Managing PCI Complications

IJN Cath Lab Symposium
IJN College
8th October 2016

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PCI
Procedure Complications

Where possible, they are best prevented

Knowledge of patient and lesion variables

But…… PCI has progressed,

PCI now applied to more complex lesions & patients

Proliferation of new technology
Procedure Complication Categories

- Death
- Stroke
- MI
- Ischaemia requiring emergency CABG
- Vascular Site Access complications
- Contrast Nephropathy
- Excessive bleeding requiring treatment
- Others – coronary perforation, tamponade
Before PCI:

Evaluate the patient
- clear indication, justifies the risks
- ‘treating ischaemia, not stenosis’

‘avoiding unnecessary procedure → avoids unnecessary complication/s’

Judge / Consider:
- risk/benefit of procedure
- lesion/technical issues
- patient co-morbidities

Prepare for potential complication/s
Assessment & Preparation

- Heart failure – treat & stabilize first
- Diabetes – prevent hypo & hyperglycemia
  -- withhold Metformin if renal-impaired
- Steroids if steroid-dependent or history of allergy
- Correct electrolyte imbalance, bleeding potential
  INR should <1.8, platelets should >50,000)
- Defib & resuscitation trolley nearby
- Ensure easy access to anaesthetic support,
echo and temporary pacing available
- Get second opinion as necessary
Assessment & Preparation

• Renal Insufficiency eGFR <60ml/min:
  • Ensure adequate hydration
  • ? N acetyl cysteine
  • Care with contrast,
    not > 5 ml x weight (kg)/serum creatinine [mg/ml]
Vascular Access:

- Femoral approach
- Radial approach
Bifurcation of common femoral artery:
~ 3 cm below inguinal ligament
**Puncture site:** inferior border of femoral head ibfh
Middle third of femoral head

Enters common femoral artery cf above bifurcation into superficial femoral artery sfa & profunda p branches
Predictors of complications related to vascular access

- Female gender
- Advanced age
- Small body surface area
- Anticoagulation
- Peripheral vascular disease
- Diabetes Mellitus
- Suboptimal technique – puncture and closure
Femoral Approach:
Prevention of complications

- Where surface anatomical landmarks are difficult, use:
  - Fluoroscopic bony landmarks
  - Ultrasound

- If closure device to be used, assess safety with femoral angiography.
Complications of Femoral Access:

- Retroperitoneal haemorrhage
- Pseudoaneurysm
- AV Fistula
- Infection
- Haematoma
- Neuropraxia
- Lower limb ischaemia (thrombosis or embolism)
- Dissection
Haematoma
Femoral Pseudoaneurysm

Vascular Ultrasound

Communicating neck (channel) between the femoral artery FA and the surrounding haematoma
Femoral Arteriovenous Fistula

turbulent colour jet between the right femoral artery & vein.
Complications of Radial Access:

- Vasospasm
- Pseudoaneurysm
- Puncture site granuloma
- Perforation
- Dissection
Problems & Complications

Arterial Spasm:

Terumo Wire

Insertion of Guide
Radial arterial damage - Perforation:

- Tortuousity and looping
- Spasm
- Often a matter of feel
- If in doubt: Take an angiogram!
Pseudoaneurysm & Haematoma
Radial artery pseudoaneurysm

successfully treated by pressure bandage
To Reduce Transradial Access Complications:

- Vasodilator “cocktail”: CCB and/or Nitrate
- Heparin 3,00 to 5,000 Units
Complications During PCI:

Potentially life-threatening, emergent:

1. Unexpected acute impairment of myocardial perfusion – slow / no reflow
2. Coronary Perforation
3. Retained equipment – fracture or embolization
Complications During PCI:

Managing Complications: General:

Stabilize haemodynamics:
- airway, breathing, circulation.
- May need iv fluids, inotropes, pacemaker, IABP

Emergency surgery:
- The need has reduced tremendously
Complications During PCI:

Indications for Emergency Surgery:

1. Unresolved Perforation / Tamponade

2. Aortic Dissection

3. Retained equipment, not retrievable by percutaneous technique
Equipment / Devices that May be Needed

✔ Defibrillators
✔ Covered stent
✔ Retrieval devices e.g Snare
✔ Pericardiocentesis and drain set
✔ Material for distal embolization – coils, foam
✔ Aspiration catheter
✔ Microcatheters
✔ IABP
✔ Temporary pacing set
✔ Echo – portable
✔ Medications – Atropine, Vasopressors,
  - Vasodilators for slow reflow or no-reflow
Microcatheter for Ostial Dissection

- False lumen with haematoma
- True lumen
- Guide catheter
- Microcatheter within dissection flap and haematoma. Aspiration decompresses the false lumen and permits re-access to the true lumen.
Prevention of Thrombus Formation

- Keep equipment dwell times to minimum
- Flush introducers and catheters
- Weight-adjusted heparin
- Keep ACT >250 – 400 seconds with regular checks
Coronary Perforation:

Potential Causes:

- Wire exit, ‘distal’ end of intracoronary wire, especially the stiff wires.
- Oversized balloons or stents
- Balloon rupture
Properly Size the Vessel

Vessel Sizing Technique - Limitations

<table>
<thead>
<tr>
<th>Actual Vessel Size</th>
<th>OCT</th>
<th>IVUS</th>
<th>QCA</th>
<th>Visual Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 mm</td>
<td>3.0 mm</td>
<td>3.1 mm</td>
<td>2.8 mm</td>
<td>2.7 – 3.3 mm</td>
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</tbody>
</table>

- **Most Accurate**: OCT
- **Over Estimation**: IVUS
- **Under Estimation**: QCA
- **Observer Variability**: Visual Estimate

Margin of Error* ↑

Recognize the Risk of Underestimating or Overestimating the size of the Vessel Size by Visual Estimation

*Margin of error estimates based on resolution for each imaging modality:
Offset and variability of visual estimate: data on file at Abbott Vascular.
Coronary Perforation:

Often associated with CTO Intervention:

- Use of stiffer guidewires with high penetration power,
- Strategies designed to cross subintimal space
- Retrograde access via an epicardial vessel.
**Coronary Perforation: Prevention:**

- Guidewires: careful manipulation especially the ‘stiffer’ wires
- Avoid oversizing balloons >1.1:1 balloon:artery ratio.
- Watch distal end of wire to prevent wire exit,
- For (antegrade/retrograde) technique of PCI CTO, use contralateral contrast injection to guide wire’s luminal access.
- Avoid unnecessary temporary transvenous pacing at the RV apex.
Coronary Perforation: Diagnosing:

✓ Unexplained hypotension ← suspect perforation, perform echocardiography, look for pericardial effusion
✓ Radiographic extravasation
✓ Errant wire position
✓ Tamponade
Coronary Perforation: Angiographic classification

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Extraluminal crater without jet extravasation</td>
</tr>
<tr>
<td>Type 2</td>
<td>Pericardial or myocardial blushing without jet extravasation</td>
</tr>
<tr>
<td>Type 3</td>
<td>Active jet extravasation</td>
</tr>
<tr>
<td>Type 4</td>
<td>Cavity spilling</td>
</tr>
<tr>
<td>Type 5</td>
<td>Distal perforation</td>
</tr>
</tbody>
</table>
RCA CTO at Middle Segment
Wire dissection of proximal RCA
Stent Deployment in Middle Segment
Stent Deployment in Proximal Segment
Post Stent Deployment
Pre: Aortic Root Dissection & Wire Dissection of RCA

Post Stent Deployment x2
Vascular Coils for embolization

Other materials that can be used:
Gelfoam gel
Autologous fat
Pre-clotted autologous blood clot
Glue
Thrombin
Perforation
For type 3 perforation, the only emergency intervention is deploying a stent graft. A covered stent with Polytetrafluoroethylene (PTFE) (Jostent) is often used.
Type 3 coronary perforation:

Perforation with jet extravasation
Stent in Prox and Middle Segment of LAD
Inflated Balloon Dislodgement
 Coronary Peforation
Coronary leak after stent placement
Persistence of Coronary Perforation After Stent Placement
Coronary Perforation Minimized After Prolonged Balloon Dilatation of Stent
Coronary Perforation

Perforation Sealed
Pericardiocentesis Set

Normal pericardium

Pericardial effusion

Pericardial sac

ASPIRATING THE PERICARDIUM

A

B
Coronary Perforation: Management:

- Type 1 & Type 2 are generally benign and seal after balloon inflation or occasionally can be left untreated.
- Careful monitoring. Heparin, 2b3a inhibitors stopped and reverted, if necessary.
- If ‘jet’ extravasation, will usually need pericardiocentesis and drain insertion.
- Trial of prolonged dilatation with larger balloon.
- ‘larger’ vessels may need stenting with PTFE-covered stent or pericardium-covered stent.
Coronary Perforation: Management:

- Type 4 – conservative management
- Type 5 perforation may require distal embolization, using vascular coils, gelfoam, polyvinyl alcohol, pre-clotted autologous blood clot, autologous fat, glue, thrombin.
- Care: a portion of the vessel may have to be sacrificed
- Avoid proximal migration of embolic material.
Retained Equipment: Management:

May include:

- Stents
- Guidewire fragments
- Catheter fragments
- Misplaced intravascular coils
- Any diagnostic equipment/s
Retained Equipment: Management:

Stent loss /embolization: May occur:

- Stent-balloon pullback into delivery guide catheter, including mother-child catheter. Associated with:
  - Poor guide support
  - Lack of coaxial guide catheter position
  - Vessel tortuosity
  - Calcification, absence of predilatation
  - Deformed stent strut
Retrieval Devices: ✓ Snare

Cook Vascular Retrieval

Distal portion of gooseneck snare

Curry Intravascular Retriever Sets
Conclusions

Best to prevent.
Evaluate the patient
Be prepared for potential problems
Have equipment that maybe required
  - covered stents
  - snares
Watch wire position
Care when handling the PCI devices and stents.
Thank You
Femoral Approach
Proper access to the common femoral artery is critical for this technique.

Vascular complications are increased if the arterial puncture is made either above or below the common femoral artery.

The main advantages to this method are its ease and substantial safety record.

The main disadvantage is the need for an extended period (2-6 hours) of bed rest after completion of the procedure.
Several types of arterial closure devices are now available that provide rapid hemostasis and shorten the period of bed rest considerably.

However, complication rates with these closure devices are similar to those of conventional manual compression.
Because of the smaller-diameter arteries in the upper extremity (and, thus, the more occlusive nature of the catheters), anticoagulation is required for the procedure.

Unfractionated heparin is used frequently.

Many operators also administer heparin when access is obtained from the femoral artery, especially if the procedure is prolonged and several catheter exchanges are required.
Vascular Complications

- Pseudoaneurysm, AV fistula, infection, deep vein thrombosis
- Arterial occlusion
  - dissection, embolism, thrombosis
- Bleeding
  - minor (up to 14%) worse with adjunctive pharmacotherapy
  - major
  - retroperitoneal hemorrhage
Complications for Coronary Angiography

- Death: ~ 0.1%
- MI: 0.05%
- Stroke: 0.07%
- Serious vent arrhythmia: 0.4%
- Major vascular complications: 1.0%
  (thrombosis, bleeding req transfusion, pseudoaneurysm)
## Complications for PCI

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
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<tr>
<td>Death (elective)</td>
<td>0.2%</td>
</tr>
<tr>
<td>Death (emergency PCI)</td>
<td>1.6%</td>
</tr>
<tr>
<td>Q MI</td>
<td>0.5%</td>
</tr>
<tr>
<td>Non Q MI</td>
<td>4.6%</td>
</tr>
<tr>
<td>Stroke</td>
<td>0.2%</td>
</tr>
<tr>
<td>Major vascular complications</td>
<td>1.0%</td>
</tr>
<tr>
<td>(thrombosis, bleeding req transfusion, pseudoaneurysm)</td>
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Risk Factors for Vascular Complications

- Old Age
- Female gender
- High grade atherosclerosis at the access site
- Obesity
- Arterial hypertension
- Adjunctive pharmacotherapy
Haematoma
radiopacities overlying right psoas muscle indicative of retroperitoneal hemorrhage.
Femoral Pseudoaneurysm

Vascular Ultrasound

Communicating neck (channel) between the femoral artery FA and the surrounding haematoma
Femoral Arteriovenous Fistula

turbulent colour jet between the right femoral artery & vein.
Occult blood loss from a retroperitoneal hematoma should be considered if:
1) hypotension cannot be explained
2) Difficult access or passage of wire, catheter.

Vasopressor agent/s should be administered if central perfusion is compromised.
Transradial
The main advantages of this approach:

- low incidence of serious vascular complications
- ability to mobilize the patient quickly after the procedure.

The disadvantages:

- a longer learning curve for the operator
- occasional severe arterial spasm, which impairs manipulation of the catheter.
In general, **transradial approach** is preferred, if the patient:

- has clinically significant iliac or femoral artery atherosclerosis, or
- has severe obesity that renders the normal landmarks for access difficult to appreciate.
- patients on anticoagulants
  \(\Rightarrow\) better control of access site
Rare & Unique Complications

- Refractory spasm
- Radial artery occlusion 1 – 5% : usu. of no consequence
- Arteriovenous fistula
- Pseudoaneurysm
- Severe haematoma [→ compartment Syndrome]
- Hand ischaemia ← absence of collateral circulation
- Radial artery avulsion or rupture during sheath removal (← excessive force)
Problems & Complications

**Arterial Spasm:**
Problems & Complications

Arterial Spasm:

Terumo Wire

Insertion of Guide
Problems & Complications

Arterial Spasm:

Prevention & Treatment:
- Intraarterial
  - Nitroglycerine or Isosorbide Dinitrate
  - Verapamil
  - Both diluted to 100µg/ml
Problems & Complications

- Arterial Spasm
  maybe refractory

- Vessel Injury bleeding & haematoma
  wire perforation of small branches
  If recognized early, compressive bandage
Problems & Complications

Loops & Kinks

• If resistance to passage of wire
• Use fluoroscopy guidance
• Angiography to identify the problem
• Judicious use of ‘Terumo’ and ‘superstiff’ wire
• Radial artery damage - Perforation:

Tortousity and looping

Spasm

Often a matter of feel

If in doubt:
Take an angiogram!
Complications of the Radial Approach

Radial artery damage- Perforation:

MIDFOREARM HAEMATOMA
Complications of the Radial Approach

Treating Forearm Hematoma

– If sheath still in do angiogram
  consider longer sheath if perforation documented
– Discontinue GP IIbIIIa inhibitors
– External pressure to forearm – bandage
– Elevate hand and forearm
– Consult (hand, plastic or vascular surgery)
- Radial artery damage
- Perforation:
Pseudoaneurysm & Haematoma
Radial artery pseudoaneurysm

successfully treated by pressure bandage
Complications Common to both Approaches
May occur, especially during coronary angiography. Some patients are sensitive to the vasodilator effects of the contrast and may experience mild chest discomfort during each dye injection, even in the absence of underlying coronary artery disease (CAD).

In patients with important CAD, myocardial ischemia with pain and ST-segment changes may occur. This frequently resolves with sublingual or IV nitroglycerin. Persistent pain with evidence of myocardial ischemia may be an indication for urgent revascularization.
**Arrhythmias:**

- Minor arrhythmias (e.g., atrial or ventricular premature beats or brief episodes of supraventricular tachycardia):
  - Common
  - Usually resolve without treatment

- Ventricular tachycardia or fibrillation:
  - Rare occurrence
  - Requires prompt defibrillation.
Death:

Death rates from cardiac catheterization have declined steadily over the past 15 years. The incidence of procedure-related mortality is now ~ 0.1%.

↑ mortality:

Age:
- Patients >60 years and <1 year

Functional Class:
- New York Heart Association (NYHA) Functional Class
  - Functional class IV associated with nearly a 10x ↑ mortality compared with classes I and II.

Left Main Disease & Ventricular function:
- Severe disease of the LM artery
- Poor left ventricular function (LVEF <30%).
Death:

↑ mortality:

✓ Associated valvular heart disease,
✓ renal insufficiency,
✓ insulin-dependent diabetes mellitus,
✓ peripheral vascular disease,
✓ cerebrovascular disease,
✓ pulmonary insufficiency

Mortality is especially high in those with preexisting renal insufficiency who experience further deterioration of renal function within 48 hours after the procedure, particularly when dialysis is required.
**Myocardial Infarction:**

- Current risk for procedure-related MI < 0.05%.

- Risk of MI is influenced by:
  - Recent unstable angina or NSTEMI
  - Severe CAD
  - Presence of significant comorbidities
    - Diabetes, esp poor-controlled
    - CRF/CKD

In high-risk patients, consider post-procedure:
- serial electrocardiography (ECG)
- cardiac enzyme measurement
Stroke:

Risk ~0.07%.
- remains most devastating complications of cardiac catheterization.

⇐ Embolization of atherosclerotic debris loosened from plaques in the proximal aorta
Allergic Reactions:

may be precipitated by:
local anesthetics,
iiodinated contrast agents,
llatex exposure.

These reactions actually may be vasovagal in origin
Reactions to iodinated contrast agents:

- They occur in ~1% of patients.
- They result from direct complement activation, "anaphylactoid reactions"
- Symptoms: sneezing, urticaria, angioedema, bronchospasm & profound hypotension.
- Risk ↑ in patients with:
  - other atopic disorders,
  - multiple other allergies,
  - h/o previous reaction to contrast

To reduce the risk:

- Premedicated with corticosteroids,
- Use nonionic contrast agent

Severe reactions:

- Reversed w/ IV injection (dilute) epinephrine.

Allergic Reactions:
Renal Dysfunction:

- a potential complication of any angiographic procedure
- ~5% of patients experience a transient rise in plasma creatinine concentration (>1 mg/dL) after contrast exposure.
- ↑ Risk in patients:
  - with preexisting renal insufficiency,
  - multiple myeloma,
  - dehydration
Renal Dysfunction:

- Creatinine levels usually begin to rise 2-3 days after contrast exposure
- slowly return to baseline within 7 days.

- Contrast-induced renal failure
  - usually is nonoliguric,
  - Dialysis occasionally necessary.
    - ~1% eventually require long-term dialysis.

- Contrast nephropathy can be avoided by:
  - limiting contrast volume
Arrythmias
Usually Ventricular
Sometimes Atrial
Occasionally Bradycardias
Coronary Dissection
Dissection
Stent Thrombosis
DES Stent Thrombosis
Stent Thrombosis
Inability to cross with balloon / IVUS
Rotablator
Rotational Atherectomy System

Prior to use, please see the complete ‘Directions For Use’ for more information on Indications, Contraindications, Precautions, Adverse Events and Operator’s Instructions.
Prior to use, please see the complete ‘Directions For Use’ for more information on Indications, Contraindications, Warnings, Precautions, Adverse Events and Operator’s Instructions.

Results from case studies are not predictive of results in other cases. Results in other cases may vary.

All photographs taken by Boston Scientific Corporation.
Intracranial Haemorrhage
Coronary Perforation
Wire Perforation
Perforation
For type 3 perforation, the only emergency intervention is deploying a stent graft. A covered stent with Polytetrafluoroethylene (PTFE) (Jostent) is often used.
Coils for embolization
Distal Embolization
Thrombus in STEMI
Debris in degenerated vein graft
Aspiration catheters
Embolic Protection Device

Angioguard

Filter Wire

Ev3 SPIDER
Wire trapped
Stent dislodgement
Curry Intravascular Retriever Set
Intra-Aortic Balloon Pump
End