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Αντιμετώπιση επιπλοκών διαδερμικής στεφανιαίας παρέμβασης.
Complications: The never ending story?

Prevention is better than treatment....

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COMPLICATIONS FROM THE CATHETERIZATION LAB.

**Left Heart**
- **Cardiac**
  - Death
  - Myocardial infarction
  - Ventricular fibrillation
  - Ventricular tachycardia
  - Cardiac perforation
- **Noncardiac**
  - Stroke
  - Peripheral embolization
  - Air
  - Thrombus
  - Cholesterol
  - Vascular surgical repair
  - Pseudoaneurysm
  - A-V fistula
  - Embolectomy
  - Repair of brachial arteriotomy
  - Evacuation of hematomas
  - Contrast-related
    - Renal insufficiency
    - Anaphylaxis

**Right Heart**
- **Cardiac**
  - Conduction abnormality
    - RBBB
    - Complete heart block (RBBB superimposed on LBBB)
  - Arrhythmias
  - Valvular damage
  - Perforation
- **Non-cardiac**
  - Pulmonary artery rupture
  - Pulmonary infarction
  - Balloon rupture
  - Paradoxical (systemic) air embolus
PCI complications......

- Over 2 million PCI procedures worldwide
- Angiographic success rate of 82-98%
- Overall major complications rates 1-5%
What is PCI Success?

ANGIOGRAPHIC SUCCESS
Residual stenosis <10%, TIMI 3 flow, no occlusion of a significant side-branch, flow-limiting dissection, distal embolization, or angiographic thrombus.

PROCEDURAL SUCCESS
Angiographic success without in-hospital major complications (e.g., death, MI, stroke, emergent CABG)

CLINICAL SUCCESS
Procedural success with relief of signs and/or symptoms of myocardial ischemia.

There is a difference between PCI ‘failure’ & PCI ‘complication’

<table>
<thead>
<tr>
<th>Complication</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death one month post PCI</td>
<td>0.6%</td>
</tr>
<tr>
<td>Death in the cath. lab suite</td>
<td>0.047%</td>
</tr>
<tr>
<td>Stroke</td>
<td>0.29%</td>
</tr>
<tr>
<td>Cardiac perforation</td>
<td>0.29%</td>
</tr>
<tr>
<td>Any myocardial infarction</td>
<td>0.74%</td>
</tr>
<tr>
<td>Emergent surgery</td>
<td>0.15%</td>
</tr>
<tr>
<td>Stent thrombosis in one month</td>
<td>0.53%</td>
</tr>
<tr>
<td>Presumed stent thrombosis</td>
<td>0.82%</td>
</tr>
<tr>
<td>Renal failure</td>
<td>0.28%</td>
</tr>
<tr>
<td>Hemodialysis</td>
<td>0.17%</td>
</tr>
<tr>
<td>Retroperitoneal bleeding</td>
<td>0.18%</td>
</tr>
<tr>
<td>Vascular complication and bleeding</td>
<td>0.79%</td>
</tr>
<tr>
<td>CEP</td>
<td>1.8%</td>
</tr>
<tr>
<td>CEPnoST</td>
<td>1.58%</td>
</tr>
<tr>
<td>Any complication</td>
<td>3.36%</td>
</tr>
</tbody>
</table>

23,399 consecutive PCIs

Hellenic J Cardiol 2009; 50: 379-387

A

- All complications: 1999-2002: 4%, 2003-2006: 2.7%
- CEPnoST: 1999-2002: 2.02%, 2003-2006: 1.1%
- Death: 1999-2002: 0.68%, 2003-2006: 0.52%
- Stroke: 1999-2002: 0.4%, 2003-2006: 0.16%
- Emergent surgery: 1999-2002: 0.19%, 2003-2006: 0.12%

B

- Vascular: 1999-2002: 0.99%, 2003-2006: 0.57%
- Stent thrombosis (ST): 1999-2002: 0.49%, 2003-2006: 0.58%
- Presumed ST: 1999-2002: 0.9%, 2003-2006: 0.7%
- MI: 1999-2002: 1.01%, 2003-2006: 0.46%
- Perforation: 1999-2002: 0.36%, 2003-2006: 0.22%

NS indicates no significant difference between the two periods.

*p < 0.001 indicates a statistically significant difference.
How a simple procedure is complicated?

Successful management of complications

• Early recognition and diagnosis
• Quick and effective treatment
• Stabilization of patient
A team approach to managing complications
Urgent vs. Emergent vs. Salvage Operations

**URGENT**
Procedure required during same hospitalization in order to minimize chance of further clinical deterioration

**EMERGENT**
Patients requiring emergency operations will have ongoing, refractory (difficult, complicated, and/or unmanageable) unrelenting cardiac compromise, with or without hemodynamic instability, and not responsive to any form of therapy except cardiac surgery.

**SALVAGE**
The patient is undergoing CPR en route to the OR or prior to anesthesia induction or has ongoing ECMO to maintain life.
Don’t treat your conscience by surgery.

Emergent CABG in 41 Patients During 5875 PCI (0.7%) 1995-2000

Reasons For CABG

- Dissection
- Maldeployed Stent
- Perforation
- Wire Failure
- Ciot Etc.

Hopkins et al CCI 2001;53:99

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Failed PCI, Urgent or Emergent CABG

Failed PCI to CABG (NCDR CathPCI, 2012)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI Complication</td>
<td>2826</td>
</tr>
<tr>
<td>PCI failure (w/o det)</td>
<td>6299</td>
</tr>
</tbody>
</table>

Isolated CABG, Indications (STS ACSD, 2011-13)

<table>
<thead>
<tr>
<th>PCI failure, no deterioration</th>
<th>Urgent</th>
<th>Emergent</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI failure</td>
<td>671</td>
<td>1170</td>
</tr>
<tr>
<td>Angio Accident</td>
<td>170</td>
<td></td>
</tr>
</tbody>
</table>

PCI Complications. Estimated ~1-3/yr per hospital
Indications for emergency cardiac surgery following PCI

- Extensive coronary dissection (54%)
- Perforation/tamponade (20%)
- Recurrent acute vessel closure (20%)
- Haemodynamic instability (3%)
- Aortic dissection (2%)
- Guidewire fracture (1%)

n=18,593 procedures 1992-2000
Coronary artery dissection

“I can’t believe I just did that!”

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Coronary artery dissection is defined as the separation of the media by hemorrhage with or without an associated intimal tear.

In the modern PCI era, where coronary dissection can be promptly resolved by stent implantation, clinically significant dissection is reported only 1.7%.

Usually due to balloon dilatation injury, during guidewire passage, or trauma due to the guiding catheter.
<table>
<thead>
<tr>
<th>DISSECTION</th>
<th>RISK OF VESSEL CLOSURE (%)</th>
<th>ANGIOGRAPHIC DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt;2</td>
<td>Minor radiolucenties within lumen during angiography without dye persistence</td>
</tr>
<tr>
<td>B</td>
<td>2-4</td>
<td>Tracks/double lumen with radiolucenties during angiography without dye persistence</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>Extrakulmonary cap with dye persistence</td>
</tr>
<tr>
<td>D</td>
<td>30</td>
<td>Spiral luminal filling defects</td>
</tr>
<tr>
<td>E</td>
<td>9</td>
<td>New persistent filling defects</td>
</tr>
<tr>
<td>F</td>
<td>69</td>
<td>Non A-E types that lead to impaired flow or total occlusion</td>
</tr>
</tbody>
</table>
Risk factors

- The use of Amplatz-shaped catheters.
- Catheterization for acute myocardial infarction.
- Vigorous catheter manipulations.
- Vigorous contrast injection.
- Deep intubations of the catheter.
- Variant anatomy of the coronary ostia.
- Vigorous, deep inspiration.
Bail-Out Stenting for Left Main Coronary Artery: A Treatable Nightmare of the Interventional Cardiologist.

C.GRAIDIS, D.DIMITRIADIS, A.NTATSIOS, V.KARASAVVIDIS, V.PSIFOS

EUROMEDICA – KYANOUS STAVROS HOSPITAL

Endovascular Cardiac Complications
15-17 JUNE 2011-LAUSANNE, SWITZERLAND
CASE PRESENTATION

• 49 years old, white male

PMH:
• Hypertension
• Dyslipidaemia
• Active smoker

The patient referred with acute sub-sternum pain of an early onset, nausea, and fatigue.

ECG findings: SR, with T wave inversion in leads II, III, aVF, V4-V6.

Physical examination unremarkable.
LAD: severe proximal disease.

Cx: critical stenosis at OM1 branch

RCA: mild irregularities
During withdrawal of the balloon, inadverted deep intubation of the guiding catheter led to dissection of the LMS.
Patient was asymptomatic, hemodynamically stable, ECG was normal and TIMI 3 flow was maintained.

What would you do?
1. CABG
2. PCI with DES

If PCI decided:
  a) LM stenting first?
  b) Treat the distal lesions of LAD and OM1 first?
A BMW guidewire was rapidly advanced across the dissected left main into the LAD.

A Promus Element 2.5x16mm was implanted in the OM1.
A Promus Element 3.0x24mm was implanted in the LAD and a Promus Element 4.0x24mm was implanted in the LMS to LAD and covered the dissection.
FINAL RESULT
EXTENSIVE, CATHETER-INDUCED DISSECTION OF THE RIGHT CORONARY ARTERY TREATED SUCCESSFULLY WITH FULL METAL JACKET.

C. Graidis, D. Dimitriadis, A. Ntatsios, V. Karasavvides, V. Psifos.

Cardiology Department, Euromedica – Kyanous Stavros, Thessaloniki, Greece.

Complication case ICE 2010

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CASE REPORT

• 57 y.o. male with effort angina
• Positive Exercise Tolerance Test
• Past Medical History: Hypertension, Dyslipidaemia
• Resting 12-lead ECG, ECHO: Normal
Coronary Angiography

Severe stenosis of the RCA (proximal, mid-vessel and at the bifurcation with severe calcification)

Moderate disease of the LAD
PCI RCA

Implantation with difficulty of an Endeavor 2.25x14mm at the distal lesion
During withdrawal of the balloon, inadvertent deep intubation of the guiding catheter led to an extensive, spiral dissection of the Right Coronary Artery from the ostium up to the implanted stent at the bifurcation level.
Final Result after post dilatation with Quantum 3.0x15 and Quantum 3.5x15.

Stented length 134mm
Prevention of catheter-induced coronary artery dissection

• Choice of guide catheter and handling techniques
  ✓ Appropriately sized and shaped catheters to avoid the contrast injection being directed at a plaque
• Awareness of the potential risk may aid in rapid recognition
• Initial contrast injections should not be forceful until correct coaxial alignment of the catheter has been demonstrated.
• Contrast should not be injected if the pressure is damped
Appropriate treatment of choice and timing is dependent upon the clinical scenario

Prompt bailout stent implantation, urgent CABG, or conservative therapy, are the alternative strategies

The strategy for managing of LMCA dissection is variable and depends upon:

- the mechanism,
- the co-morbidities of the patient and
- degree of hemodynamic stability
- prompt treatment availability,
- and the operator’s experience.
Coronary artery dissection

Acute closure

Vessel < 2.5 mm
- Medical therapy for No symptoms and Small territory
- RePTCA or Stent

Vessel > 2.5 mm
- Focal dissection
  - Stent
    - Acceptable result
    - Poor result
      - Bailout catheter
        - Poor result
        - Acceptable result
  - Extensive or spiral dissection
    - Multiple stents
It seems that the nature of this complication is dynamic, as the dissection may extend and/or intramural hematoma may develop, leading to progressive deterioration. **Because of this dynamic nature, a conservative treatment strategy is rarely adopted**

**Bail-out stenting is considered an acceptable treatment strategy with a high success rate and reasonable long-term outcomes**

- If PCI is chosen, wiring the true lumen of the dissection is paramount, because inadvertent stenting of the false lumen will completely occlude the coronary artery
- **Soft-tip wires should be used to access the true lumen**, and contrast should be injected through an over-the-wire balloon to confirm the true lumen.
- **If the initial attempt fails and enters the false lumen, another soft-tip** wire should be carefully manipulated into the true lumen, guide may be withdrawn a bit.
Catheter induced dissection with retrograde extension to aortic root is a rare and a potentially catastrophic complication of coronary angiography and intervention with a frequency **of about 0.008–0.02% of diagnostic catheterizations and 0.04–0.06% of PCIs**.

- Of the type-A dissections in the International Registry of Aortic Dissection (IRAD), **27% were caused by coronary angiography or interventions.**
- This event is a devastating complication of PCI, **with a mortality rate up to 32%,** similar to that of spontaneous type-A aortic dissection (35%).
- It occurs following a trauma caused by the tip of the guiding or diagnostic catheter (due to unintended deep intubation), subintimal passage of the rigid guidewire, or because of balloon dilatation.
Risk factors

- Hypertension,
- Older age,
- Extensive atherosclerosis
- History of MI
- Underlying structural weakness of media (e.g., cystic medial necrosis)
- Variant anatomy of the coronary ostia (e.g., downward sloping origin of the left main coronary artery),
- The shape and size of the diagnostic catheters
- Vigorous hand injection of contrast material

Iatrogenic aortic root dissection
Most described cases occurred during angiography and angioplasty of the right coronary artery (RCA) 

The RCA may be more susceptible to retrograde aortocoronary dissection than the left coronary because

(1) the diameter of the left coronary artery is larger than that of the RCA
(2) the angle of the ascending aorta with the left coronary artery is acute, possibly providing a better approach for Catheterization and
(3) the peristial wall and sinotubular junction of the left coronary artery are formed by more smooth muscle cells and by a dense matrix of collagen type-I fibers.
Classification of aortic dissection

<table>
<thead>
<tr>
<th>De Bakey Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>De Bakey Type I</td>
<td>Originates in the ascending aorta, propagates at least to the aortic arch and often beyond it distally.</td>
<td></td>
</tr>
<tr>
<td>Type II</td>
<td>Originates in and is confined to the ascending aorta.</td>
<td></td>
</tr>
<tr>
<td>Type III</td>
<td>Originates in the descending aorta and extends distally down the aorta or, rarely, retrograde into the aortic arch and ascending aorta.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stanford Type A</th>
<th>Type A</th>
<th>Type B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stanford Type A</td>
<td>All dissections involving the ascending aorta, regardless of the site of origin.</td>
<td></td>
</tr>
<tr>
<td>Type B</td>
<td>All dissections not involving the ascending aorta.</td>
<td></td>
</tr>
</tbody>
</table>
# Proposed Classification for Coronary Dissection With Retrograde Extension Into the Aortic Root

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLASS 1</strong></td>
<td>Involving the ipsilateral aortic cusp</td>
</tr>
<tr>
<td><strong>CLASS 2</strong></td>
<td>Involving cusp and extending up the aorta &lt;40 mm</td>
</tr>
<tr>
<td><strong>CLASS 3</strong></td>
<td>Involving cusp and extending up the aorta &gt;40 mm</td>
</tr>
</tbody>
</table>

(All such dissections are Type A Stanford)
Most iatrogenic aortic dissections from the coronary ostia remain confined to the coronary sinus and almost all are limited to the ascending aorta (Stanford type A; DeBakey types 1 or 2).

But remember...........

The extent of dissection might be underestimated by angiography, especially if the entry point has been sealed by stenting.
Aortocoronary Dissection With Extension to the Suprarenal Abdominal Aorta

A Rare Complication After Percutaneous Coronary Intervention

Therapeutic strategies include:

1. *surgical intervention*,

2. *stenting the entry point of the coronary dissection*

3. *conservative treatment.*
   • Conservative management is a reasonable option only in hemodynamically stable patients with localized aortic dissection.
   • Sinus of Valsalva dissections that remain localized during catheterization tend to resolve spontaneously in the first month.
   • Nevertheless, conservative treatment is unsuccessful in 50% of cases due to myocardial infarction, progression of retrograde dissection or death.

The optimal management of iatrogenic aortic dissection *remains controversial and is based largely on case reports* and anecdotal experience.
Concurrent Dissections of the Ascending Aorta and Right Coronary Artery During Percutaneous Coronary Intervention: A Case Report


However, the patient was managed conservatively. Serial evaluation with noninvasive imaging studies showed resolution of the ascending aortic dissection.

Magnetic resonance imaging 45 days later demonstrating nearly complete healing of the aortic dissection

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Stenting the ostium of the coronary artery (RCA or left main) can be a valid and life-saving therapeutic option for the patient.
Iatrogenic aortic root dissection

Initial ostial stenting is crucial and an opportunity for conservative treatment:

• Sealing the entry point of the dissection raises the chances for and healing of the entire dissected ascending aorta

“watch and wait” strategy

The second step is to keep the patient under close surveillance, titrate blood pressure to low normal values and perform repetitive ultrasound imaging in short intervals.

The dissection it can still persist or relapse in some cases, despite ostial stenting.
Iatrogenic aortic root dissection

However, even when the dissection is extensive, **stenting of the ostium may be enough to control the dissection**

- In previous reported series, the need for urgent surgery ranged between 22% and 25%

**Surgical consultation, when**

- Involvement of the supra-aortic vessels
- Extensive retrograde aortic dissection > 40 mm
- Significant aortic regurgitation
- Pericardial effusion/tamponade

A cardiac surgical consult should be sought early.
Iatrogenic aortic dissection can also occur independent of a dissection extending from the coronary circulation. Manipulation of catheter equipment without a guidewire is the predominant cause.
If there are no important symptoms, the dissection is small and the imaging studies show no progression, it seems reasonable to follow a conservative strategy. If not, surgery may need to be considered.
In patients who are considered **high risk for a potentially poor outcome** related to direct surgical repair of their AAD, **an endovascular approach may prove to be a very acceptable alternative therapy.**
Coronary artery perforation

When ‘good’ is the enemy of ‘good enough’...

“Sometimes you only know what is enough by learning what is too much...”
Background

Angiographic evidence of coronary perforation has been reported in 0.1 to 3.0% of lesions treated using different types of intervention and 20% of the cases are referred for emergency revascularization surgery.

When coronary perforation occurs, it may rapidly result in cardiac tamponade, myocardial infarction or death, hence prompt treatment is required.
Coronary artery perforation

Several factors can be associated with these conditions:

**Clinical variables:**
- advanced age
- female sex
- renal dysfunction and non-ST-segment elevation myocardial infarction

**Angiographic factors:**
- chronic total occlusion, coronary artery calcification, tortuous vessels
- target lesions in the circumflex and right coronary arteries
- long target lesions (>20 mm), and eccentric lesions

**Technique-associated factors:**
- use of hydrophilic/extra stiff wires, atherectomy devices
- increased balloon to artery ratio, intravascular ultrasound guided PCI
- optimization and high-pressure stent postdilatation, percutaneous excimer laser coronary angioplasty, and cutting balloons
Ellis Classification

• **Grade I:** Extraluminal crater without extravasation

• **Grade II:** Pericardial or myocardial blush without contrast extravasation

• **Grade III:** Extravasation through frank (>1mm) perforation or cavity spilling into an anatomic cavity chamber
Coronary artery rupture during Optimization of Coronary Stents Using High-Pressure-Balloon Inflations: A treatable nightmare?

C.GRAIDIS, D.DIMITRIADIS, V.PSIFOS, V.KARASAVVIDIS, G.TSONIS, O.HALVATZOULIS

EUROMEDICA – KYANOUS STAVROS HOSPITAL THESSALONIKI, GREECE

9o PANHELLENIC CONGRESS Of Hellenic Society of Thoracic and Cardiovascular Surgeons Thessaloniki 23-24 November 2012
CASE PRESENTATION

• 72 y.o female.
• Risk factors for IHD: Hypertension, Dyslipidaemia.
• DHx: Aspirin, Clopidogrel, statin, β-blocker, nitrate.
• Referred for cardiac catheterisation because of exertional angina and a strongly positive Exercise Tolerance Test.
Diagnostic coronary angiogram

LMS: Normal
LAD: Severe proximal and mid-vessel disease
Cx: Normal    RCA: Mild irregularities
• Heparin 6.000 IU.
• Two overlapping 3.0x32 and 3.5x24mm Taxus stents were directly implanted.
• Due to underexpansion of the distal stent, we decided to perform postdilatation.
What balloon would you choose for post-dilatation?

1. Non-compliant balloon 3.5mm?
2. Non-compliant balloon 3.0mm?
3. Balloon of the proximal stent (3.5mm)?
Immediately after postdilatation with the 3.5x24mm balloon (of the proximal stent) at 16 Atm...

Sudden cardiovascular collapse
Severe perforation of the LAD with contrast extravasation (Ellis type III perforation)

• The patient developed chest pain and dyspnoea.
• Blood pressure dropped to 70/50mmHg – cardiac tamponade.
How would you manage this complication?

1. Call the surgeons
2. Balloon inflation, emergent pericardiocentesis, reversal of heparine.
3. Covered stents.

OR....
Pray Hard!!!!!!
Management of Coronary Perforation

**Hemodynamic Support**
- Volume, Inotropes
- Pericardiocentesis
- IABP

**Seal Perforation**
- Reverse heparin
- Balloon occlusion
- Platelets (abciximab)
- Embolization (coil, gel foam, thrombin)
- Covered stent
- Surgery
• Prolonged balloon inflation to stop the leakage.
• Emergent Pericardiocentesis.
• Blood pressure increased to 100/70mmHg.

Initial balloon dilatation can be done just at or proximal to the site of dye extravasation (many Type I and II perforations may seal off with prolonged balloon inflation alone but significant risk of late tamponade requires vigilant monitoring).
Two PTFE covered stents 3.0x16 and 3.5x12mm (Jostent graftmaster) were deployed (Single guiding catheter used- Leak sealed, anticoagulation not reversed).
Coronary angiography 1 hr later, showing successful sealing of the perforation.
• Peak CK after the procedure was 450 U/L.

• The patient was discharged five days later and was advised to continue dual antiplatelet therapy for at least 1 year.
PTFE COVERED STENT

The Jomed Covered Stent Graft is a balloon expandable, slotted tube stent comprising a layer of ultra-thin (75μm) PTFE graft material sandwiched between two stents of reduced wall thickness.

Shortening on expansion <3%. Mounted profile 1,6mm.

High pressure inflation (16 to 20Atm).
For most type III perforation, lower pressure balloon inflation is essential to prevent further leakage, tamponade or even death and should not be interrupted for a relatively long time.

The double guiding catheter technique gives the operator much enough easiness and time to deliver PTFE-covered stent while keeping the patient hemodynamically stable.
Dual guide catheter technique for the treatment of coronary perforation.
Perforation Grade and Outcome

- Tamponade: Grade I 0.0%, Grade II 4.0%, Grade III 10.0%
- E-CABG: Grade I 0.0%, Grade II 9.0%, Grade III 15.0%
- Death (in hospital): Grade I 0.0%, Grade II 1.0%, Grade III 11.0%

Javad. Am J Cardiol 2006;98:911-914
Outcomes After Perforation
(May 1996-May 2005)

Use of covered stent
Without use of covered stent

p=0.74

Tamponade:
- Use of covered stent: 15.0%
- Without use of covered stent: 20.0%
- p=0.67

CABG:
- Use of covered stent: 31.0%
- Without use of covered stent: 35.0%
- p=0.49

Death:
- Use of covered stent: 23.0%
- Without use of covered stent: 15.0%

72 perforations/38559 cases = 0.19%

Javad. Am J Cardiol 2006;98:911-914

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**Conclusion.**

✓ In coronary perforations during percutaneous interventions, today coated stent implantation seems to be the first choice in treatment of coronary perforation considering the high mortality and morbidity rate of surgery.

✓ **PTFE-covered stent implantation is easy, rapid and appears to offer the best treatment option for acute perforations.**
Coronary air embolism is a rare complication of cardiac catheterisation ranging in incidence from 0.1 to 0.3%, and is almost always iatrogenic.
Sequelae range from various clinically-insignificant events to an acute coronary syndrome and death

*Signs and symptoms of coronary air embolism:*
- chest pain,
- hypotension,
- transient ECG changes consistent with myocardial ischemia,
- arrhythmias (bradycardia, heart block, ventricular tachycardia, and ventricular fibrillation),
- and even cardiac arrest.

*More than half of these embolic events are asymptomatic.*
Coronary air embolism

The possible mechanisms
• Incomplete aspiration and flushing of the angiographic or guiding catheters
• The rupture of a balloon during high inflation,
• The movement of air from catheter to coronary system during intracoronary medication
• Structural failures of the equipment
• Leakage of air via a defective manifold system

Retrospective data suggest that inadequate technique is the predominant cause
• With junior operators, particularly in the first months of training, more prone than senior;
• And events more common during PCI than diagnostic catheterisation
The consequences of coronary air embolism depend on:

- the volume of air injected into the coronary arteries
- the rate of accumulation.
- the sizes of micro air bubbles
- the baseline cardiac function
- subsequent vascular responses such as vasospasm or distal air-lock. The latter may require arterial pressures of up to 200 mmHg to dislodge into the venous system.

The amount of gas required to cause clinical symptoms may be remarkably small (in porcine models as little as 0.02 ml/Kg).
Coronary air embolism

There are no sufficient data to guide decisions on therapy

Adequate management of this complication has not been established because these cases usually remain unreported due to the clinicians’ reluctance to discuss the complications of their work.

The vast majority of observed emboli are extremely small volumes of air that do not result in symptoms or hemodynamic consequences; therefore, they require no therapy.

For the mild to moderately symptomatic episodes, routine management with supportive measures:
- 100% oxygen by face mask,
- analgesics for chest pain,
- monitoring and treating arrhythmia for the few minutes it takes for the air to clear spontaneously.
Coronary air embolism

The management of massive air embolism should be extremely quick so as to save life of the patient. Aggressive efforts to reestablish the coronary blood flow as soon as possible are essential to reduce injury to the myocardium and to speed recovery from the hemodynamic crisis.

Disruption or dislodgement by the guidewire, forceful injection of saline to fragment the air embolus and allow dispersal distally.

• Such interventions may result in main vessel patency but have a potential to damage the distal microvasculature due to widespread, smaller embolizations.
Management

- Aspirate immediately with manifold
- 100% Oxygen with non-rebreather
- Vasopressors
- Hemodynamic support
- Give vasodilators IC
- Give epinephrine IC
- Increase perfusion pressure
- Manual Blood perfusion
- Mechanical or manual aspiration catheters
- Disrupt air bubbles with guidewire
In contrast, aspiration aims at resolving the blockage by removing the air.

• Aspiration has been attempted with nondedicated devices such as over the wire (OTW) balloons or the angiography catheter itself.

• Use of aspiration catheter
Massive Coronary Air Embolism Treated Successfully by Simple Aspiration by Guiding Catheter

Santosh Kumar Sinha, Amit Madaan, Ramesh Thakur, Umeshwar Pandey, Kush Bhagat, Surendra Punia

Use of the angiography catheter is limited by the ability to manipulate it deeply enough to affect the distal embolus
In contrast, the export aspiration catheter is a dedicated system for coronary artery aspiration. As such, it has the favorable qualities of being a monorail system that has the flexibility and slenderness to reach distal lesions down tortuous vessels.
ROUTINE IS NEVER ROUTINE

“I was navigating by sight because I knew the depths well and I had done this manoeuvre three or four times,”

Captain Francesco Schettino
Master, Costa Concordia

Consequences of complacency…

Hellenic Institute of Cardiovascular Diseases

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