Close and Open

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Case history

- 85/F
- DM, HT, Hyperlipidaemia
- **ACS** & CHF
- ECG - T wave inversion anterior and lateral leads
- Raised cardiac enzymes
- Echo *LVEF 25-30%* global hypokinesia, mild MR
- Persistent anginal symptoms despite maximal medical therapy (DAPT, LMWH, anti HF regime)
Coronary angiogram – LCA

Short LMN calcified 50+%
oLAD calcified 90+%
mLAD long diffuse calcified lesion
pLCx 90%
Coronary angiogram – LCA

Short LMN calcified 50+%

oLAD calcified 90+%, mLAD long diffuse calcified lesion

pLCx 90%
Coronary angiogram – RCA

oRCA CTO with retrograde from LCA
Fail to engage with multiple catheters
Summary

85/F, ACS/CHF, poor LVEF

LMN-3VD – Diffusely calcified LMN-LAD disease, pLCx focal disease, oRCA CTO with retrograde from LCA

SYNTAX score 41
How would you manage the patient?

1. Maximize medical treatment
2. Off table; stress test first then decide
3. Consult CTS for urgent CABG
4. Adhoc PCI to all lesions for complete revascularization
5. **PCI to LCA first, then staged PCI to RCA CTO**
LVEF <50%: Evaluate Algorithm

LVEF <40%: Recommend RHC prior to PCI

+2 Cardiac Index < 2.0 or PA sat < 55%
+1 Syntax score ≥ 22
+1 EF < 25%
+1 Systolic < 100mmHg at baseline
+1 ACS presentation
+1 Planned Revascularization ≥ 2 territories
+1 Likely Prolonged Ischemia
  - Retrograde CTO
  - Atherectomy
+1 Severe mitral regurgitation
+1 Decompensated state
  - LVEDP >20
  - Significant new orthopnea
-1 High risk vascular injury / significant bleeding
-1 Hemoglobin < 8
PCI strategy – Guide and MCS

RFA 7Fr JL4 guide

LFA Impella 2.5
PCI strategy – PTCS to LCx, then LMN-LAD (provisional as oLCx minor lesion)
PTCS to LCx
PCI to LAD

Diffusely calcified disease
IVUS failed to cross
Rotational atherectomy
1.25 → 1.5mm burr@160,000rpm few times
for lesion preparation

lesion preparation
PCI to LAD

NC 2.5mm balloon
Ellis type III perforation (very close to LMN)
Suggested algorithm by PCR

Muller O. et al. Management of two major complications in the cardiac catheterization laboratory: the no-reflow phenomenon and coronary perforations. EUROINTERVENTION, 2008
Balloon tamponade

Immediate balloon tamponade with same 2.5mm balloon

Echo minimal pericardial effusion

Perforation persists after balloon tamponade

CANNOT tolerate prolonged balloon tamponade with severe ischaemia and hypotension
Suggested algorithm by PCR

Muller O. et al. Management of two major complications in the cardiac catheterization laboratory: the no-reflow phenomenon and coronary perforations. EUROINTERVENTION, 2008
Double (ping-pong) guiding technique

A
- Balloon inflation at perforation site

B
- Balloon deflation
- 2nd guiding catheter
- 2nd guidewire

C
- Balloon re-inflation
- Covered stent over 2nd guidewire

D
- Covered stent deployed at perforation site
- Deflated balloon
PTCS to LAD

**NOT for ping pong guide** as limited vascular access; and poorly tolerate LMN-LAD balloon occlusion

Overlapping 3.5x20 + 3.0x32 DES quickly deployed to LMN-mLAD
Scenario get worse...

*Persistent perforation* after stenting

REPEATED balloon tamponade but tolerated poorly despite Impella support

Increasing pericardial effusion with near **no intrinsic cardiac output** (full support by Impella and patient remain fully conscious)

**Urgent pericardiocentesis** - 300ml blood aspirated

Haemodynamic much stabilized
Rescue to LAD

Repeated balloon tamponade (dLMN-LAD)
What would you do next?

1. repeated balloon tamponade as far as tolerate
2. call surgeon for open heart surgery to repair the perforation and bypass the coronary
3. stent graft across LMN knowing that the LCx would be closed
## Coronary covered-stent devices

<table>
<thead>
<tr>
<th>Device name</th>
<th>PK Papyrus</th>
<th>GraftMaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover material</td>
<td>Polyurethane</td>
<td>PTFE</td>
</tr>
<tr>
<td>Nominal Pressure</td>
<td>8 atm (7atm / ø4-5mm)</td>
<td>14 atm</td>
</tr>
<tr>
<td>Rated Burst Pressure</td>
<td>16 atm</td>
<td>18 atm</td>
</tr>
</tbody>
</table>

- **Device Design**
  - Single Stent
  - Stent Sandwich

- **Available Size Range**
  - L: 15 - 26mm
  - ø: 2.5 - 5.0mm

- **PK Papyrus 3.0/15**
  - Crossing profile
  - 24% reduction in diameter
  - 43% reduction in cross-sectional area

- **GraftMaster 3.0/16**
  - Data on file at BIOTRONIK
  - *4.5 and 5.0mm diameters are 6F compatible*
Deploy stent graft

PK Papyrus 3.5x15mm to dLMN-pLAD
Post stent graft

LAD perforation SEALED
Yet LCx CLOSED by stent graft
ECG ST elevation, severe hypotension
What would you do next?

1. Observe as LAD perforation sealed off already
2. Call surgeon for urgent CABG to OM and RCA
3. Try to reperfuse LCx by using small balloon over jailed LCx wire
   4. Try puncture the stent graft with stiff wires to LCx; then ballooning and stent across covered stent
Wire puncture through stent graft to LCx

Tried 90 degree Supercross/Conquest pro 9 – FAILED

Tried Crusade/Conquest pro 12 – puncture several time to previous perforation site
Wire puncture through stent graft to LCx

Redirect and repuncture
Successfully cross to mLCx (jailed LCx wire as guidance)
PTCA/S to LCx through covered stent

LAD balloon anchoring
Caravel to LCx
Exchange to soft GW

LAD balloon anchoring
1mm CTO balloon through PK papyrus

LAD balloon anchoring
Sequential 2.0 & 2.5mm balloon through PK papyrus
PTCS to oLCx, then FKB & POT

- 2.75x12mm DES (T-stenting)
- FKB
- IVUS inadequate LMN stent expansion POT with 4mm balloon
Final angiogram

Still mild residual leakage at oLAD
Echo minimal pericardial effusion
Haemodynamic stable
What would you do now?

1. Conservative mx first as mild leakage
2. Reverse all heparin and transfuse
3. Call CTS for urgent surgery
4. Wait and see; for surgical exploration if deterioration
5. Deploy MORE covered stents; re-puncturing GWs to LCx and then put more stent; more high pressure/bigger balloons, FKB etc (repeat ALL STEPS again!)
Outcome

• Echo - minimal pericardial effusion, no tamponade
• To CCU for close monitoring, *heparin reversal*, transfusion of RC and platelets
• Notify surgeons
• ACT – satisfactory
• Persistent drainage of fresh blood from drain >100cc/hr
• Discussed with surgeons – *emergency operation for hemostasis* (no need CPS)
Intraoperative findings

• Heart edematous and friable; poor global LV function
• Minimal blood clots inside pericardial space with patent drain
• 1mm perforation at very calcified pLAD with oozing
• Severe diffuse oozing due to DIC, extremely difficult haemostasis
Post operative

• No more active bleeding from drain

• **DIC**

• Acute kidney injury on dialysis

• Persistent cardiogenic shock

• Severe sepsis, metabolic acidosis

• **Multi-organ failure**

• Succumbed on day 2 post PCI despite maximal support
Recap
What had gone wrong?

*ballooning and stenting* through the covered stent

disruption of graft apposition and result in rebleeding
What had gone wrong?

*inadvertent puncture* of thin stent graft materials

High pressure with a larger balloon may *enlarge the hole* and *cause persistent leak*.
Hindsight
Lessons to learn

• **Know your patient well**
  • Protected PCI (e.g. Impella assisted) is beneficial for selected high risk PCI

• **Respect the anatomy**
  • Never underestimate any calcified lesion
  • Even after rotablation, perforation can still occur following subsequent lesion preparation

• **Prepare for the worst**
  • anticipate and prepare for rescue measure of perforation
  • Immediate balloon tamponade should be the first rescue; buy times for planning and reassessment
  • Perfusion balloon (if available) may be considered for prolonged tamponade
  • In some cases with severe perforation, double guiding technique
Lessons to learn

• **Understand your gadgets**
  • New generation covered stents: low profile, easily deliverable and effective
  • Apply CTO techniques: stiff GWs with microcatheter support (e.g. supercross, crusade, cavarel) is feasible to re-open the blocked branch by the covered stent

• **Stay alert; do not get excited too early**
  • Exercise extreme caution in subsequent ballooning and stenting through the covered stent; might lead to disruption of graft apposition and rebleeding
  • Avoid inadvertently puncturing of thin stent graft materials; subsequent high pressure with larger balloon may enlarge the hole and cause persistent leak

• **Call our dear friend if necessary**
  • For persistent case with unsatisfactory result after covered stent, timely surgical exploration with haemostasis is our last resort
The end