Antegrade techniques for CTO recanalization

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can CTOs be reliably opened by PCI?

Meta-Analysis of 18,061 Patients
Techniques Used

Successful technique

PROspective Global REgiStry for the Study of CTO interventions

Christopoulos G, Int J Cardiology 2015;198:222-228
Crossing strategy selection

![Graph showing the percentage of different crossing strategies based on approach sequence. The graph compares antegrade wiring, antegrade dissection/re-entry, and retrograde strategies across 1st, 2nd, and ≥3rd approach sequences.](image-url)
Keys to successful antegrade CTO PCI

➢ IMAGING
  ▪ Angiography
  ▪ Coronary CT

➢ EQUIPMENT
  ▪ Guidewires
  ▪ Support

➢ TECHNIQUE
  ▪ Single Wire
  ▪ Dual Wire
  ▪ Complex Antegrade CTO Techniques

Good procedure planning Not “ad-hoc”
Keys to successful antegrade CTO PCI

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## Predictors of anterograde procedural failure

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Univariate predictors</th>
<th>Multivariate predictors</th>
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<tbody>
<tr>
<td></td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Dyslipidaemia</td>
<td>0.5</td>
<td>0.375-1.456</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0.2</td>
<td>0.186-2.356</td>
</tr>
<tr>
<td>Hypertension</td>
<td>0.7</td>
<td>0.452-1.856</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.6</td>
<td>0.532-1.156</td>
</tr>
<tr>
<td>Previous MI</td>
<td>0.8</td>
<td>0.620-1.03</td>
</tr>
<tr>
<td>Previous CABG</td>
<td>0.7</td>
<td>0.569-1.05</td>
</tr>
<tr>
<td>In-stent CTO</td>
<td>0.7</td>
<td>0.345-1.756</td>
</tr>
<tr>
<td>Severe tortuosity</td>
<td>0.4</td>
<td>0.332-1.876</td>
</tr>
<tr>
<td>Severe calcification</td>
<td>0.43</td>
<td>0.348-0.686</td>
</tr>
<tr>
<td>CTO length &gt;20 mm</td>
<td>0.49</td>
<td>0.301-0.619</td>
</tr>
<tr>
<td>CTO diameter &lt;3 mm</td>
<td>1.1</td>
<td>0.850-1.775</td>
</tr>
<tr>
<td>Blunt stump</td>
<td>0.63</td>
<td>0.490-0.816</td>
</tr>
</tbody>
</table>

ERCTO, EuroIntervention 2011;7:472-479
Angiographic assessment for CTO-PCI → Procedure Planning

Angiographic review for CTO-PCI

1. Proximal cap ambiguity
2. Lesion length
3. Quality of distal target vessel
4. Collateral circulation

Dual Injections
Angiography for CTO-PCI: Dual Injections
Angiography for CTO-PCI: dual injections
Coronary computed tomography

➢ Information on the occluded segment:
  ▪ course
  ▪ length
  ▪ tortuosity
  ▪ calcification
  ▪ resolve issues of anatomic ambiguity

➢ Identification of the best angiographic projection for CTO crossing.

➢ Co-registration of the CCTA image with angiographic images

Wilson W, Current Cardiology Reviews, 2014, 10, 127-144
Keys to successful antegrade CTO PCI

➢ IMAGING
  ▪ Angiography
  ▪ Coronary CT

➢ EQUIPMENT
  ▪ Guidewires
  ▪ Support
    • guiding catheters
    • guide catheter extension
      – Guideliner
      – Guidezilla
    • anchoring techniques
      – wire
      – balloon
    • micro-catheters

➢ TECHNIQUE
  ▪ Single Wire
  ▪ Dual Wire Complex Antegrade CTO Techniques
Support: guide catheters

- **Guide catheters size (7F-8F):**
  - enhanced passive support
  - better visualization
  - accommodation for:
    - micro-catheters
    - IVUS
    - anchoring balloon
    - CrossBoss catheter, the Stingray balloon

- **Access:**
  - bilateral femoral
  - femoral + radial
  - bilateral radial ?

- **Guide catheters shape:**
  - Left coronary artery:
    - XB, EBU, and AL, for the left coronary
  - right coronary artery:
    - AL, JR
Guiding catheter size selection in the ERCTO

Alfredo R. Galassi, Euro CTO Insights, TCT 2015
Radial access in the ERCTO

Alfredo R. Galassi, Euro CTO Insights, TCT 2015
Support: guide catheter extension

- Guideliner (Vascular Solutions)
- Guidezilla (Boston Scientific)

Brilakis E, 2014, Coronary Chronic Total Occlusion Interventions
Support: anchoring techniques

- Wire anchoring
- Balloon anchoring

Wilson W, Current Cardiology Reviews, 2014, 10, 127-144
Support: anchor balloon

- Side branch anchor
- Coaxial anchor
- Distal anchor

Brilakis E, 2014, Coronary Chronic Total Occlusion Interventions
Support: micro-catheter & Over-the-Wire balloon

**micro-catheters & OTW balloons:**
- enhance the wire-penetrating capacity
- improve wire torque response
- allow wire tip reshaping without losing wire position
- facilitate wire exchanges.

**micro-catheter vs OTW balloon:**
- more flexible and track better
- less kinking upon wire removal
- less likely to cause proximal vessel injury
- better assessment of the tip location
- better penetration of the CTO once a wire is through
- ↑↑↑ cost

a micro-catheter or OTW balloon should be used for antegrade crossing in all CTOs
Support: micro-catheters

Change in GW tip stiffness with various GW lengths extending past a micro-catheter tip
Support: micro-catheters

Finecross (Terumo)

Corsair (Asahi)
Keys to successful antegrade CTO PCI

➢ IMAGING
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➢ EQUIPMENT
  ▪ Guidewires
  ▪ Support

➢ TECHNIQUE
  ▪ Single-wire
  ▪ Dual-wire
  ▪ Complex antegrade CTO techniques
Single-wire antegrade CTO techniques

- drilling
- penetrating
- sliding
- advance – deflect – rotate - advance
Single-wire antegrade CTO techniques: drilling

- controlled rotation of the GW in both directions.
- small tip bend (to avoid the creation of a large subintimal space).
- GW:
  - moderate tip stiffness
  - escalation to stiffer wires

Single-wire antegrade CTO techniques: penetrating

- forward GW advancement intentionally steering (directing)
- Indications:
  - lesions with a calcified, hard-to-penetrate, proximal cap
  - short occlusions with well understood vessel courses
- GW:
  - Miracle 12
  - Confianza Pro 12
  - Gaia 3
Gaia family GW concept
advance – deflect – rotate - advance

Intentional manipulation

When the wire tip is deflected, it is directed towards sub-intimal space.
If you push too much, the knuckled tip will dissect the vessel.
It’s important 1) to change the wire direction or 2) to increase the tip force “keeping the wire tip straight”.

Tactile feelings are translated into visual perception!
Single-wire antegrade CTO techniques: Gaia

Gaia 3rd
Penetration of proximal cap with stiff wire to allow introduction of microcatheter and soft wire to CTO body
Single-wire antegrade CTO techniques: sliding

micro-channels
(up to 250µm in diameter)

Sumitsuji S, J Am Coll Cardiol Intv 2011;4:941–51
Single-wire antegrade CTO techniques: sliding

- support by a micro-catheter
- gently advancement and rotation to find micro-channels
- check for the wire position in 2 orthogonal planes
- avoid entry into sub-intimal space
  - tapered polymer coated GW (Fielder XT, Gaia 1)
  - tapered hydrophilic GW (Runthrough NS)
Dual-wire antegrade CTO techniques

- parallel-wire
- see saw
- dual lumen catheter
Dual-wire antegrade CTO techniques: parallel-wire

Brilakis E, 2014, Coronary Chronic Total Occlusion Interventions
Dual-wire antegrade CTO techniques: see-saw

Initial wire and microcatheter left in place

Second microcatheter

Second guidewire

Successful entry of second guidewire into distal true lumen

*Brilakis E, 2014, Coronary Chronic Total Occlusion Interventions*
Dual-wire antegrade CTO techniques: dual lumen catheter

Brilakis E, 2014, Coronary Chronic Total Occlusion Interventions
Complex antegrade CTO techniques

Dissection & re-entry strategies:

• dissection:
  • Knuckle wire
  • CrossBoss catheter

• re-entry:
  • wire-based re-entry:
    ○ STAR technique
    ○ contrast enhanced
    ○ mini-STAR & LAST technique
  • device-based re-entry:
    ○ Stingray balloon and guidewire
    ○ IVUS guided
Dissection strategies: knuckle wire

- Fielder XT
- Pilot 200

Brilakis E, 2014, Coronary Chronic Total Occlusion Interventions
Dissection strategies: device based (CrossBoss catheter)

- 3F (1.0 mm) atraumatic tip
- 6F Guide Catheter compatible
- 0.14 in GW compatible
CrossBoss catheter vs. knuckle wire

- Smaller & more controlled sub-intimal dissection space → more predictable and controlled re-entry into the distal true lumen

- CrossBoss catheter tends to advance along a longitudinal path parallel to the artery axis
  #GW sometimes wrap around the artery circumference
Re-entry strategies: wire-based

- Pilot 200
- Confianza Pro 12
Re-entry strategies: STAR

- often results in side-branch loss
- is less predictably successful
- high re-occlusion rates
- rarely used as a definitive technique (never in LAD)

Brilakis E, 2014, Coronary Chronic Total Occlusion Interventions
Re-entry strategies: mini-STAR & LAST

- mini-STAR re-entry GW:
  - the Fielder FC or XT
- LAST re-entry GW:
  - Pilot 200
  - Confianza Pro 12

- lower success rates because of difficulty in reliably re-entering the true lumen

Brilakis E, 2014, Coronary Chronic Total Occlusion Interventions
Re-entry strategies: device based (Stingray balloon + wire)

Brilakis E, 2014, Coronary Chronic Total Occlusion Interventions
Re-entry strategies: device based (Stingray balloon + wire)

- Self-orienting, flat balloon hugs the vessel
- Automatically positioning one exit port toward the true lumen
Re-entry strategies: device based (Stingray balloon + wire)
CTO anatomy suited to antegrade dissection re-entry strategy

- Well defined proximal cap
- >20mm CTO
- Good distal vessel with no large side branches at distal cap (made visible via contralateral injections)
Re-entry strategies: device based (CrossBoss + Stingray system)

FAST-CTOs trial

Re-entry strategies: IVUS guided technique
Re-entry strategies: IVUS guided technique

Re-entry strategies: IVUS guided technique
Antegrade alone cases: successful crossing strategy

<table>
<thead>
<tr>
<th></th>
<th>Total (3021)</th>
<th>2012 (1063)</th>
<th>2013 (1138)</th>
<th>2014 (820)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure success</td>
<td>93% (2798)</td>
<td>92% (976)</td>
<td>94% (1064)</td>
<td>93% (758)</td>
<td>0.3170</td>
</tr>
</tbody>
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Successful CTO crossing strategy
Antegrade escalation GW algorithm

Wilson W, Current Cardiology Reviews, 2014, 10, 127-144
Revascularization in CTO
Treat the Lesions that Need to Be Fixed, Not Just the Ones that You Can Fix