Retrograde CTO PCI: Reverse CART and its variation

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Background

- Bi-direction approach increase the success rate of CTO-PCI.
Current of Retrograde Approach

• CTO is one of the most challenging lesion subsets in PCI.

• During the past three decades, there has been significant progress in equipment and techniques, resulting in significant improvement in success rates of CTO PCI.

• One of the most important advances is the introduction and subsequent evolution of retrograde techniques.
Procedural Steps of Current CTO-PCI

- **Antegrade approach**
- **Retrograde approach**
  - Collateral dual injection
  - Single wire technique
  - Parallel wire technique
  - Directed Retrograde wire cross
  - Kissing wire
  - Rendezvous
  - CART
    - Conventional (Original)
    - Directed (Contemporary)
    - Reverse CART
    - Extended

- Success
- Failure
# Current of Retrograde Approach

<table>
<thead>
<tr>
<th>Country/region</th>
<th>Europe</th>
<th>USA</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>2011</td>
<td>2012</td>
<td>2013</td>
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<tr>
<td></td>
<td>2015</td>
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<td>2017</td>
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<tr>
<td><strong>Study</strong></td>
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<tr>
<td>Study</td>
<td>Galassi et al$^{13,22}$</td>
<td>Maeremans et al$^{24}$</td>
<td>Karmpaliotis et al$^{19,23}$</td>
</tr>
<tr>
<td></td>
<td>Sapontis et al$^{25}$</td>
<td>Tsuchikane et al$^{21}$</td>
<td>Yamane et al$^{20}$</td>
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<tr>
<td></td>
<td>Suzuki et al$^{26}$</td>
<td></td>
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<tr>
<td><strong>Retrograde CTO PCI, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrograde CTO PCI, n (%)</td>
<td>234 (12)</td>
<td>1,582 (16)</td>
<td>207 (17)</td>
</tr>
<tr>
<td></td>
<td>462 (34)</td>
<td>539 (41)</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>801 (27)</td>
<td>378 (25)</td>
<td>1,206 (46)</td>
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<tr>
<td><strong>Overall technical success in retrograde PCI, %</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall technical success in retrograde PCI, %</td>
<td>65</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>81</td>
<td>85</td>
<td>NA</td>
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<tr>
<td></td>
<td>85</td>
<td>84</td>
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</tr>
</tbody>
</table>

**Distribution of retrograde wire crossing strategies**

<table>
<thead>
<tr>
<th>Reverse CART, %</th>
<th>CART, %</th>
<th>Retrograde wire crossing, %</th>
<th>Kissing wire, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>–</td>
<td>31.8</td>
<td>37.2</td>
<td>22.3</td>
</tr>
<tr>
<td>16.0</td>
<td>13.9</td>
<td>31.2</td>
<td>22.0</td>
</tr>
<tr>
<td>67 ↑</td>
<td>3 ↓</td>
<td>28 ↑</td>
<td>NA</td>
</tr>
<tr>
<td>46</td>
<td>11.5</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>62</td>
<td>2.7</td>
<td>19</td>
<td>3.3</td>
</tr>
<tr>
<td>70 ↑</td>
<td>–</td>
<td>30</td>
<td>–</td>
</tr>
<tr>
<td>55.2</td>
<td>–</td>
<td>22.9</td>
<td>15.5</td>
</tr>
<tr>
<td>42.1</td>
<td>–</td>
<td>23.3</td>
<td>22.6</td>
</tr>
<tr>
<td>62.4</td>
<td>–</td>
<td>16.3</td>
<td>17.7</td>
</tr>
</tbody>
</table>

Matsuno S et.al. EuroIntervention 2018;14:94-101
# Terminology of Reverse CART

<table>
<thead>
<tr>
<th>Prior term</th>
<th>Contemporary term term</th>
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</thead>
<tbody>
<tr>
<td><strong>Original</strong> reverse CART</td>
<td>”Conventional” reverse CART</td>
</tr>
<tr>
<td><strong>Contemporary</strong> reverse CART</td>
<td>“Directed” reverse CART</td>
</tr>
<tr>
<td><strong>Modified</strong> reverse CART</td>
<td>“Extended” reverse CART</td>
</tr>
</tbody>
</table>
Current Retrograde Approach

1. Retrograde wire and micro catheter access
   Wire (SUOH 03, SION, others)
   Micro catheter (Corsair, Caravel, Fine cross, others)

2. Retrograde wire with high torque into CTO body
   Wire (GAIA series)

3. CTO length <15mm

→ Direct retrograde wire crossing
The Asia Pacific Algorithm for CTO Crossing

Careful analysis of angiogram/MSCT

- In-stent restenosis
  - Consider use of Crossboss as primary strategy

Proximal cap ambiguity
  - YES
  - IVUS-guided entry
  - NO

Poor distal vessel quality
  - YES
  - Interventional collateral present
  - NO

Antegrade wire-based approach
  - If suitable reentry zone
    - Dissection reentry (CrossBoss/Stingray)
    - Parallel wiring +/- IVUS-guided wiring
      - IVUS-guided wiring/LaST

Retrograde approach

Primary intentional knuckle wire / ADR with Stingray
- Ambiguous course in CTO
- Tortuous CTO segment
- Heavy calcification

Use of intentional knuckle wire / ADR after failed wiring
- Length >20 mm
- Previous failed attempt

Consider stopping if >3 hr; 3.7x eGFR ml contrast; Air Kerma > 5Gy unless procedure well advanced
According to Algorithm

Procedural Issues
• Ambiguous course in CTO
• Tortuous CTO segment
• Heavy calcification
• The long CTO
• Primary knuckle wire

Recommend
“Directed” reverse CART
(IVUS is not mandatory)
Current Retrograde Approach

Next
→ **IVUS** guided wiring with penetration directable retrograde wire

If **FAIL**, IVUS guided reverse CART
Need to confirm both wire position
“Conventional” Reverse CART

1. Antegrade preparation
2. Passing Retrograde wire through collateral
3. Advance Retrograde wire into CTO body

Increasing the success rate of CTO PCI

But, there are procedural Issue …

- Bigger balloon
- Longer stent
- More vessel dissection
Bidirectional knuckle wire, Detection of wire position by using IVUS, Balloon dilation decided size by IVUS
“Directed” reverse CART

Connection within intimal space in the CTO body

Small balloon

Connection close to the subintimal space in the CTO body
“Directed” reverse CART

Antegrade wire: GAIA 2 ⇒ Miracle neo 3, Retrograde wire: UB 3 ⇒ GAIA 2
Balloon size 2.0mm
“Extended” reverse CART

Not make connection
- Ambiguous CTO course
- Eccentric calcified plaque
- Not pass any device at proximal part

Connection at the Proximal or Distal true lumen
“Extended” Reverse CART

Antegrade wire: Conquest pro not advance

Retrograde wiring
Not pass any device at proximal part

Made the connection at proximal part at the diagonal branch
performed “Extended” reverse CART
## Comparison of the reverse CART

### “Conventional”

- Extent of subintimal space: Within CTO
- Prior wiring: Both (A and R) OK
- Retrograde wiring: Usually low to intermediate penetration force wire. However, **HIGH** penetration force wire is required if the antegrade wire is in the subintima and the retrograde wire is in the intima.

### “Directed”

- Extent of subintimal space: Within CTO
- Prior wiring: Antegrade is Better
- Retrograde wiring: One choice, **GAIA series** with high torque

### “Extended”

- Extent of subintimal space: Beyond the CTO segment
- Prior wiring: Both (A and R) OK
- Retrograde wiring: Proximal: anywire **without** high penetration wire. Distal: **HIGH** penetration wire
<table>
<thead>
<tr>
<th>Technique</th>
<th>Suitable case</th>
<th>Unsuitable case</th>
<th>If necessary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knuckle wire technique</td>
<td>Recommend (Considered when there is difficulty in achieving reverse CART)</td>
<td>Not routinely used (due to the clear target)</td>
<td>Recommend (prevent from extension of the subintimal space)</td>
</tr>
<tr>
<td>Using Ba. size</td>
<td>Large</td>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td>IVUS guided</td>
<td>Recommend (Considered when there is difficulty in achieving reverse CART)</td>
<td>Not routinely used (due to the clear target)</td>
<td>Recommend (prevent from extension of the subintimal space)</td>
</tr>
<tr>
<td>Suitable case</td>
<td>Bidirectional approach which <strong>NOT</strong> suitable directed reverse CART</td>
<td>CTO with clear proximal cap, without severe calcification, severe tortuosity</td>
<td>CTO with proximal or distal cap penetration is <strong>NOT</strong> possible due to ambiguity or calcification</td>
</tr>
<tr>
<td>Unsuitable case</td>
<td><strong>Not limited</strong></td>
<td>CTO with ambiguous proximal cap and vessel course, severe calcification and tortuous short length</td>
<td></td>
</tr>
</tbody>
</table>
Another Retrograde technique

If retrograde MC was **fail** to pass the channel, **Antegrade KISSING wire technique**

$\Rightarrow$ Antegrade wire can trace retrograde wire
$\rightarrow$ Antergrade micro catheter or balloon will be able to advance through CTO lesion
Another Retrograde technique

Rendezvous technique

In coronary

Antegrade wire

microcatheter

Retrograde wire

In guiding catheter

Antegrade microcatheter

Antegrade wire

Retrograde wire
Messages

• The current reverse CART technique has evolved significantly over time with the introduction of new dedicated equipment and techniques.

• We should understand the underlying concepts and the procedural steps of each technique. This in turn will aid appropriate selection and application of these wire crossing techniques and also facilitate communication and teaching.

• Prospective validation of the usefulness of the classification and examination of the clinical impact of techniques are required.

• The innovation is required in contemporary intervention era.