Coronary Dissection

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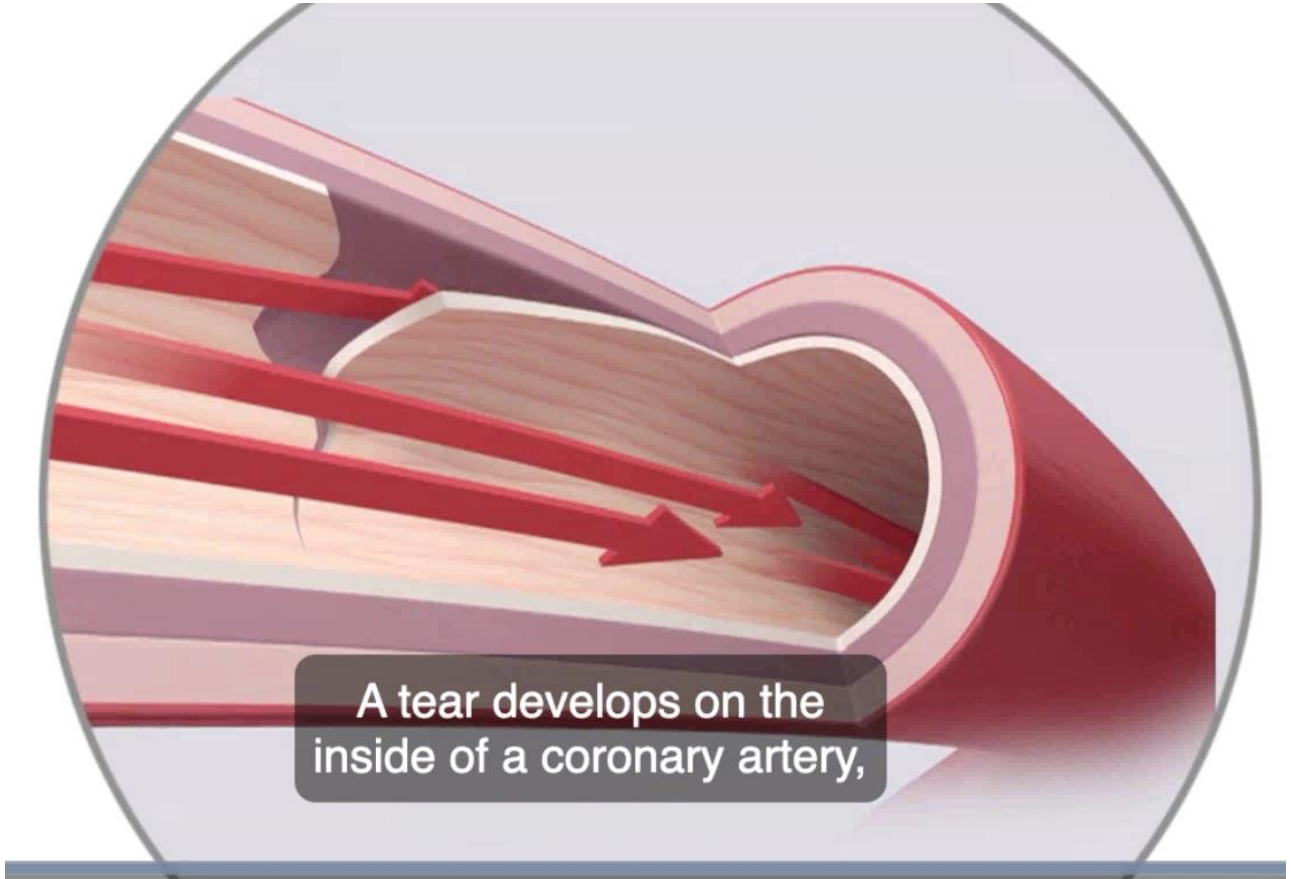
DEFINITION

Definition

Separation between any 2 coronary artery layers Intima/Media or Media/Adventitia – forming a false lumen within the artery that can compromise the lumen of the artery and thus affect blood flow (anterograde or retrograde perfusion)



CAUSES

CAUSES

- Spontaneous Coronary Artery Dissection
- Trauma
- Iatrogenic

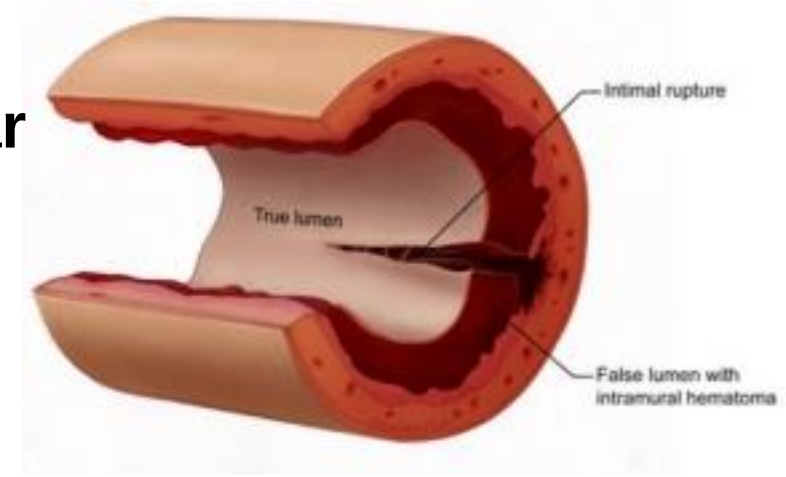
Spontaneous Coronary Artery Dissection

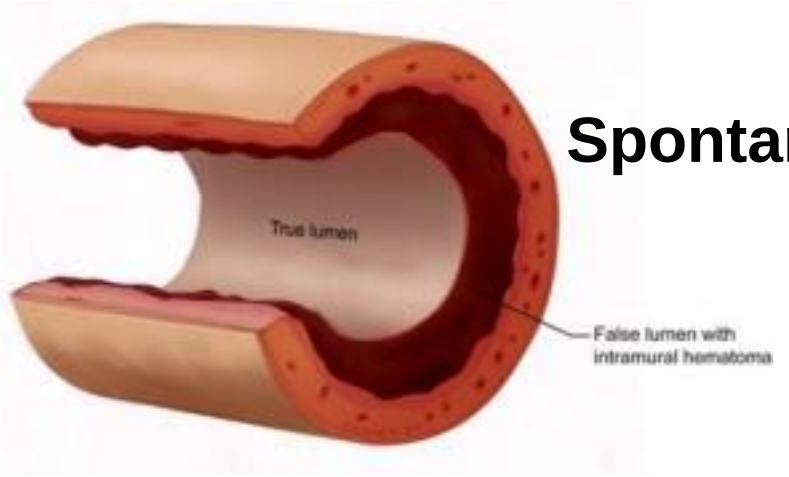
Spontaneous Coronary Artery Dissection (SCAD)

Definition:

- Non-traumatic, non-iatrogenic, non-atherosclerotic separation of the coronary arterial wall by intramural hemorrhage creating a false lumen, with or w/o an intimal tear
- Separation can occur between any arterial layers (intima, media or adventitia)
- Resulting intramural hematoma compresses the arterial lumen, compromising antegrade blood flow, and can cause myocardial ischemia or infarction

Intimal Tear





Spontaneous Bleed

Coronary Angiogram Classification of Spontaneous Coronary Artery Dissection

Jacqueline Saw,* MD

ANGIOGRAPHIC VARIANTS OF SCAD APPEARANCE

There are three distinct angiographic appearances and patterns of SCAD that can be characterized:

1. Type 1 (evident arterial wall stain): This is the pathognomonic angiographic appearance of SCAD with contrast dye staining of arterial wall with multiple radiolucent lumen (Fig. 1).
2. Type 2 (diffuse stenosis of varying severity): This angiographic appearance is not well appreciated and is often missed or misdiagnosed. SCAD commonly involves the mid to distal segments of coronary arteries, and can be so extensive that it reaches the distal tip. There is an appreciable (often subtle) abrupt change in arterial caliber, with demarcation from normal diameter to diffuse narrowing. This diffuse (typically >20 mm) and usually smooth narrowing can vary in severity from an inconspicuous mild stenosis to complete occlusion (Figs. 2–5).
3. Type 3 (mimic atherosclerosis): This appearance is the most challenging to differentiate from atherosclerosis (Figs. 6 and 7) and most likely to be misdiagnosed. Angiographic features that favor SCAD are: (a) lack of atherosclerotic changes in other coronary arteries, (b) long lesions (11–20 mm), (c) hazy stenosis, and (d) linear stenosis. Angiographer needs to have a high index of suspicion for SCAD (Table I) and liberally use intracoronary imaging for such cases.

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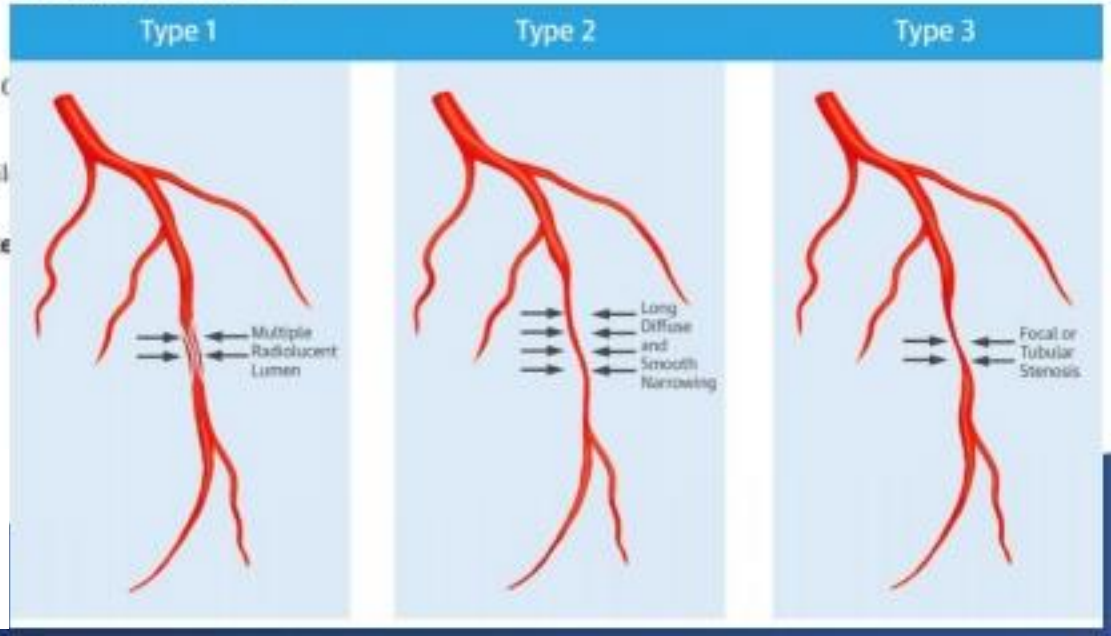
Catheterization and Cardiovascular Inte



Saw J. Cathet Cardiovasc Interv 2014;84(7):1115-22.
Saw J, et al. JACC 2017 Aug;70(9):1148-58.

Type 1: Arterial wall stain, multiple radiolucent lumen

Spontaneous Coronary Artery Dissection Type 1

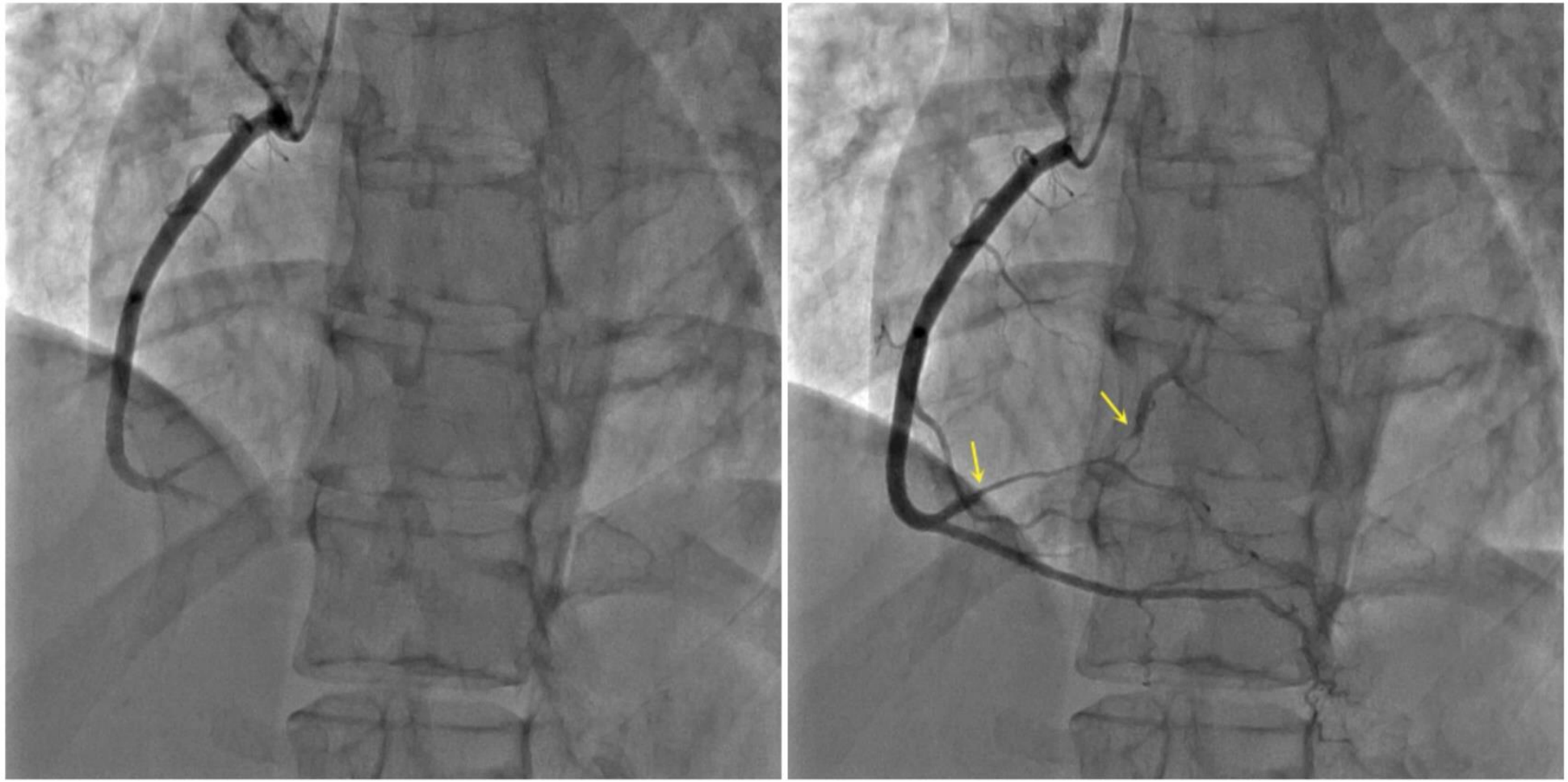
Type 1 SCAD lesion is characterized by the pathognomonic appearance of contrast dye staining of arterial wall with multiple radiolucent lumens, with or without the presence of dye hang-up or slow contrast clearing from the lumen.

Projection angle: 14 RAO, 35 CRA. Type 1 SCAD is seen in OM2.

Type 2 Variant A: Diffuse stenosis of any severity (normal prox & distal)

Type 2 Variant A

In type 2 variant A lesion, the coronary segments proximal and distal to dissection are normal.

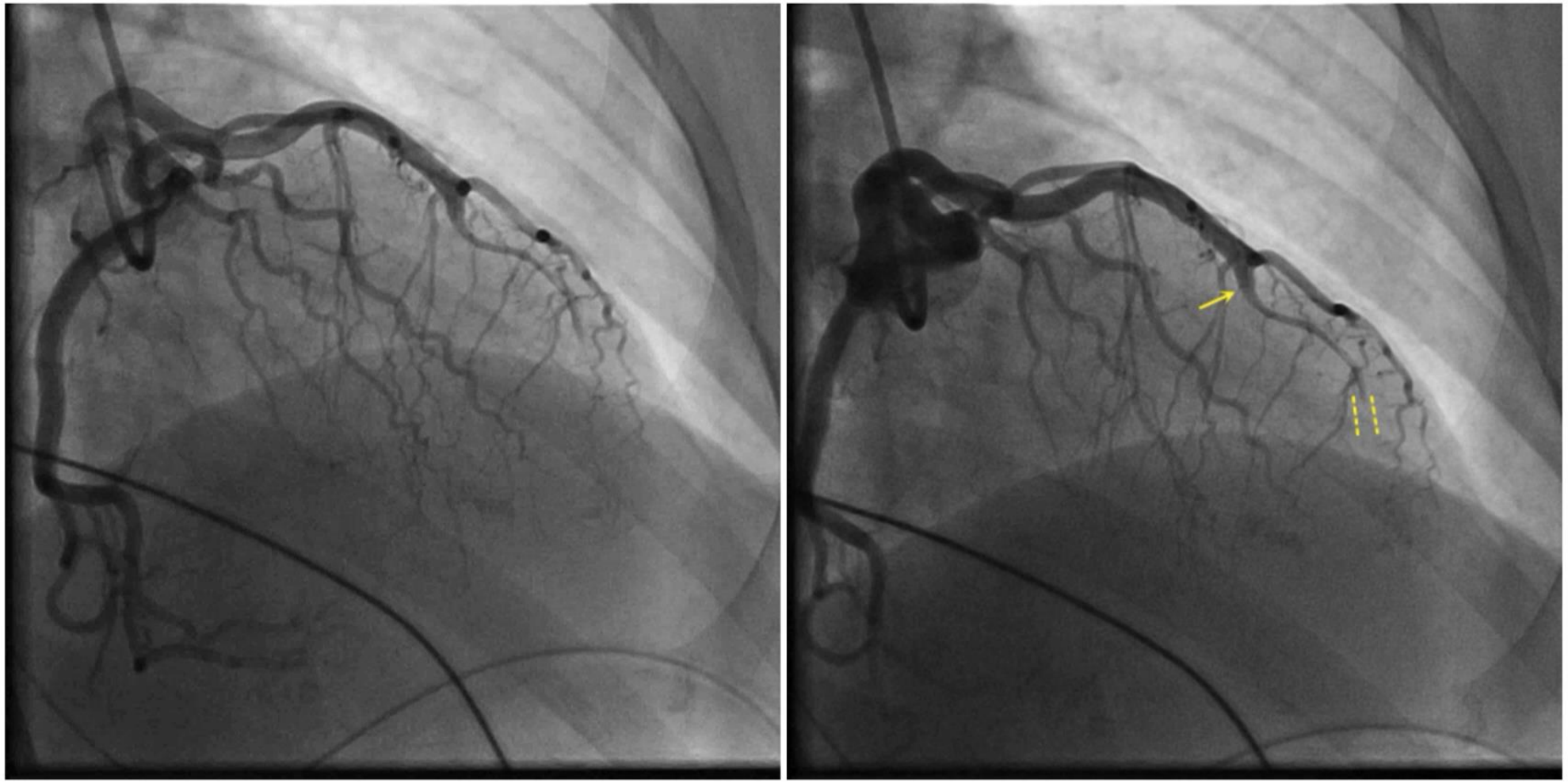


Projection angle: 25 LAO, 20 CRA. Type 2A SCAD is seen in R3, R4.

Type 2: Variant B (extends to distal tip)

Type 2 Variant B

In type 2 variant B lesion, the dissection extends to the apical tip of the artery without discernible normal segment distally.



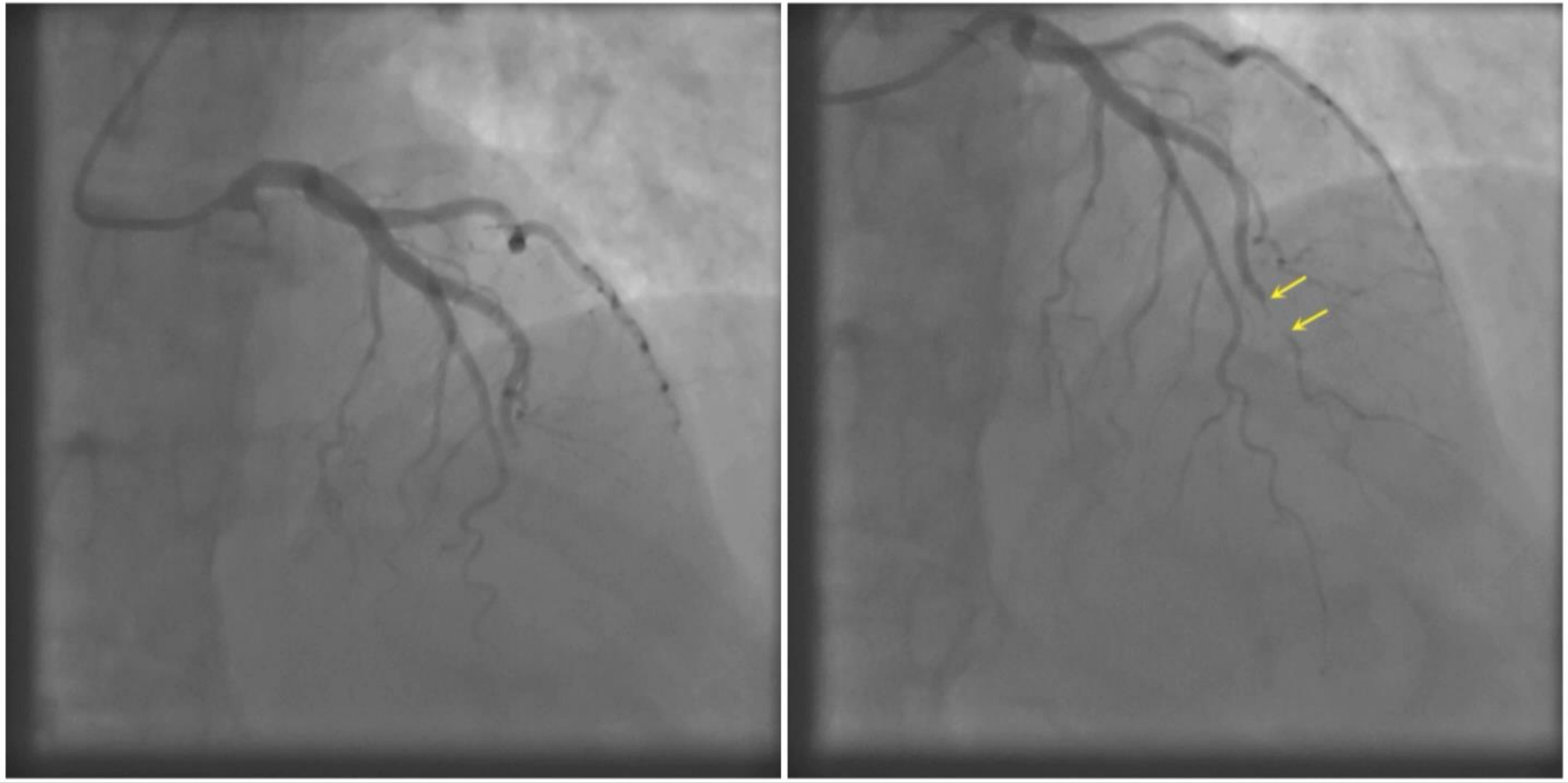
Projection angle: 41 RAO, 19 CRA. Type 2B SCAD is seen starting in L2 resulting in a total occlusion.

Type 3: Mimics Atherosclerosis

Spontaneous Coronary Artery Dissection Type 3

Type 3 SCAD lesion is characterized by focal or tubular (typically <20 mm) stenosis that mimics atherosclerosis, which requires intracoronary imaging (e.g. optical coherence tomography or intravascular ultrasound) to prove the presence of intramural hematoma or double-lumen. Angiographic features that may be useful in differentiating type 3 SCAD lesion from atherosclerosis include:

a. lack of atherosclerotic changes in other coronary arteries
b. long lesions (11–20 mm)
c. hazy stenosis
d. linear stenosis



IVUS and OCT

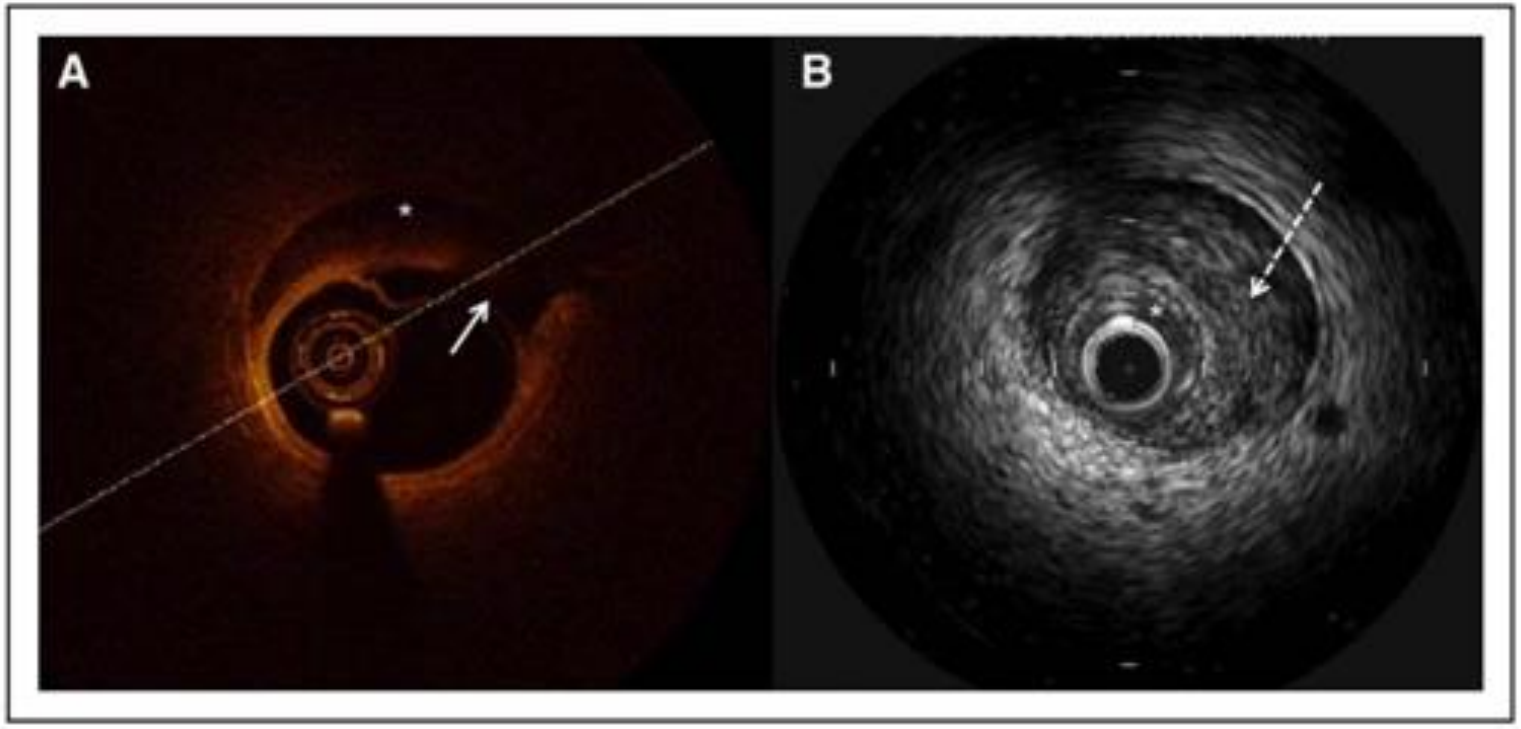


Figure 6. Intracoronary imaging for spontaneous coronary artery dissection.
A, Optical coherence tomography shows intimal dissection (solid arrow) and intramural hematoma (asterisk). **B**, Intravascular ultrasonography shows intramural hematoma (dotted arrow) compressing the true lumen (asterisk).

AHA SCIENTIFIC STATEMENT

Spontaneous Coronary Artery Dissection: Current State of the Science

A Scientific Statement From the American Heart Association

Sharonne N. Hayes, MD, FAHA, Chair
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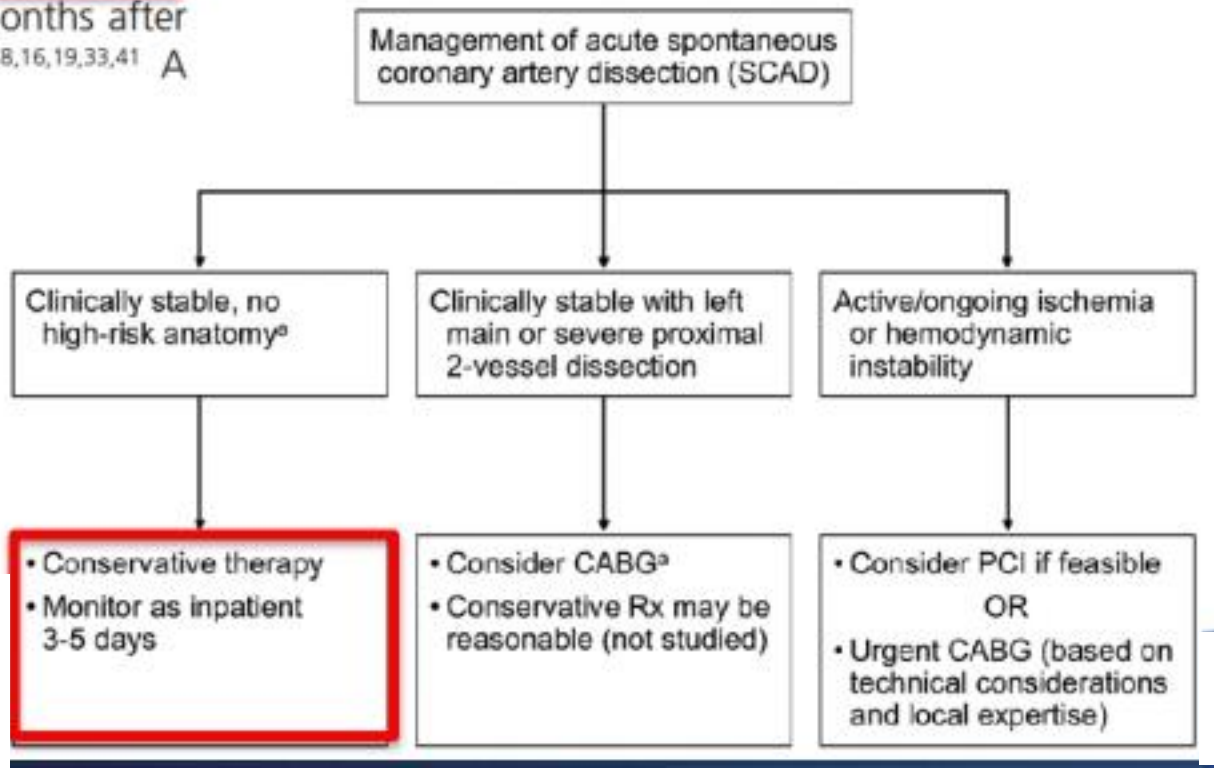
On behalf of the American Heart Association Council on Peripheral Vascular Disease; Council on Clinical Cardiology; Council on Cardiovascular and Stroke Nursing; Council on Genomic and Precision Medicine; and Stroke Council

Conservative Management

No comprehensive prospective studies have routinely performed angiographic restudy after SCAD, but observational data have indicated angiographic "healing" of SCAD lesions in the majority of patients (70%–97%) who were selectively restudied weeks to months after a conservatively managed index episode.[6,8,16,19,33,41] A

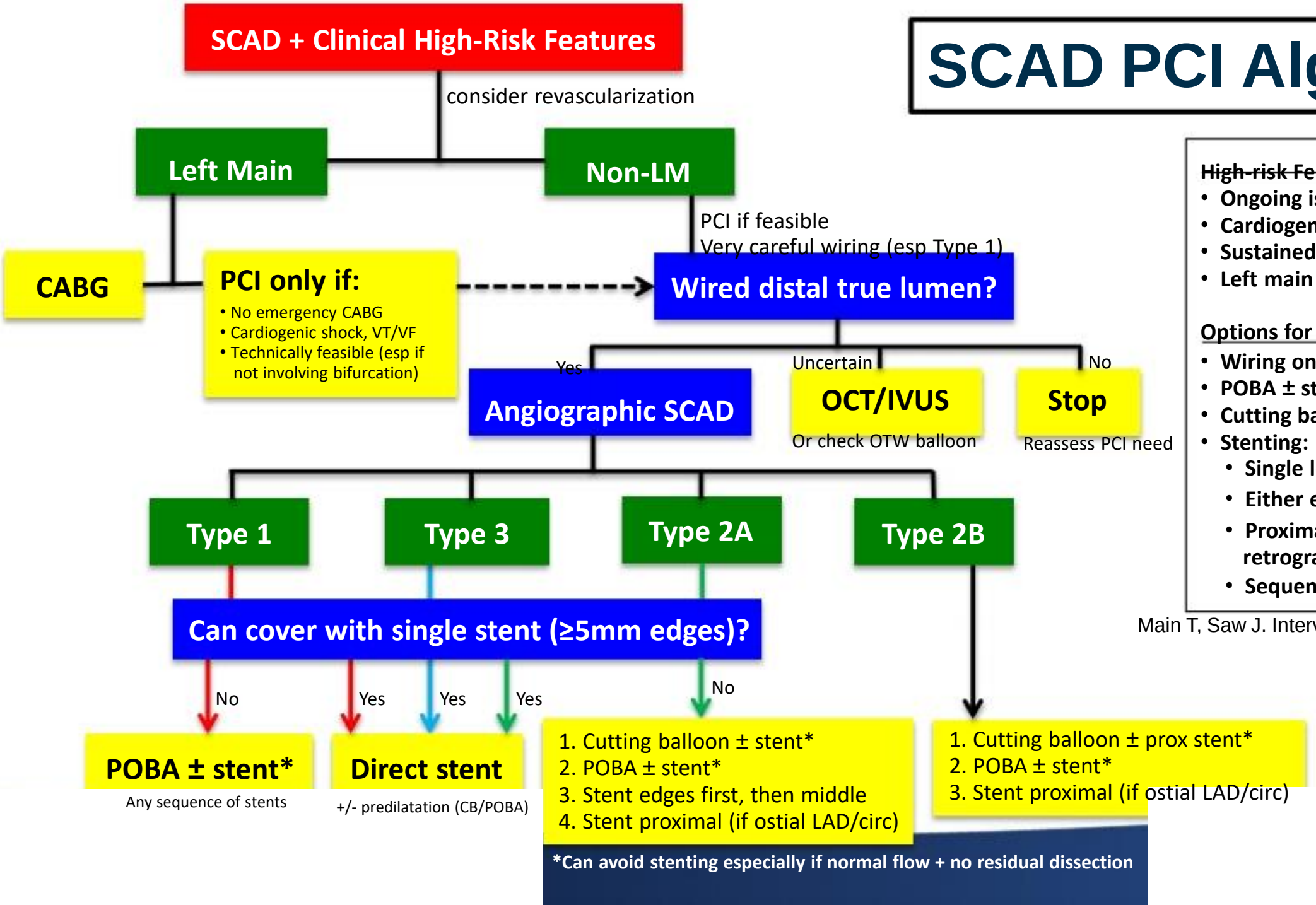
Percutaneous Coronary Intervention

Observational studies have shown consistently that PCI for the treatment of SCAD is associated with an increased risk of complications[8–11,13,16,19,33] and suboptimal outcomes. Affected coronary arteries may be inherently



Circulation. 2018;137:00–00.

SCAD PCI Algorithm



~~High-risk Features:~~

- **Ongoing ischemia**
- **Cardiogenic shock**
- **Sustained ventricular arrhythmia**
- **Left main dissection**

Options for PCI:

- **Wiring only**
- **POBA ± stent**
- **Cutting balloon ± stent**
- **Stenting:**
  - **Single long stent**
  - **Either edges first, then middle**
  - **Proximal first (to avoid retrograde extension)**
  - **Sequential stenting**

Main T, Saw J. Interventional Cardiology Clinics 2018 (in press).

Traumatic Coronary Artery Dissection

Traumatic Coronary Dissection

TABLE 1. Summary of the cases

Author/year	Sex	Age	Comor-bidity	Artery	Mechanism	Time until symptoms	Treatment	Sur-vival
Boland *et al.*, 1988[5]	F	32	None	LAD and LCx	Car driver	Immediate	Bypass	Yes
Goulah *et al.*, 1988[6]	M	31	None	LAD	Car accident	2 years	Conservative	Yes
Marcum *et al.*, 1996[7]	M	44	None	RCA	Kicked	Immediate	Angioplasty	Yes
Masuda *et al.*, 1996[8]	F	17	None	LAD	Motorcycle	Immediate	Conservative	Yes
Chun *et al.*, 1998[9]	M	17	None	Left main	Falling	Immediate	Conservative	Yes
Greenberg *et al.*, 1998[10]	F	35	None	Lcx	Waterski accident	3 days	Conservative	No
Kawahito *et al.*, 1998[11]	M	43	None	RCA	Falling	2 months	Conservative	Yes
Hazelger *et al.*, 2001[12]	M	29	None	LAD and obtuse branch	Sport accident	2 months	Stent	Yes
Moore *et al.*, 2001[13]	M	30	None	LAD	Sport accident	Immediate	Angioplasty	Yes
Harada *et al.*, 2002[14]	M	14	None	L main	Motorcycle	Immediate	Bypass	Yes
Kerwin *et al.*, 2002[15]	M	49	hyperlipidae-mia	LCx	Minor trauma	2 days	Conservative	Yes
Naseer *et al.*, 2003[16]	M	32	None	LCx	Kicked	Immediate	Stent	Yes
Yoon *et al.*, 2003[17]	M	66	None	LAD	Car driver	20 hours	Conservative	Yes
Swinkels *et al.*, 2005[18]	F	43	Smoking	RCA	Falling	10 days	Conservative	Yes
Morenot *et al.*, 2005[19]	M	17	None	RCA	Bycicle accident	Immediate	Stent	Yes
Brasseur *et al.*, 2006[20]	M	43	Smoking, hypertension	LAD	Punch in chest	Immediate	Stent	Yes
Korach *et al.*, 2006[21]	M	40	None	LAD	Pedestrian	Immediate	Bypass	Yes
Leong *et al.*, 2006[22]	M	50	None	LAD	Motorcycle	Immediate	Stent	Yes
Hobelmann *et al.*, 2006[23]	M	32	None	RCA	Sport accident	1 hour	Stent	Yes
Tepe *et al.*, 2006[24]	F	55	Not specified	LCx	Car driver	Not specified	Stent	Yes
Yuichi *et al.*, 2007[25]	M	54	None	L main	Motorcycle	1 month	Bypass	Yes
Li *et al.*, 2007[26]	M	33	None	L main	Motorcycle	13 hours	Bypass	No
Nan *et al.*, 2007[27]	M	40	None	L main and LAD	Car driver	Immediate	Bypass	Yes
Pawlik *et al.*, 2007[28]	M	21	None	LAD	Car driver	Not specified	Stent	Yes
Redondo *et al.*, 2009[29]	F	41	None	L main and RCA	Car driver	Immediate	Angioplasty	No
Lima *et al.*, 2009[30]	M	29	None	LAD	Car driver	1 month	Conservative	Yes
Chang *et al.*, 2010[31]	M	24	None	L main and LAD	Motorcycle	21 days	Angioplasty and stent	Yes
Adler *et al.*, 2010[32]	M	48	None	RCA	Car driver	6 days	Stent	Yes
James *et al.*, 2010[33]	M	37	Not specified	L main	Car driver	Immediate	Bypass	Yes
Ney *et al.*, 2011[34]	M	20	None	LAD	Car driver	Immediate	Stent	Yes
Guo *et al.*, 2011[35]	F	56	Not specified	LAD	Hit by object in chest	3 weeks	Angioplasty and stent	Yes
Lin *et al.*, 2011[36]	M	50	Not specified	L main and LAD	Motorcycle	Immediate	Stent	Yes
Lobay *et al.*, 2012[37]	F	50	Not specified	L main and LAD	Car driver	Immediate	Stent	Yes
Shao *et al.*, 2012[38]	M	43	Smoking	LAD and RCA	Car accident	3 months	Stent	Yes
Da Silva *et al.*, 2012[39]	M	43	None	LAD and LCx	Motorcycle	Immediate	Stent	Yes
Hamonic *et al.*, 2012[40]	M	37	Not specified	LAD	Motorcycle	12 hours	Stent	Yes
Brugger *et al.*, 2012[41]	M	35	Smoking	LAD	Parachute jump	1 hour	Stent	Yes
Gottam *et al.*, 2012[42]	M	26	None	LAD	Kicked	2 days	Conservative	Yes
Fradley *et al.*, 2012[43]	F	69	Hypertension	RCA	Car passenger	3-4 weeks	Conservative	Yes
Kotsovolis *et al.*, 2013[44]	M	58	Hypertension	RCA	Car passenger	5 hours	Stent	No
Han *et al.*, 2013[45]	F	60	Not specified	RCA	Car driver	Immediate	Stent	Yes
Radojevic *et al.*, 2014[46]	M	69	Not specified	LAD	Car driver	Dead on the scene		No
Li *et al.*, 2014[47]	M	24	None	LAD	Falling	Immediate	Angioplasty and stent	Yes
Own case	M	56	No info	LAD	Car driver	One hour	Stent	No

L main – left main coronary artery, LAD – left anterior descending coronary artery, LCx – left circumflex coronary artery, RCA – right coronary artery, M – male, F – female

Traumatic Coronary Dissection: Case Presentation and Literature Review

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Traumatic Coronary Dissection

ELSEVIER

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Case report

Mediastinal hematoma and left main dissection following blunt chest trauma

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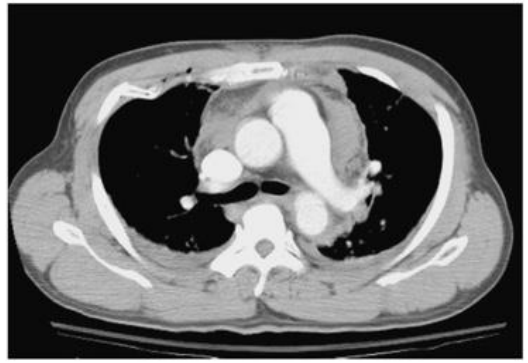


Fig. 1. The chest computed tomography revealed retrosternal hematoma and multiple ribs fractures.

Fig. 2. The coronary angiography demonstrated dissection of left main trunk with left anterior descending artery involvement.

Iatrogenic Coronary Dissection

- Can occur from catheter engagement (mechanical or injection-induced), wires (particularly hydrophilic jackets/coatings), and from trauma due to balloons/stents/atherectomy
- Guide catheter dissection is the most common referral for emergency CABG surgery
- Initially reported in up to 50% of PTCA cases; now <1%
- Grading system previously used to guide tx
- Increased MACCE (OR 3.1); without establishing TIMI 3 flow, MACCE increases (OR 10.2)

Classification

Classification

Table 61.1 NHBLI classification system of coronary dissection according to angiographic appearance

Type	Definition	Angiographic appearance	Risk of abrupt closure (%)
A	Radiolucent area in the lumen during contrast injection with little or no dye staining		<2
B	Parallel tracts or double lumen separated by a radiolucent area during contrast injection, with mild or no persistence after dye clearance		2–4
C	Contrast outside the coronary lumen with persistence of contrast in the area after dye clearance		10
D	Spiral-shaped filling defect with delayed distal flow and often persistent staining		30
E+*	New and persistent filling defect in the affected vessel		9
F+*	Impaired flow or total vessel occlusion		69

Classification of dissection according to IVUS

- Intimal: Limited to the intima or atheroma, and not extending to the media.
- Medial: Extending into the media.
- Adventitial: Extending through the EEM
- Intramural hematoma: An accumulation of blood within the medial space, displacing the internal elastic membrane inward and EEM outward. Entry and/or exit points may or may not be observed.
- Intra-stent: Separation of neointimal hyperplasia from stent struts, usually seen only after treatment of in-stent restenosis.


Predictors

Risk factors

- Risk factors have been identified and can be categorized into anatomical, clinical, and technical factors.
  - Angiographic predictors include calcified, eccentric, and long atherosclerotic lesions; ACC/AHA type B or C complex plaque morphology; and vessel tortuosity
  - Clinical presentations as acute myocardial infarction or unstable angina increase the risk of coronary dissection and subacute thrombosis
  - Technical factors and operator experience are very often important determinants for the occurrence of coronary dissections. Inappropriate selection and manipulation of guiding catheters, eccentric contrast injection with damping pressure, inadvertent advancement of guidewires and balloons, and inappropriately sized or excessive balloon and stent dilatation (balloon-to-artery ratio of >1.2)

Predictors

- Heavy calcification at the ostium
- Aggressive guide, non-coaxial
- Stiff wires
- Ostial/proximal CTO
- Retrograde wiring that wraps around in the aortic wall
- Forceful injection

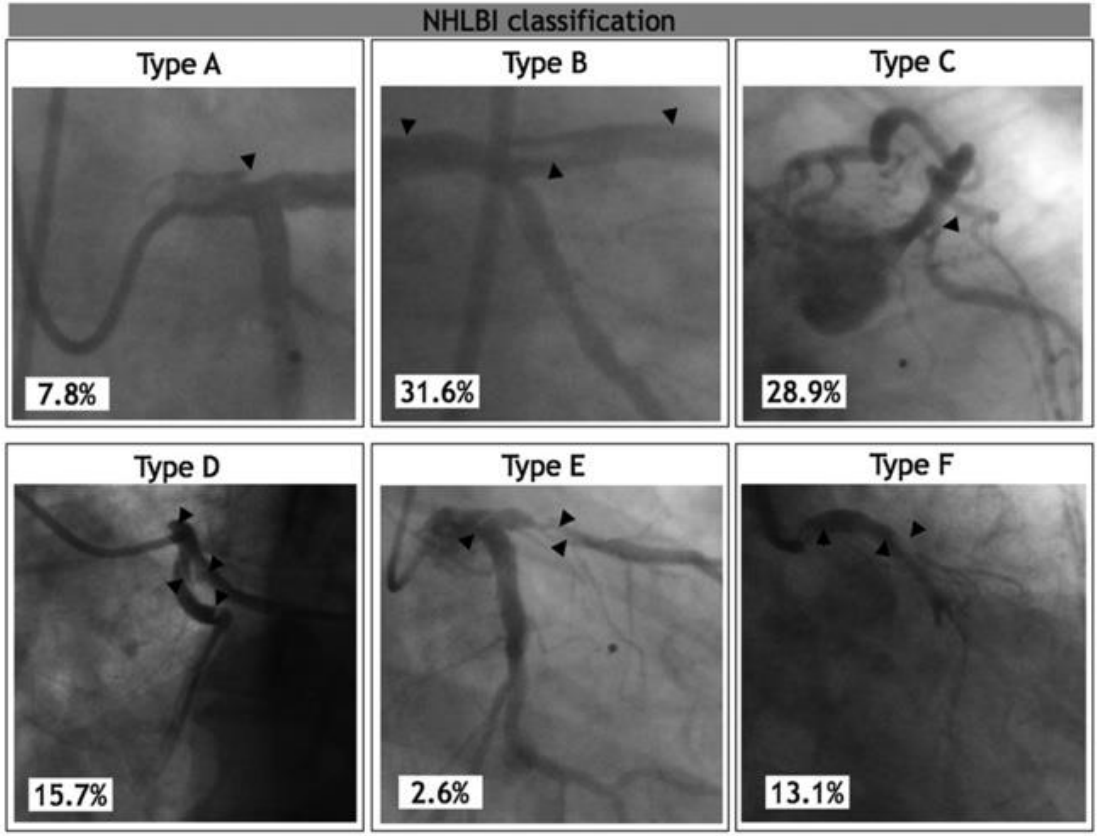
Outcomes

Outcome

- Iatrogenic left main, ostial right coronary artery (RCA), and ostial graft dissections induced by guiding catheters are the most feared complications of coronary catheterization, all of which can cause catastrophic sequelae including hemodynamic collapse, electric storms, and impending death in a matter of minutes.
- Proximal dissections also extend in a retrograde direction up to the coronary ostium and aorta, resulting in left main dissection and aortic dissection with potentially fatal outcomes.
- Extensive and major dissections (types C to F) often require immediate attention and careful management by maintaining a secure guidewire position followed by stenting.

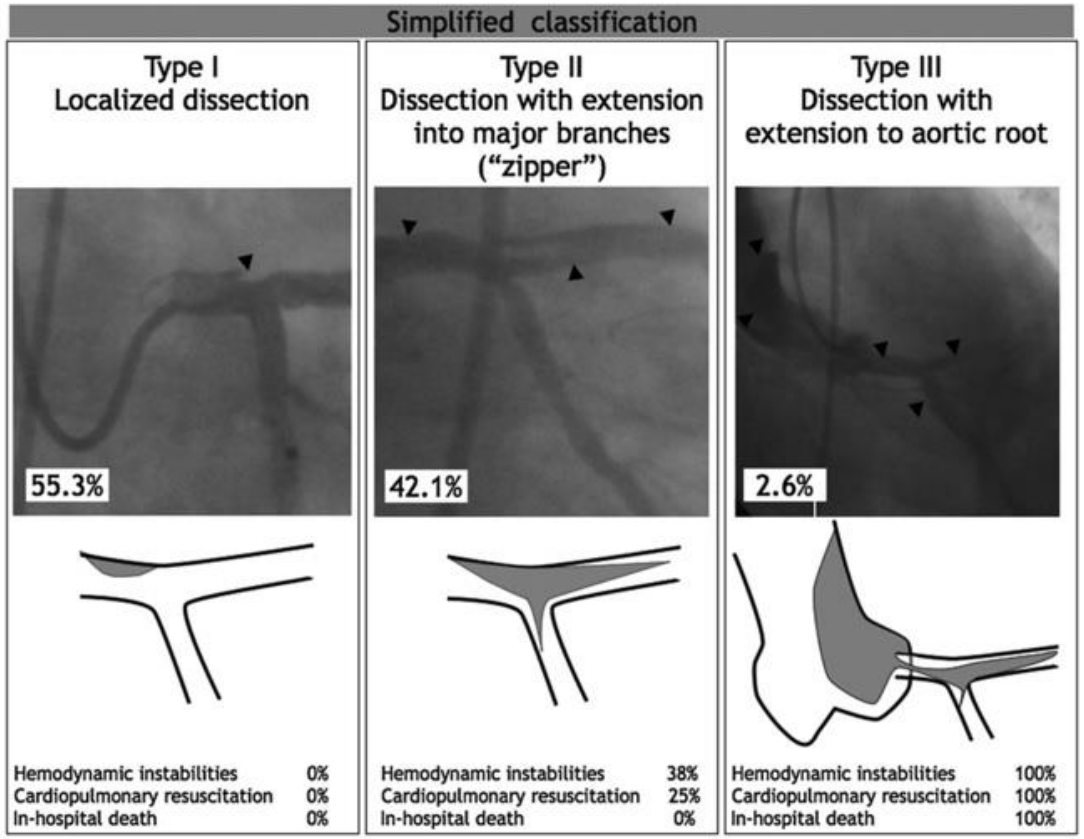
Iatrogenic left main coronary dissection

- Iatrogenic left main coronary artery (LMCA) dissection is a potentially fatal complication of coronary intervention which requires rapid and effective management.
- The overall incidence of iatrogenic LM dissection was 0.07% and almost twice as common with percutaneous coronary intervention than coronary angiography.
- Treatment of iatrogenic LM dissection consists of conservative therapy, bailout stent implantation, or urgent coronary artery bypass grafting (CABG).



Examples and relative incidence (percentage) of types of left main dissection according to the NHLBI classification system for coronary artery dissection.

Iatrogenic left main coronay dissection



Examples, relative incidence (percentage), and in-hospital clinical outcome of iatrogenic left main dissection according to a simplified classification system.

Dissection with extension to aortic root

Category	Description
Class 1	Involving the ipsilateral aortic cusp
Class 2	Involving cusp and extending up the aorta <40mm
Class 3	Involving cusp and extending up the aorta >40mm

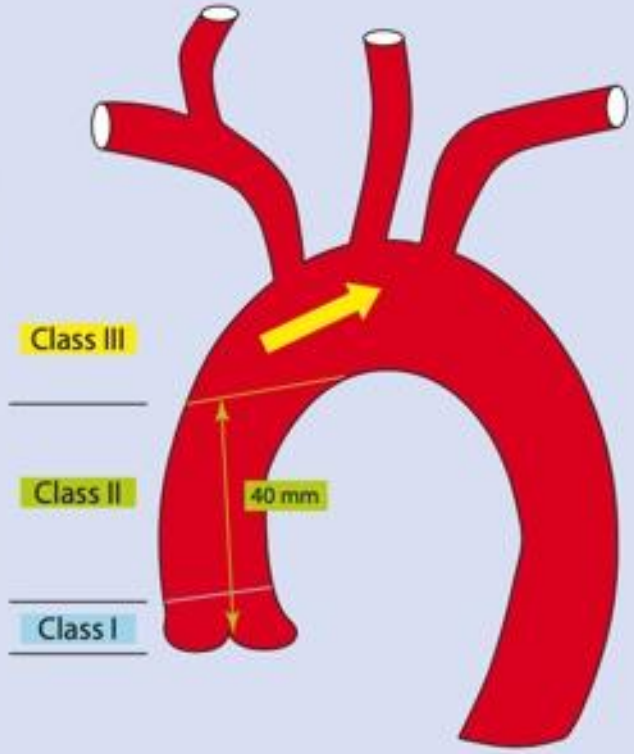


Fig. 61.7 Dunning classification system of iatrogenic aortic dissection

Dissection with extension to aortic root

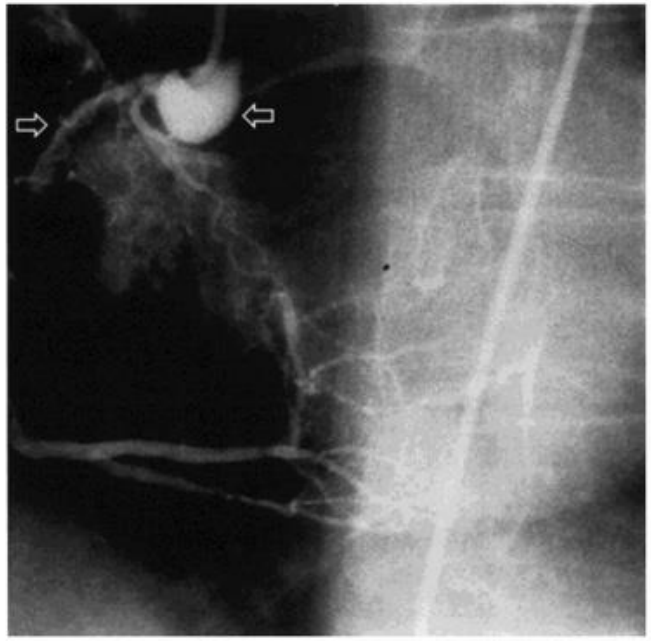


Fig. 1. Case 8 with Class 1 dissection from right coronary artery into right coronary cusp (arrows), JR4 guide. Successfully treated with stent and discharged home on Day 2.

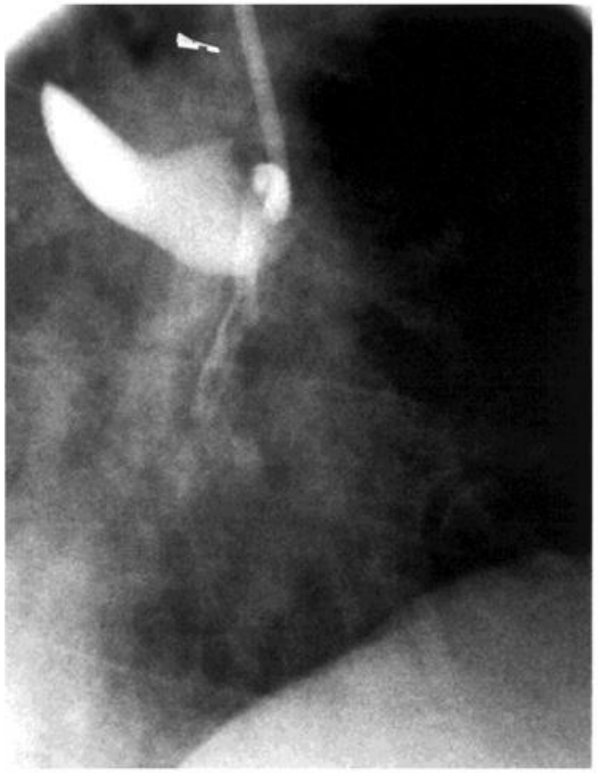


Fig. 2. Case 5, Class 2 dissection occurring during diagnostic angiography in an acute myocardial infarction. Right coronary artery could not be wired and bypass was performed. Patient went home Day 6. JR4 catheter.

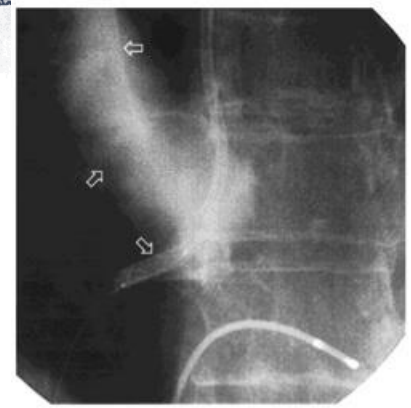


Fig. 4. Case 3, Class 3 dissection. JR4 guide. Stent was placed in proximal right coronary artery (lower arrow) but extra-luminal contrast outlines a widening dissection of the ascending aorta (middle and upper arrows).

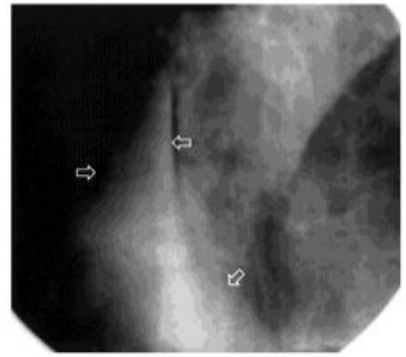


Fig. 5. Another view of Case 3 showing extension of the dissection into the aortic arch. The dissection flap and width are readily identified (arrows). The patient was taken emergently to surgery but was unable to be weaned from bypass and died.

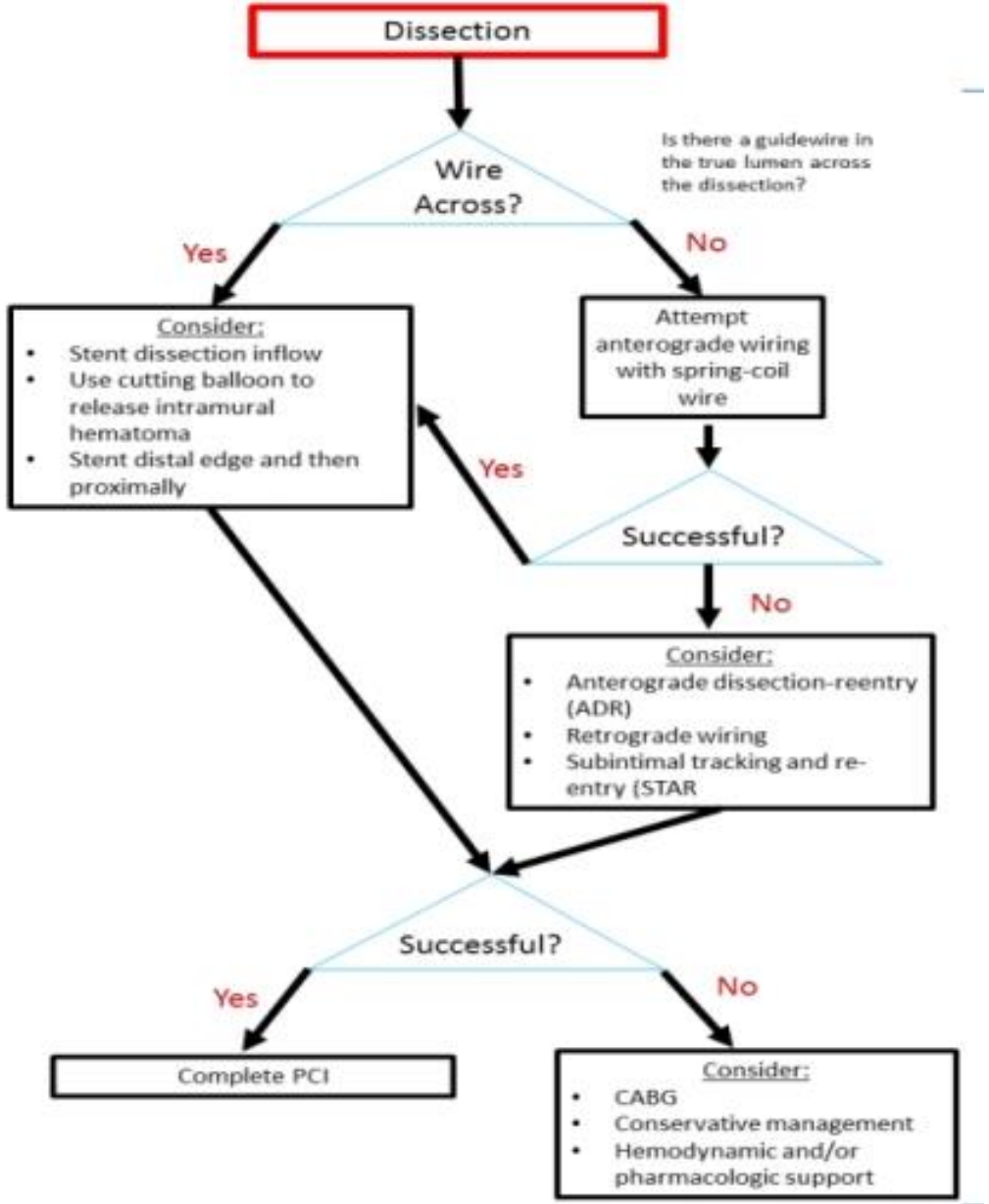
Emergency heart team

Management

General Algorithm for Treatment of Coronary Dissections

3 Big Questions:
1) Wire across?
2) Vessel open or closed?
3) Patient stable?

Principles of Dissection Management:
1) Avoid/minimize anterograde injections
    a) Need for retrograde visualization?
    b) Use of IVUS to mark true lumen
2) Hematoma management
    1) STRAW
    2) Cutting/releasing hematoma



Prevention

Prevention

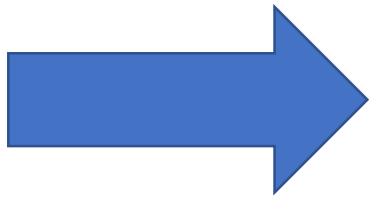
Catheter manipulations

Vigorous contrast injection

Deep intubations of the catheter within the coronary artery

Vigorous, deep inspiration

Variant anatomy of the coronary ostia

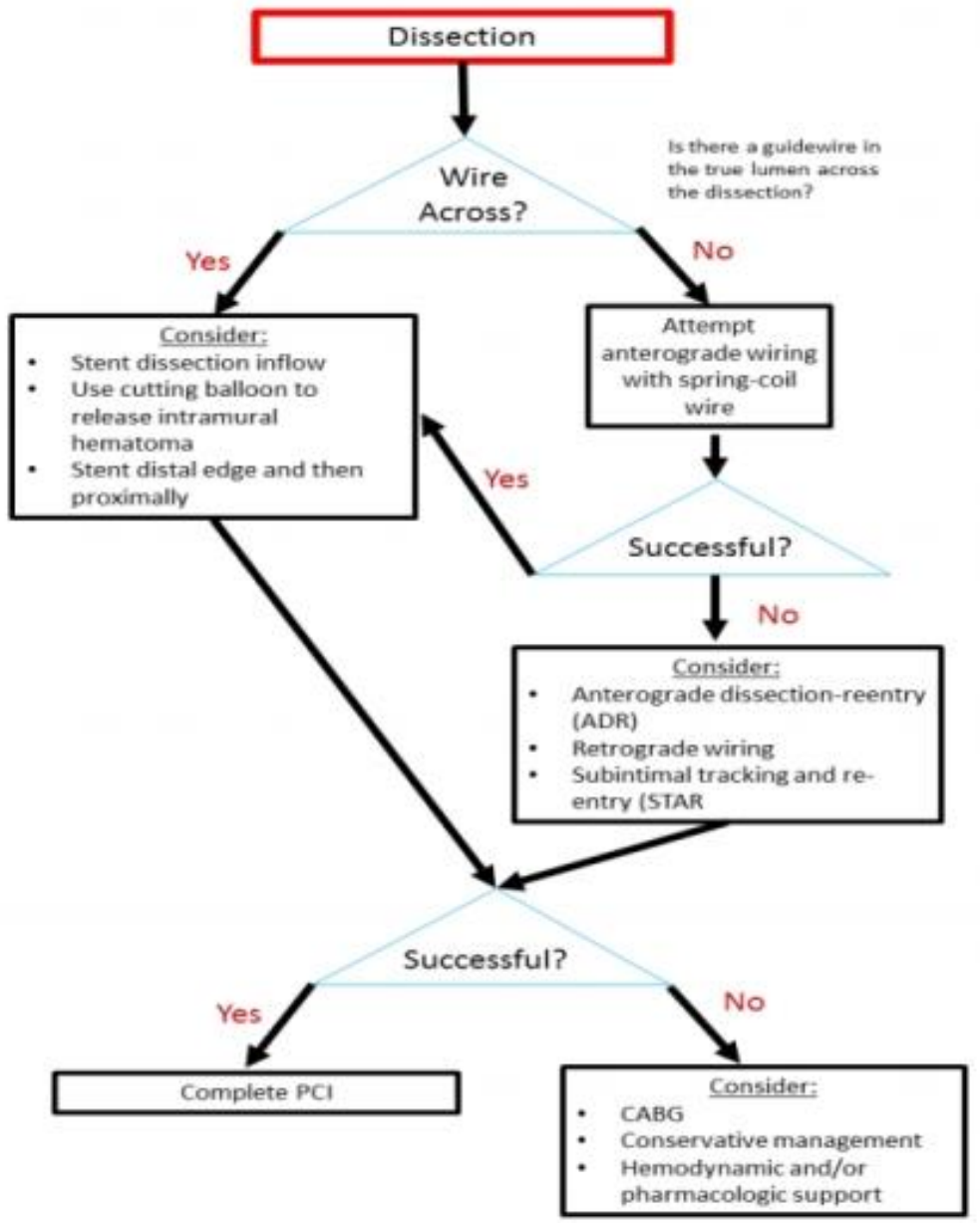


GENTLE

Conclusion

Conclusions

- Coronary dissections are not common but can contribute to significant MACE if not managed appropriately
- 3 big questions
  - Wire still across?
  - Vessel still open?
  - Patient stable?
- Algorithmic approach to management



Conclusions

- Iatrogenic aortocoronary dissection during routine PCI is a rare but potentially life threatening complication.

- The therapeutic options consider either a **conservative** approach with a “wait-and-see” strategy or **interventional treatment with PCI** and sealing of the coronary dissection entry or **surgical treatment** .

- Intracoronary imaging such as IVUS or OCT are useful to guide the percutaneous treatment.

- In case of residual dissection, CT-Scan can be a helpful tool for non-invasive follow-up.

The 4 S law:

- Keep a cool head and manage emotions… be ***S*** *mart*
- Maintain the stability of your catheter system… be ***S*** *table*
- Manipulate stably and rapidly… be ***S*** *wift*
- Perform ***S*** *tent* implantation as soon as possible