
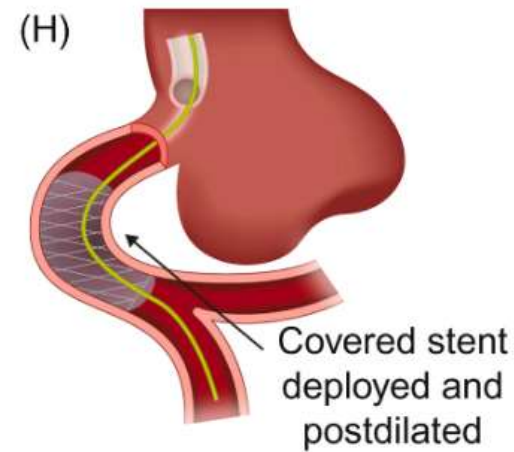
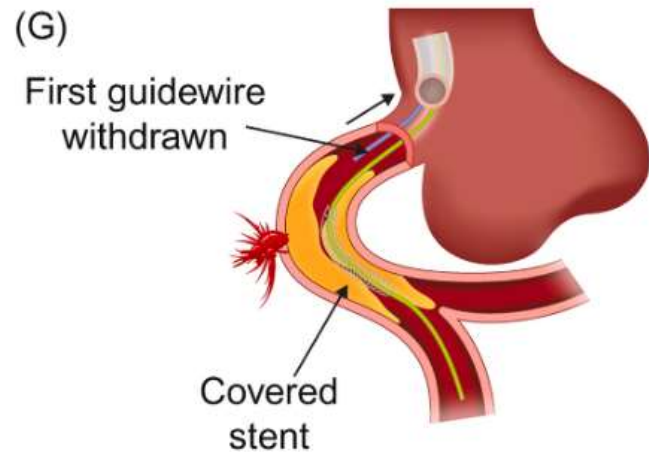
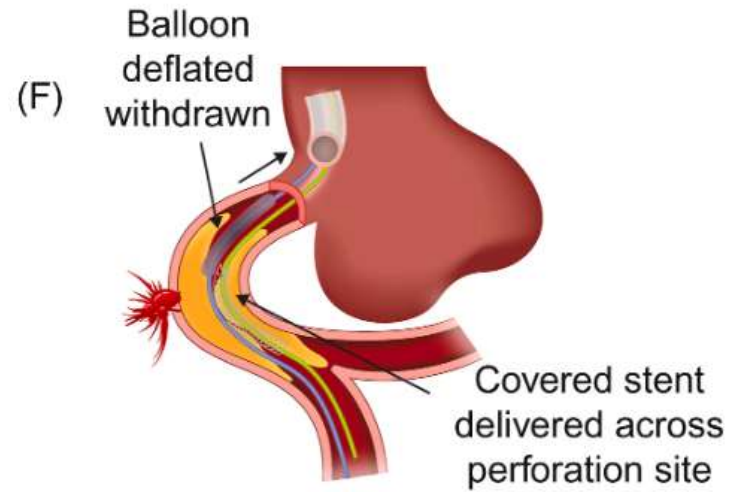
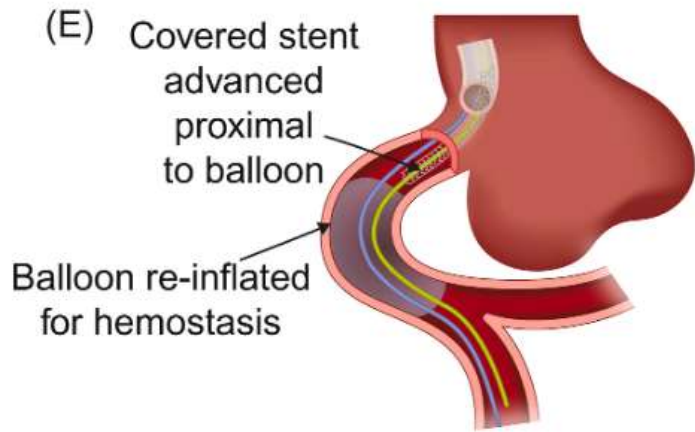
**Ping pong guide
(2 guides)**



Block and delivery – single guide part 1

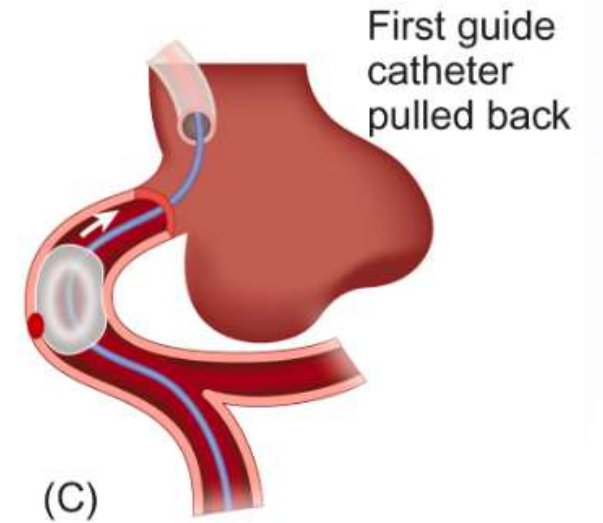
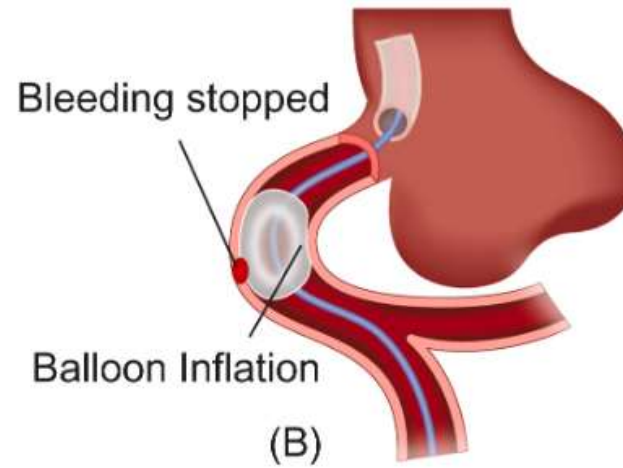
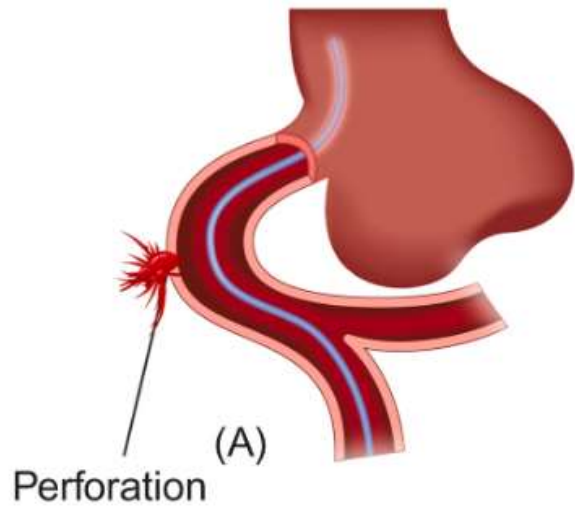


Block and delivery – single guide part 2

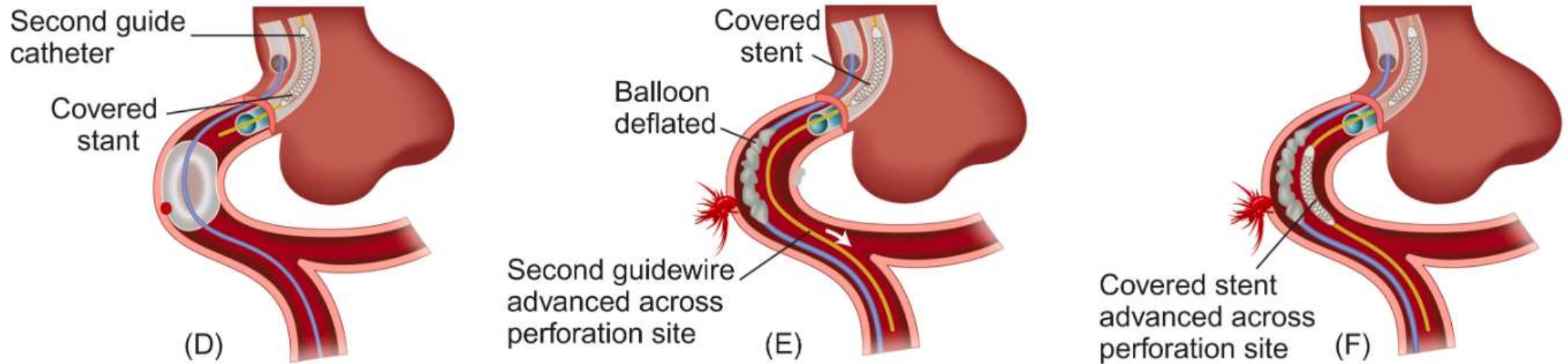


Ping pong – 2 guides part 1

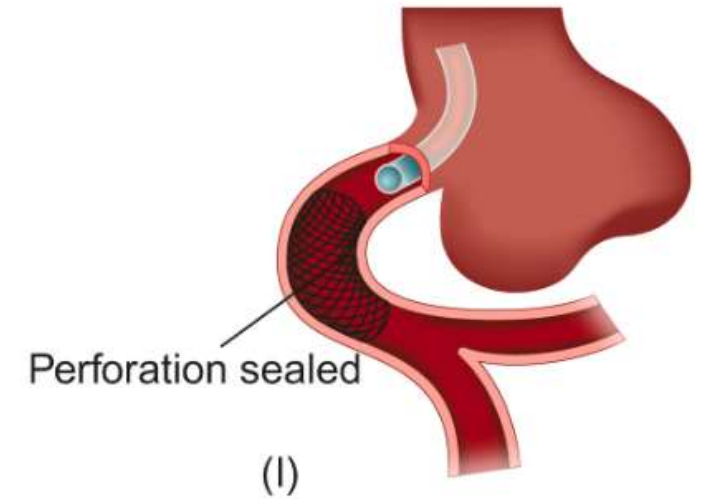
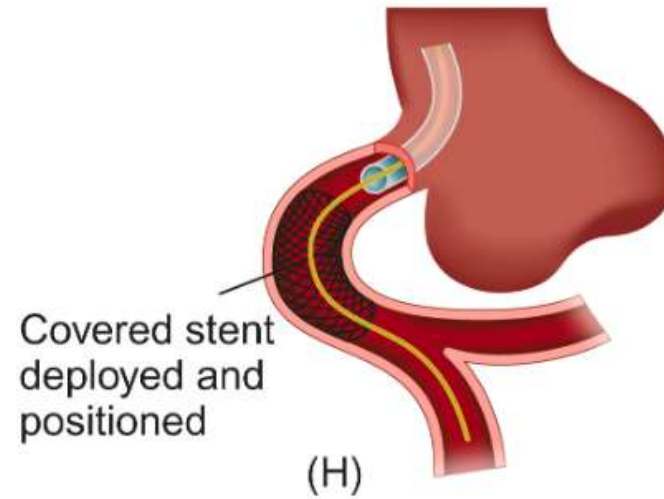
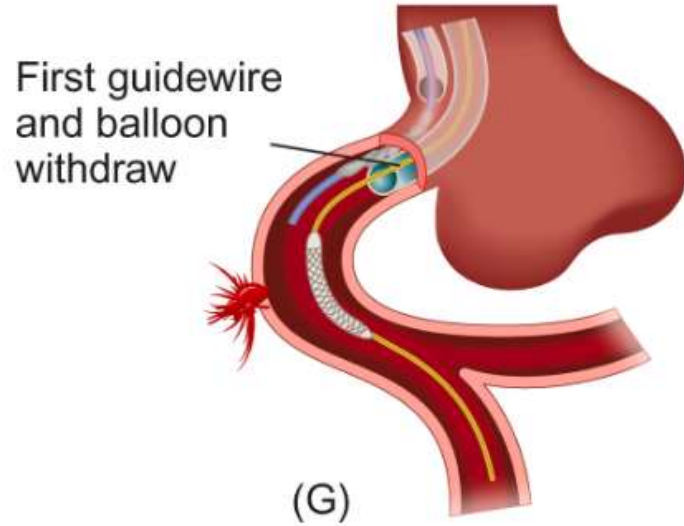
Dual guide technique for covered stent



Ping pong – 2 guides part 2



Ping pong – 2 guides part 3



1. Inflate balloon to occlude vessel

2. Intravenous fluids / vasopressors

**3. Pericardiocentesis if hypotension –
? autotransfusion**

4. Notify surgeons

**“Universal” Algorithm for
Coronary Perforations**

Persistent extravasation?

no

Monitor patient

yes

Treat the cause

Distal vessel perforation

- 1. Embolization (fat, coils, etc)**
- 2. Covered stent over perforated branch origin**

**Type-specific
Treatment**

Small vessel perforation

Causes

1. Advancement of guidewire, balloon, microcatheter into distal small branch
2. Collimation
3. Stiff, polymer-jacketed wires have higher risk

Prevention

1. Meticulous attention to distal guidewire position
2. Use workhorse wires for equipment delivery
3. Trapping technique

Small vessel perforation treatment

1. Balloon inflation - ? Suction

2. Embolization

- Fat
- Coils
- Other (gelfoam, thrombus, etc)

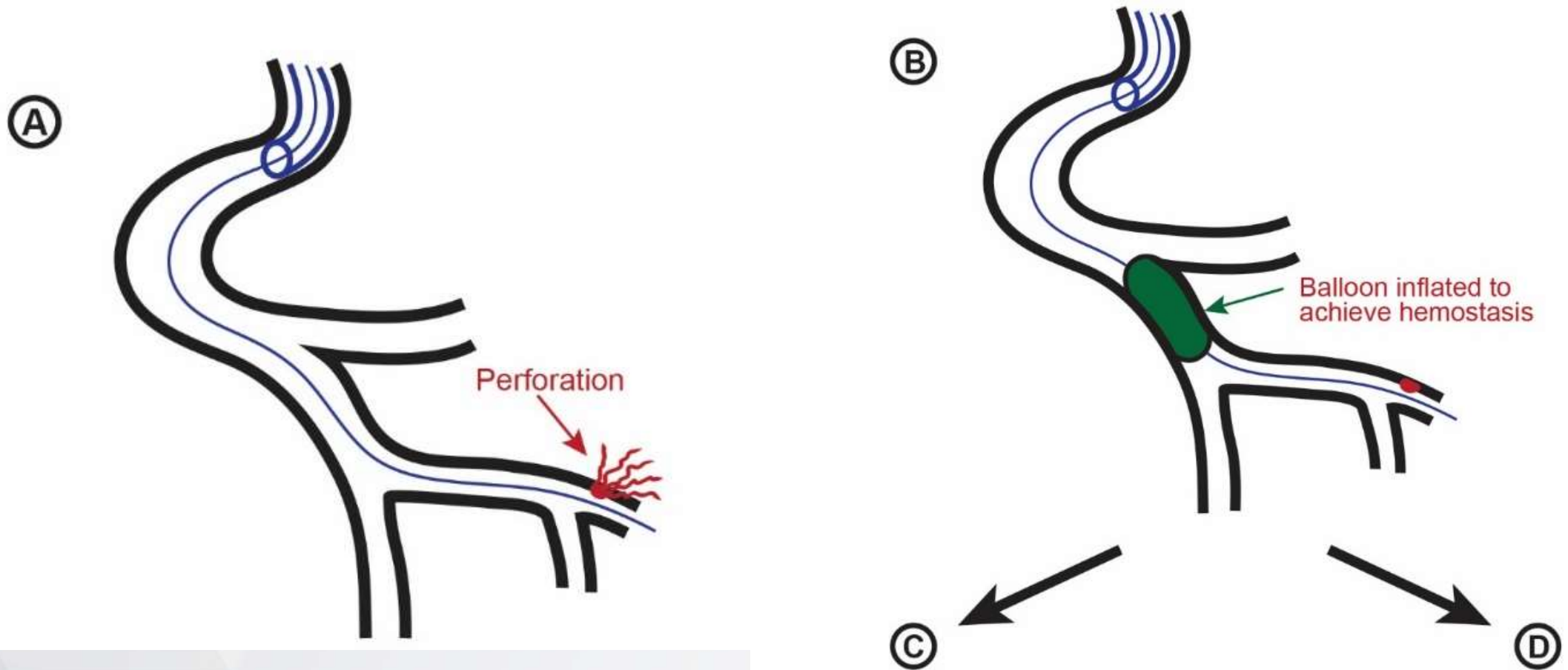
3. Covered stent across origin of perforated branch

4. Surgery

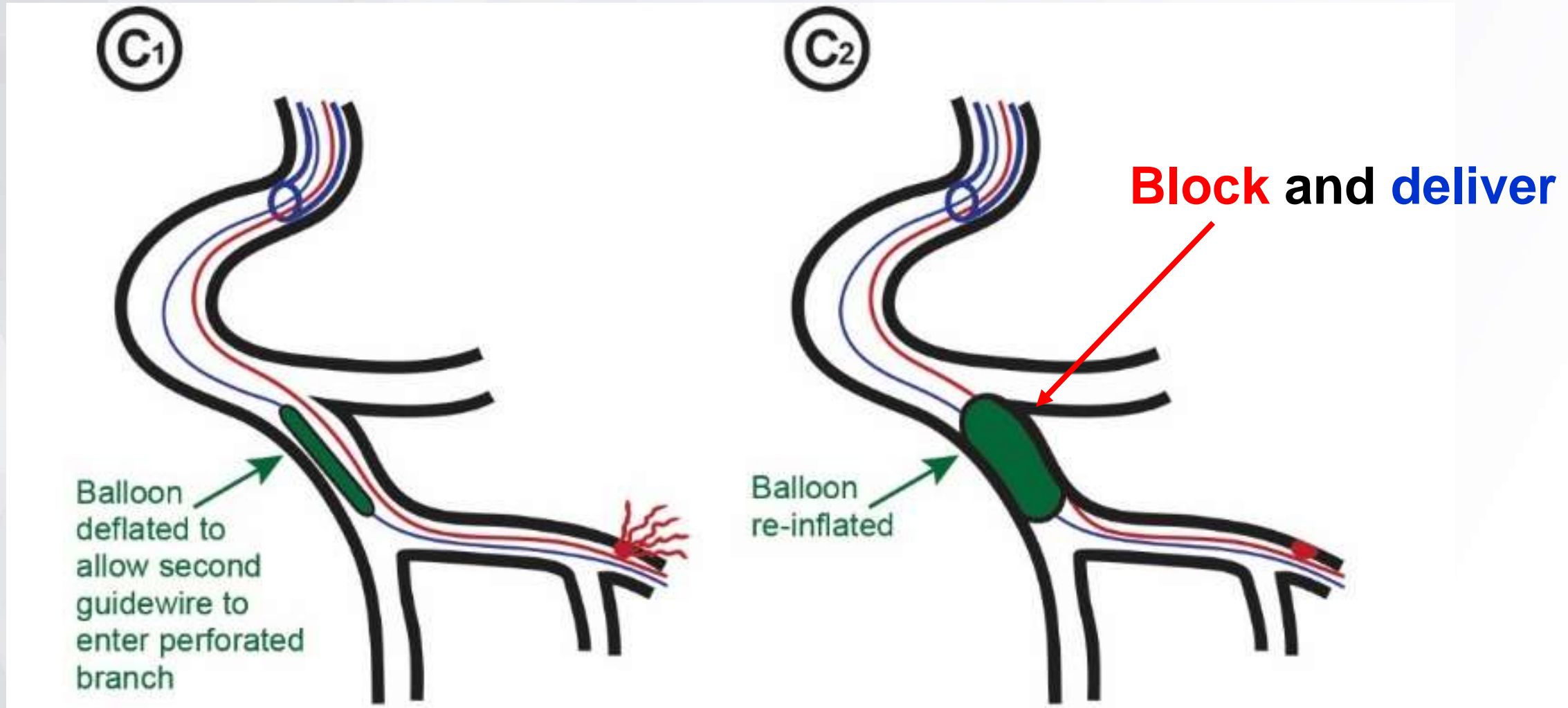
Coil vs. fat embolization

	Fat	Coil
Visibility	0	+
Controlled delivery	0	+
Catheter needed for delivery	Any microcatheter	Larger microcatheter*
Availability	Universal	Often limited
Cost	0	High

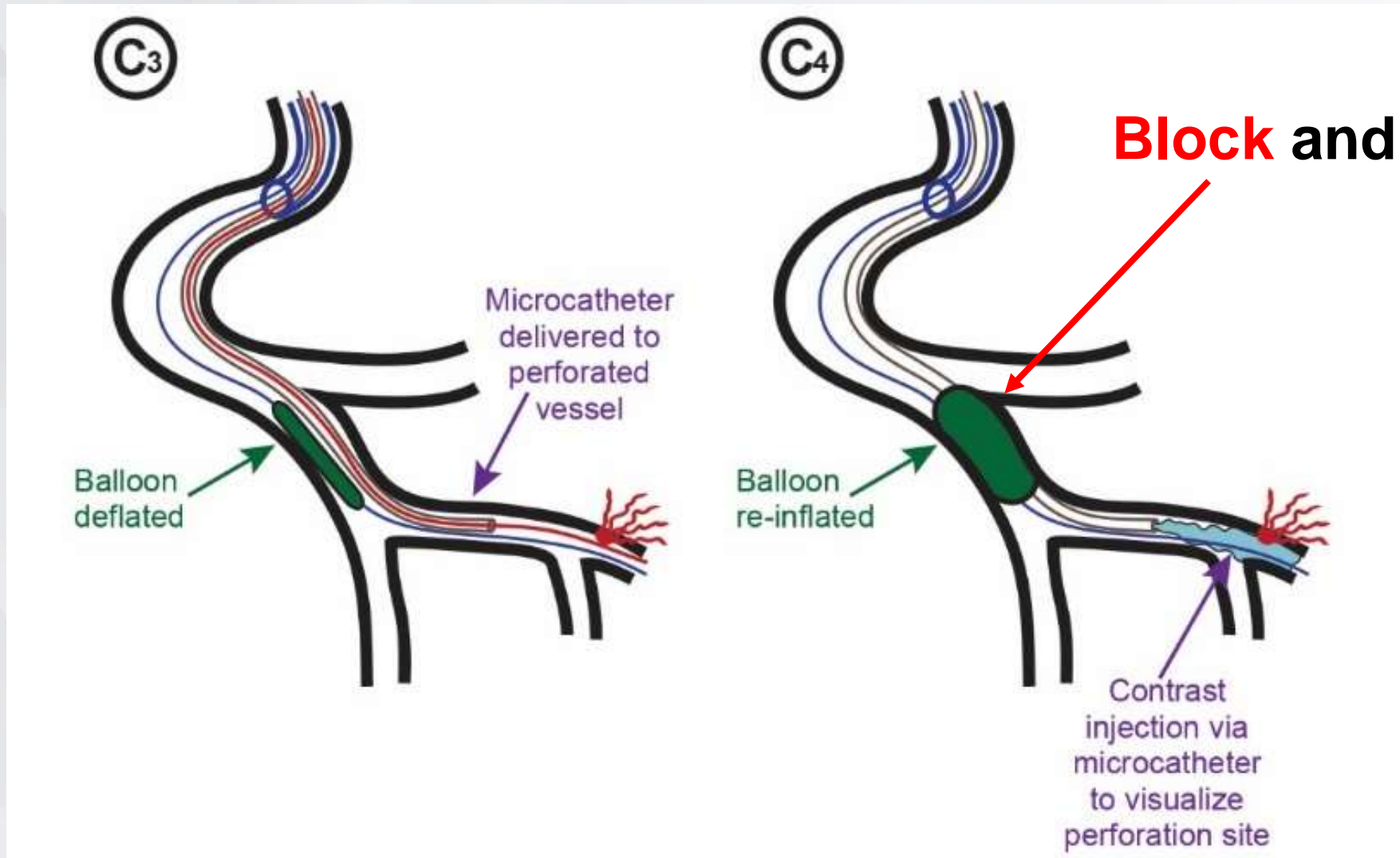
Embolization – part 1



Embolization – part 2

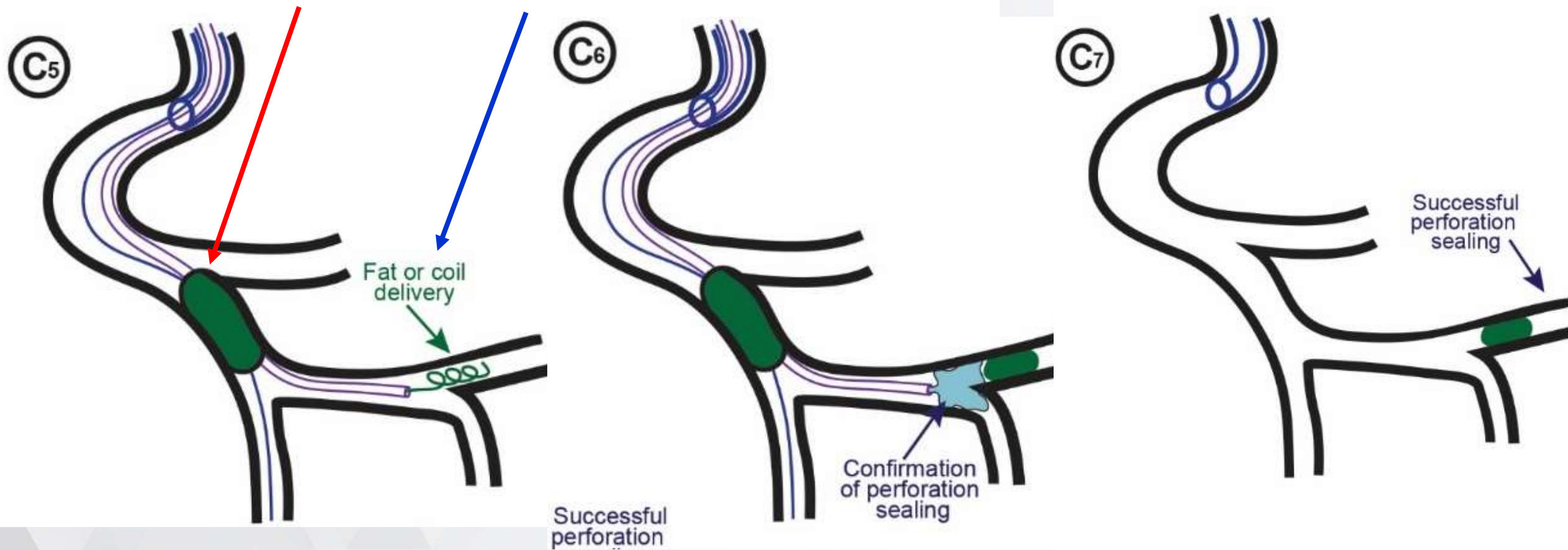


Embolization – part 3



Embolization – part 4

Block and deliver



TIP
Fat floats!



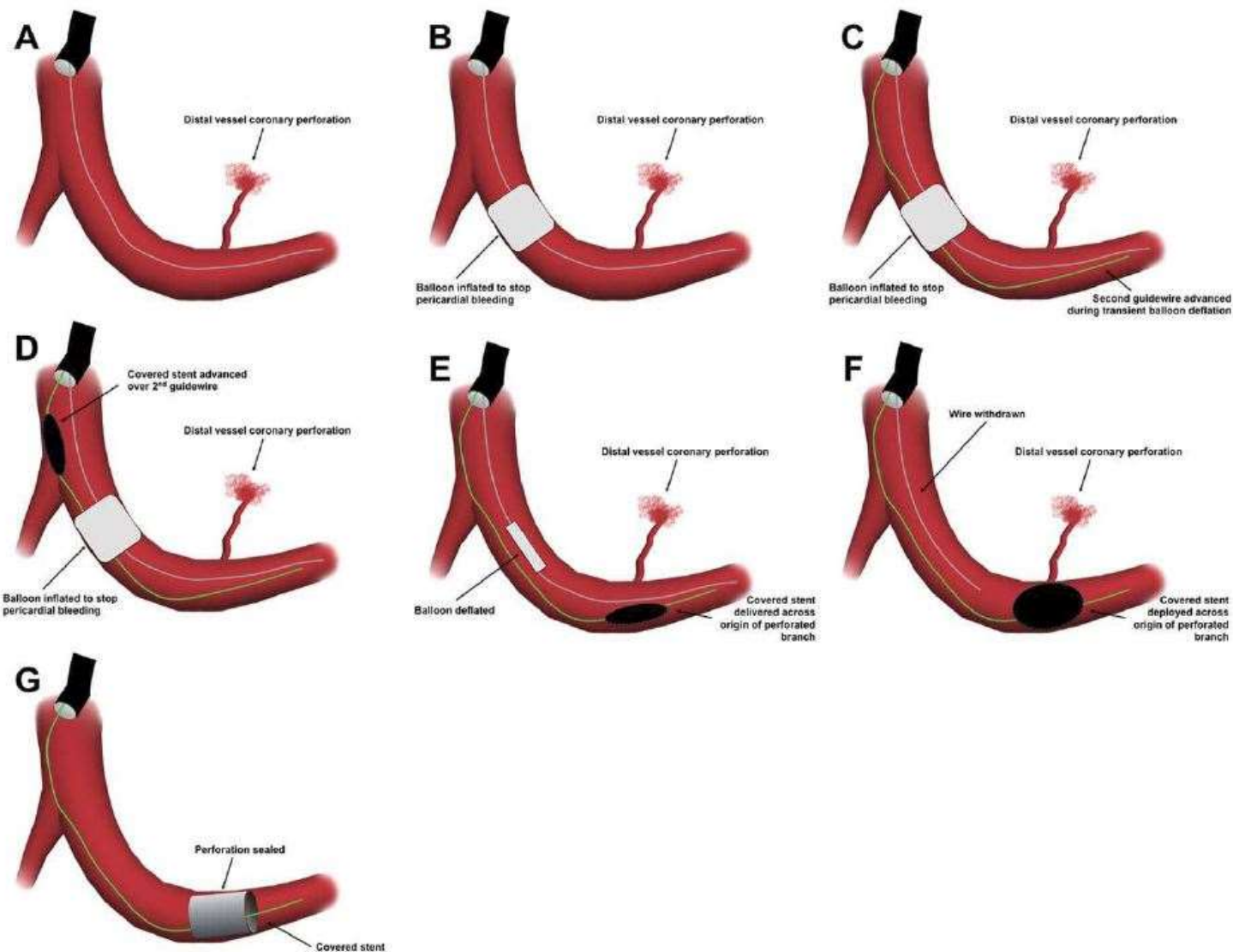
Case Report

Covered Stent Implantation Through a Single 8-French Guide Catheter for the Management of a Distal Coronary Perforation

Yader Sandoval,^{1,2} MD, Angie S. Lobo,³ MD, and Emmanouil S. Brilakis,^{2*} MD, PhD

Distal coronary perforation can cause early or late tamponade and is usually treated with fat or coil embolization. An alternative treatment strategy is occlusion of the ostium of the perforated vessel via implantation of a covered stent in the main vessel, which is typically achieved using the ping-pong guide catheter technique. In this technique, a balloon is inflated over one guide catheter to stop pericardial bleeding and a covered stent is delivered through a second guide catheter due to inability to fit both a balloon and a covered stent through a single guide catheter. With development of lower profile rapid exchange covered stents, a single guide catheter can be used to both occlude the target vessel and deliver the covered stent. We describe a case of distal vessel perforation in which a balloon was inflated to stop pericardial bleeding, followed by delivery of a covered stent (Graftmaster, Abbott Vascular) through a single 8-Fr guide catheter. This "block and deliver" technique represents a novel paradigm for treating coronary perforations through a single guide catheter, obviating the need for the ping-pong guide catheter technique. © 2017 Wiley Periodicals, Inc.

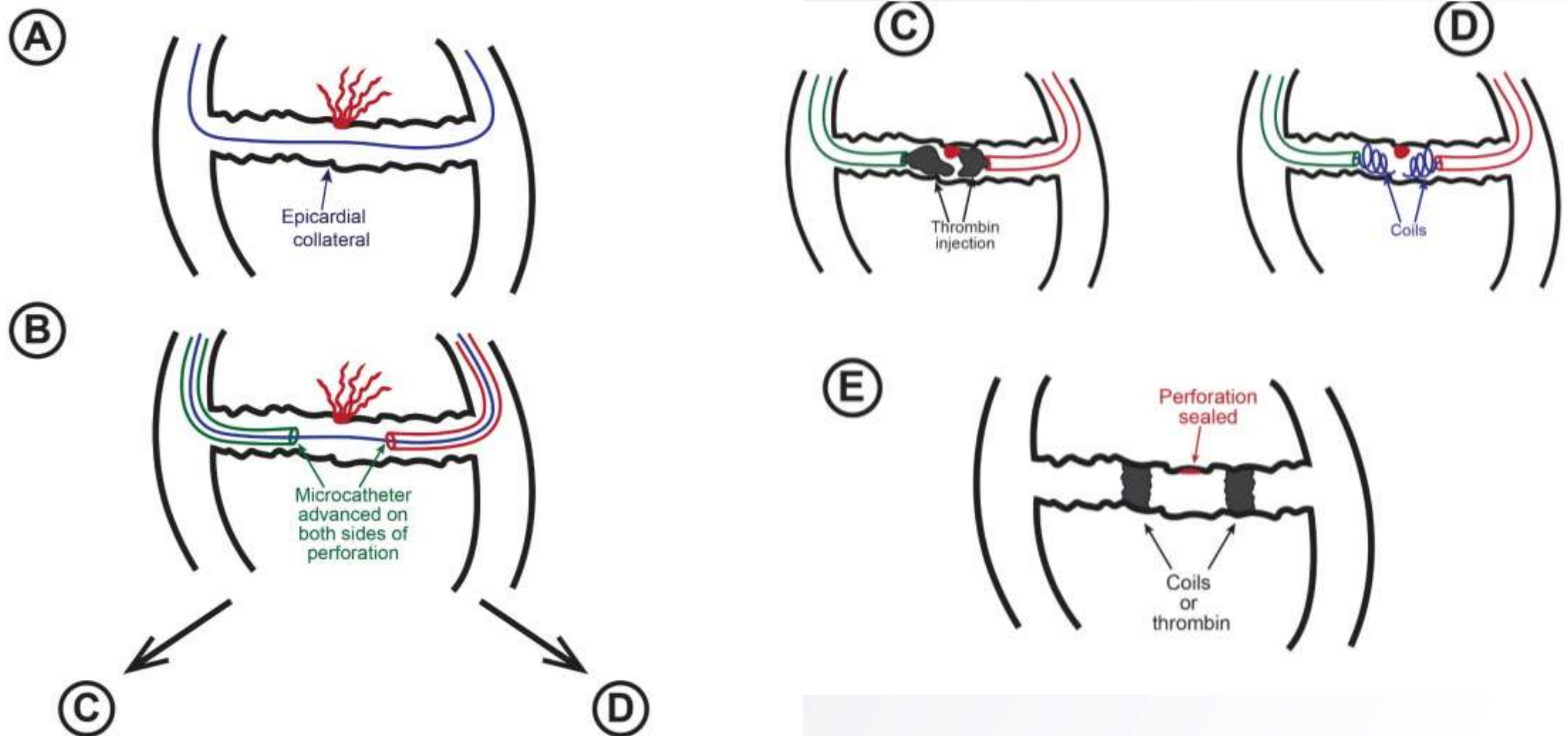
Key words: perforation; complications; percutaneous coronary intervention



Septal collateral perforation



Sealing an epicardial collateral perforation



Thrombin Injection for Sealing Epicardial Collateral Perforation During Chronic Total Occlusion Percutaneous Coronary Interventions

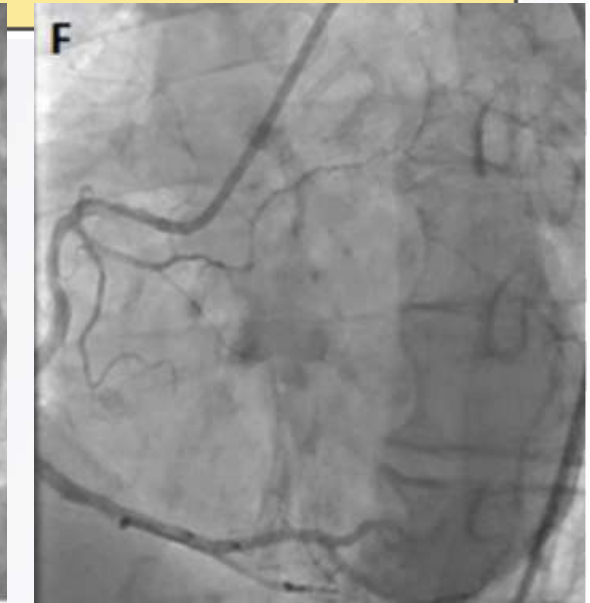
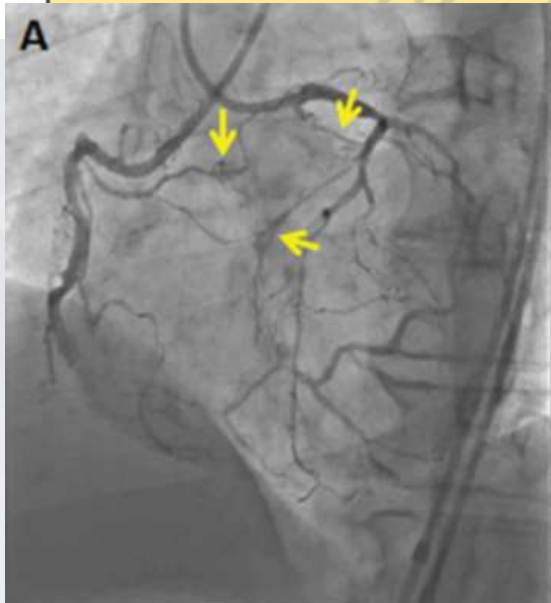
Lesson
Epicardial collateral perforation requires sealing from both sides

ABSTRACT: Epicardial collateral perforation during percutaneous coronary intervention. We describe a case of epicardial collateral perforation during percutaneous coronary intervention. We describe a case of epicardial collateral perforation during percutaneous coronary intervention. We describe a case of epicardial collateral perforation during percutaneous coronary intervention.

J INVASIVE CARDIOL

KEY WORDS: chronic total occlusion, percutaneous coronary intervention, thrombin injection

percutaneous coronary intervention.



1. Inflate balloon to occlude vessel

2. Intravenous fluids / vasopressors

**3. Pericardiocentesis if hypotension –
? autotransfusion**

4. Notify surgeons

**“Universal” Algorithm for
Coronary Perforations**

Persistent extravasation?

no

Monitor patient

yes

Treat the cause

Large vessel perforation

- 1. Covered stent**
- 2. Prolonged balloon inflations**
- 3. Dissection techniques**

Distal vessel perforation

- 1. Embolization (fat, coils, etc)**
- 2. Covered stent over perforated branch origin**

**Type-specific
Treatment**

Continued extravasation?

yes

Reverse anticoagulation

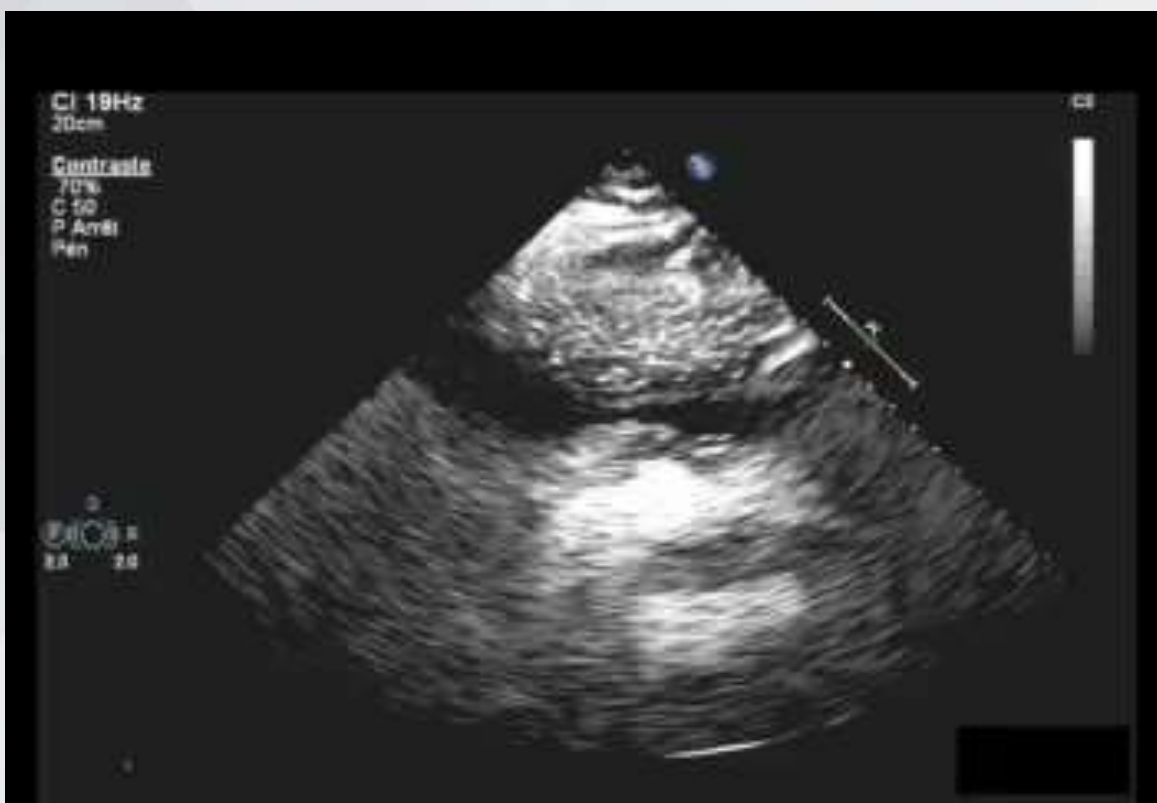


ACT=227

TIP

**Perforation can be further complicated by thrombosis
DON'T REVERSE HEPARIN UNTIL
AFTER EQUIPMENT REMOVED
FROM CORONARY ARTERY**

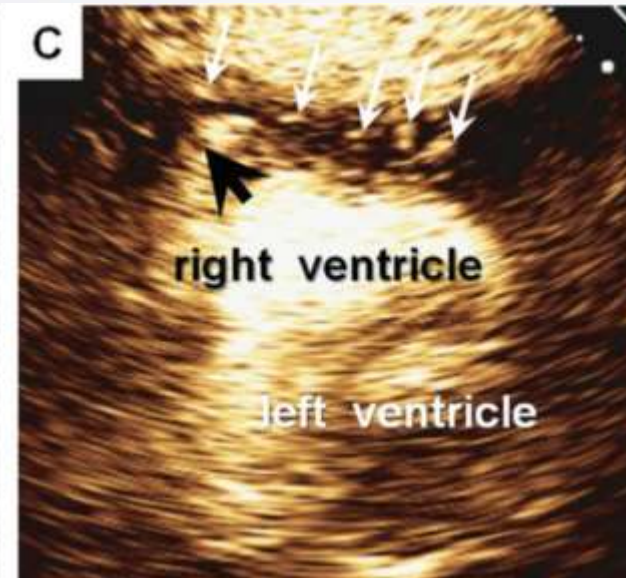
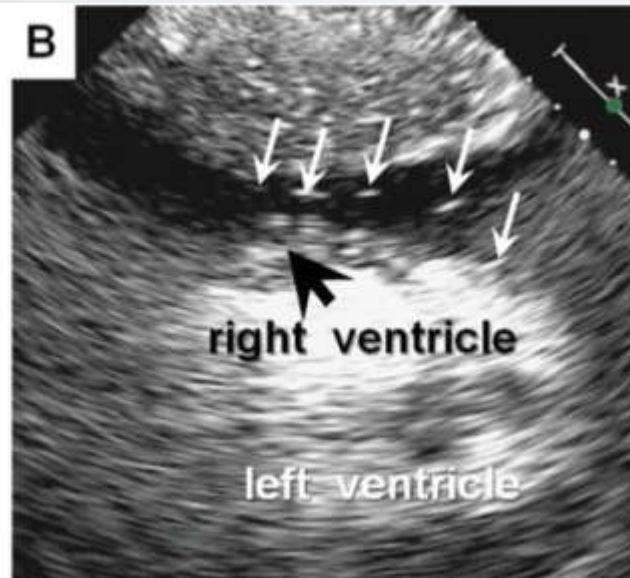
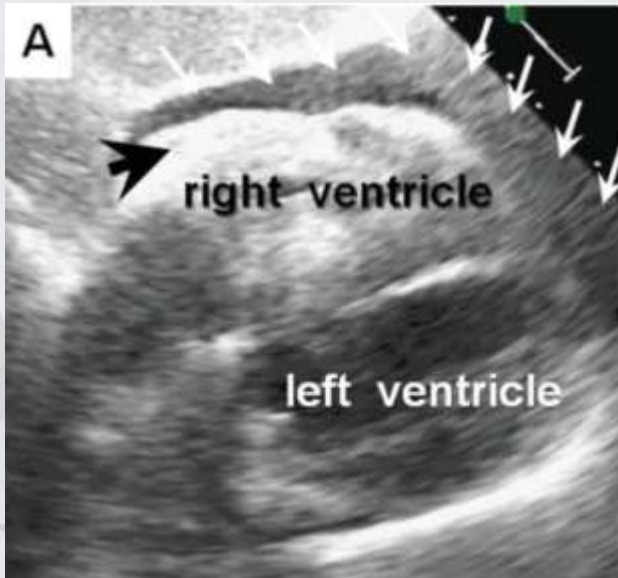




Clinical Decision Making

A Novel Application of Contrast Echocardiography to Exclude Active Coronary Perforation Bleeding in Patients with Pericardial Effusion

Rodrigo Bagur,¹ MD, Mathieu Bernier,¹ MD, FRCP(C), David E. Kandzari,² MD, FACC, FSCAI, Dimitri Karpaliotis,² MD, Nicholas J. Lembo,² MD, and Stéphane Rinfret,^{1*} MD, SM, FRCP(C)



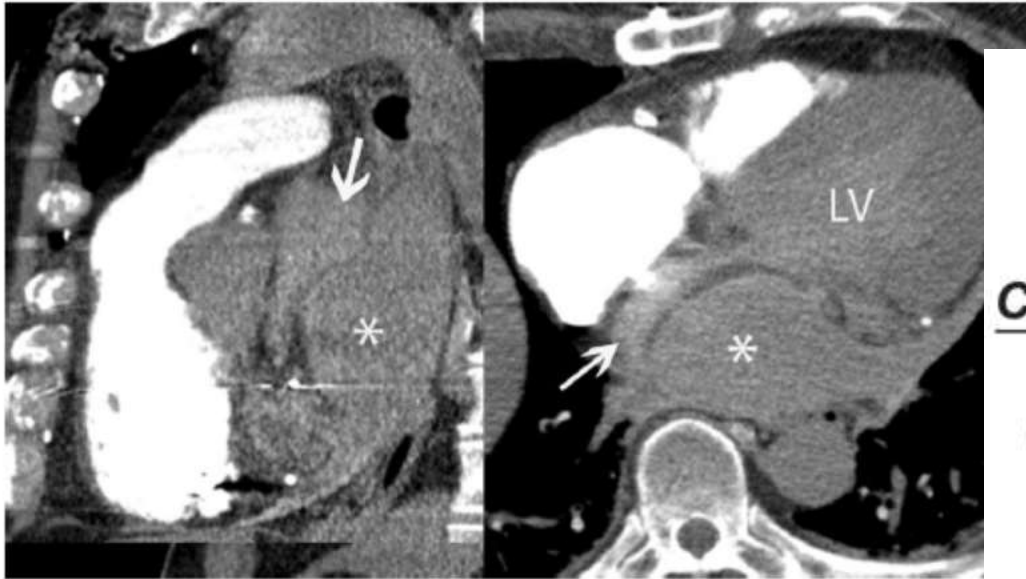


Fig. 5. Cardiac CT (left = sagittal plane, right = axial plane). Arrow indicates compressive left atrium. Asterisk indicates hematoma.

Case Reports

Cardiovascular Collapse Post Chronic Total Occlusion Percutaneous Coronary Intervention Due to a Compressive Left Atrial Hematoma Managed with Percutaneous Drainage

William M. Wilson,¹ J.C. Spratt,¹ and W.L. Lombardi^{2*}

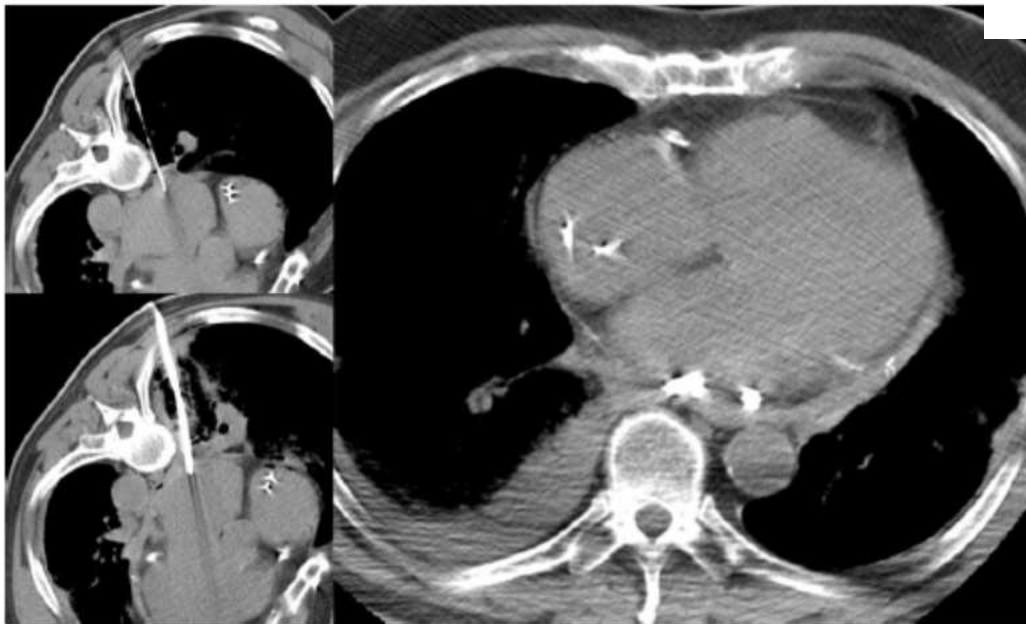


Fig. 6. Percutaneous drainage of hematoma (Left upper = needle aspiration, left lower = drain tube in situ, right = resolution of hematoma with right pleural collection post drain removal).

Lesson

Perforation in the post CABG patient can be a lethal complication – and very hard to treat

Wilson et al. CCI 2015;86:407–41

Conclusion / Take-home Message

- **Coronary perforation: most feared complication of CTO PCI**
- **Classification by severity – location**
- **Universal algorithm**
- **First step: inflate a balloon**
- **Large vessel perforation: covered stent**
- **Small vessel perforation: coil/fat embolization**
- **Septal collateral perforation: usually no Rx**
- **Epicardial collateral perforation: embolization from both sides**