The causes and management of no-reflow phenomenon during PCI procedure

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No-reflow occurs during primary PCI procedure

Pre-stent  Post-stent
Background

“No-reflow” occurs in 5.5%-15.9% of the patients treated with primary PCI for STEMI in Chinese population.

“No-reflow” sometimes occurs after POBA or stents deployment during staged PCI procedure.

No reflow is often associated with unfavorable prognosis.

It is critical to clarify the causes for no-reflow so that promptly restore blood flow.
The causes of no-reflow during primary PCI

- reperfusion injury
  - Oxidative stress
  - Endothelial dysfunction
  - Inflammation storm
  - Microvascular obstruction
    - plugging of capillaries by endothelial bleb and packed neutrophils
- Embolization of thrombus or/and plaque materials
Angiographic morphological features of IRA in predicting no-reflow during primary PCI

<table>
<thead>
<tr>
<th>Variables</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much intracoronary thrombus</td>
<td>1.56</td>
<td>1.23–1.98</td>
<td>0.0003</td>
</tr>
<tr>
<td>Cutoff pattern</td>
<td>7.09</td>
<td>3.88–12.98</td>
<td>0.0001</td>
</tr>
<tr>
<td>Presence of accumulated thrombus</td>
<td>3.45</td>
<td>2.09–5.826</td>
<td>0.003</td>
</tr>
<tr>
<td>Presence of floating thrombus proximal to occlusion</td>
<td>4.34</td>
<td>1.24–15.14</td>
<td>0.021</td>
</tr>
<tr>
<td>Presence of persistent dye staining</td>
<td>3.22</td>
<td>1.02–10.15</td>
<td>0.046</td>
</tr>
<tr>
<td>distal to obstruction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RLD ≥ 4.0 mm</td>
<td>4.14</td>
<td>2.439–7.2</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Chest 2002;122:1322-1332
Longer reperfusion time is associated with higher incidence of no-reflow during primary PCI

Chest 2002;122:1322-1332
The causes for no-reflow during staged PCI procedure

- Spasm. (easy to remove by Nitro, adenosine, sodium nitroprusside or Verapamil)
- Embolization by plaque materials or debris.
- Coronary dissection and intramural hematoma.
No-reflow caused by plaque material embolization
Attenuated plaque

Non-attenuated plaque

Attenuated plaque

J Am Coll Cardiol Intv 2009;2:65–72
Attenuated plaque lesions easily cause no-reflow

<table>
<thead>
<tr>
<th>Post PCI TIMI flow</th>
<th>Attenuated plaque (n=75)</th>
<th>No attenuated plaque (n=218)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/1</td>
<td>2 (2.7)</td>
<td>3 (1.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>26.7</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>18 (24)</td>
<td>7 (3.2)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>55 (73.3)</td>
<td>208 (95.4)</td>
<td></td>
</tr>
</tbody>
</table>

J Am Coll Cardiol Intv 2009;2:65–72
Ultrasound attenuation depth is related to no-reflow

Figure 7. The incidence of no-reflow is significantly higher in patients with ultrasound attenuation ≥5 mm compared to those with ultrasound attenuation <5 mm or without ultrasound attenuation. The risk of no-reflow phenomenon is higher in patients with ultrasound attenuation ≥5 mm.

*Circ J* 2015; 79: 24–33
Balloon dilatation cause severe dissection and hematoma resulting in no-reflow case 1

Chronic total occlusion in mid-LAD stent  Balloon dilatation again and again  No-reflow post balloon dilatation
Balloon dilatation cause severe dissection and hematoma resulting in no-reflow case 1
How to remove no-reflow during primary PCI

- Suck by manual or mechanical aspiration device.
- Intracoronary administration of vasodilatation agents (Nitro, verapamil, sodium nitroprusside or adenosine).
- Intracoronary administration of mixture of adrenaline (100ug or less) and nitro (100-200ug).
Mixture of adrenaline and nitroglycerin is effective to remove distal embolization during primary PCI.

Pre-stent

Post-stent

Mixture of adrenaline (50ug) and nitro (200ug) given by microcatheter.
Vasodilatation agents and adrenaline can help to restore distal blood flow

Pre-stent  Post-stent  TIMI 3 flow after NTG and verapamil were given by microcatheter combined by bolus of 100ug adrenaline
Management of **diffuse** dissection and intramural hematoma
Management of **diffuse** dissection and intramural hematoma: fenestration by cutting balloon

Dilatation by 2.5mm cutting balloon

After fenestration by cutting balloon
Fenestration of diffuse intramural hematoma by scoring balloon and stenting of dissection.

A: Diffuse narrowing in mid- and prox-LAD with TIMI flow grade 1; A': OCT shows intramural hematoma; B and B': fenestration of hematoma using scoring balloon guided by OCT; C and C': BVS was deployed in proximal LAD.

Circ Cardiovasc Interv. 2015;8:e002266
Management of **focal** dissection and intramural hematoma by stent deployment

Male patient, 68 y/o, CTO in mid-LAD  
TIMI 3 flow in LAD post dilatation  
No-reflow occurred post two stents deployment
Management of focal dissection and intramural hematoma by stent deployment

- Microcatheter injection indication of no distal embolization
- IVUS showed stent edge dissection and focal intramural hematoma
Management of **focal** dissection and intramural hematoma by stent deployment

2.25*30mm stent deployed in distal LAD

Post-stent
Flow diagram for management of no-reflow during primary PCI

1. Signs of intracoronary thrombus
   - yes: Thrombus aspiration and GPIIb/IIIa inhibitor
   - no: Microcatheter tip injection

2. Thrombus aspiration and GPIIb/IIIa inhibitor
   - TIMI flow grade 3
     - yes: Finish procedure
     - no: Contrast dye distally

3. Contrast dye distally
   - yes: Intravascular imaging
     - yes: Dissection and intramural hematoma
       - yes: Mixture of adrenaline and nitro
         - no: Fenestration and/or stents
     - no: Vasodilatation agents
       - yes: TIMI flow grade 3
         - yes: Finish procedure
         - no: TIMI flow grade 3

4. Intravascular imaging
   - no: no
Flow diagram for management of no-reflow during staged PCI

1. Microcatheter tip injection
   - Yes
     - Contrast dye distally
       - Yes
         - Vasodilatation agents
           - TIMI flow grade 3
             - Yes
               - Mixture of adrenaline and nitro
                 - TIMI flow grade 3
                   - Yes
                     - Finish procedure
                   - No
                     - Intravascular imaging
                       - Dissection and intramural hematoma
                         - Yes
                           - Fenestration and/or stents
                             - TIMI flow grade 3
                               - Yes
                                 - Finish procedure
                               - No
                                 - Intravascular imaging
                                   - No
                                     - Finish procedure
   - No
     - Intravascular imaging
       - Dissection and intramural hematoma
         - Yes
           - Fenestration and/or stents
             - TIMI flow grade 3
               - Yes
                 - Finish procedure
               - No
                 - Intravascular imaging
                   - No
                     - Finish procedure
         - No
           - Intravascular imaging
             - No
               - Finish procedure
Summary

- No-reflow, life-threatening complication, needs to manage promptly.
- Microcatheter and intravascular imaging provide useful information to clarify the reason for no-reflow.
- Intracoronary administration of vasodilatation agents and adrenaline is effective to remove distal embolization and microvascular constriction.
- Fenestration and/or stents can deal with coronary dissection and intramural hematoma.
THANK YOU FOR YOUR ATTENTIONS