PCI for Chronic Total Occlusions

Suresh G. Vijan
MD., MRCP., FACC., FESC., FEISI.
Interventional Cardiologist
Lilavati and Fortis hospitals.
Mumbai., INDIA
CTO Strategies
Principles of Technique

- Contralateral angiography
- Multiple views
- Guiding catheter selection
- Wire/device selection
- Incremental stiffness (‘drilling’) vs. ‘penetration’
- Parallel/Seesaw wiring, STAR
- IVUS
- Retrograde via collaterals, CART, Reverse CART

↑ Success vs.
↑ Complications
CTO lesion assessment

- Proximal and distal caps.
- Presence of micro channels.
- Calcification at entry and distal caps.
- Angulation and tortuosity.
- Side branch relationship.
- CTO length (>20 mm).
- Presence and quality of collaterals.
- Disease in donor and distal artery.
- Donor and CTO vessel anatomy for guide and guide wire selection.

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Angiographic Lesion Morphology

- Tapered Stump Functional occlusion
- Stump absent
- Total occlusion

- Pre or Post-branch occlusion
- Bridging collaterals absent
- Occlusion at side-branch
- Bridging collaterals present

Favor Procedural Success

Does Not Favor Procedural Success
Identification of the entry with IVUS
Distinguish false and true lumen

Penetration vs Drilling
Parallel wire technique
Subintimal Tracking and Re-entry

Retrograde crossing
Kissing Wire
CART, Reverse CART,
Wire Externalization

Contralateral angiography
Guiding catheter selection
Mother-in-Child Technique
Basic Concepts of Antegrade CTO PCI

- **Antegrade Goal**
  - *Move gear safely and quickly to distal cap to focus on true lumen entry*
  - or...
  - *Move gear beyond distal cap to focus on reentry*
Which wire and when?

- Detailed study of cine angiogram - Micro-channels present in 30-50% cases

Micro-channels visible
- Plastic jacket or hydrophilic wires
  - Fielder XT, Fielder FC, & Fielder
  - Pilot 50
  - Terumo runthrough NS

Severe fibro-calcific segment
- Stiff extra support wires
  - Miracle series 3, 4.5, 6, 12 gm
  - Cross IT 100, 200, 300
  - Intermediate wires
  - Conquest pro, 8/12 gm

Always start with the soft wires as micro-channels are sometimes not visible and quickly upgrade to stiffer wires in a step up strategy.
CTO Guidewires – Tip Shaping

Primary bend ~ <30°
1-2mm from tip

Secondary bend ~ 10-15°
PCI for CTO
When you can’t cross with wire

- Advance wire techniques.
- Advance support with guides, mother and child, anchor balloons, microcatheters.
- IVUS guidance.
- Switch to Retrograde approach.
Antegrade CTO Wiring

Parallel wire technique
Anchor Technique

Transit

2.5x20mm balloon

Miracle 3g

Whisper MS
Mother Child Support with Guideliner

Guide catheter distal tip

GuideLiner distal tip
Antegradec CTO Wiring Techniques

*IVUS guidance*

**Blunt occlusion at sidebranch takeoff**

Alternatively, PTCA balloon in SB to help direct wire into proximal cap —”open sesame”
IVUS in false lumen
True lumen
Guidewire

T. Suzuki, Toyohashi Heart Center
IVUS Guided Technique for Finding the CTO Entry Point

Complex CTO of MLCX

Where is the origin?

IVUS in LA branch
PCI for CTO
When you can’t cross with balloon.

- Buddy wire, Low profile balloons.
- Guide support, anchor balloons.

**Crossing devices**
- Tornus catheter or Corsair/Fine cross
- Laser.
- Rotablator

- Switch to retrograde approach.
ASAHI TORNUS™

A Novel Breakthrough for the Treatment of Chronically Stenosed Lesions
Asahi Corsair

After the screw head structure, the grade and the thickness of the polyamide elastomer resin are gradually increased to provide optimal rigidity and pushability at the proximal shaft.
Basic Steps in retrograde technique

- Simultaneous bilateral angiograms.
- Identify collateral channels.
- Wiring and device tracking thru collateral channel.
- Reach the true lumen distal to CTO.
- Cross the CTO – Direct/CART/ Reverse CART.
- Retrograde wire in proximal segment.
- Externalise the guide wire / antegrade wire.
- Dilate and stent the CTO.

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Suitable equipment

- Bi-femoral, Bi-radial or Radio-femoral approach.
- 7Fr/8Fr guides.
- Short (90 cms) guide for donor artery.
- Fielder FC, Fielder XT or stiffer wires.
- Corsair or Fine cross catheters.
- Appropriate anticoagulation (ACT>300). Check every 30 mins.
PCI for CTO
Collateral channels for retrograde approach

- Septal channels.
- Epicardial channels.
Patterns of Septal Collaterals

1. < 90 degree
2. >90 degree
3. Corkscrew
4. Corkscrew
5. Recepient vessel >90
6. >90 R Vessel
Patterns of Epicardial channel

- Usually very tortuous,
- Large, visible.
- Easier to cross with Corsair.
PCI for CTO
Wire handling

- Slow rotation and advancement of wire.
- Stop if PVC.
- Wire migration into side branch.
- If in doubt, advance microcatheter and pull out the wire and inject 2 cc of dye.
- Immediate wash out of dye.
- Contrast hangs-- chose new channel.
Collateral channel isolation

- Selective CC angiography to assess the course and morphology
- Wires: Fielder FC, Fielder XT with Corsair/ Finecross support
Wiring the collateral channel
Kissing wire technique
Limitation of Kissing wire

If antegrade and retrograde wires are in different layers, it is difficult to align both wires.
Concept of CART™ technique

(Controlled Antegrade and Retrograde subintimal Tracking)

- make connection between antegrade and retrograde subintimal space utilizing behavior of subintimal dissection.
- antegrade wire automatically gets into distal true lumen.
CART Technique
Limitations of CART

- Retrograde wire usually gets into plaque, not into subintima at proximal part of distal CTO end so that retrograde balloon is inflated at intra-plaque.
- If antegrade wire is advanced into subintima at the site of retrograde balloon dilation, it is difficult to direct the antegrade wire to the true distal lumen, similar to a difficult situation in the antegrade approach.
- Collateral dilatation is needed to pass balloon.
CONCEPT OF REVERSE CART
ROLE OF IVUS AND SNARE

When the recoil occurs again due to the flap even after re-dilation with a bigger balloon.

The 0.014 inch snare wire can be delivered through any catheter.

Check where the subintimal connection is created and where the recoil occurs.

The snare wire can keep open the subintimal connection by pushing the flap and minimize the vessel injury.
LAD - CTO

AP cranial

LAO cranial
Failed antegrade approach

Conquest Pro
Tornus
Conus to LAD

Short distance, large size but torturous and rigid
Conus to LAD

Choice floppy
Transit
Reverse CART

Antegrade 2.5mm

Retro wire: Fielder FC

Retrograde wire crossed to the guiding.
Wire direction was changed to antegrade with a Grandslam 3.5mm balloon.
Cypher 3.5x33mm

TAXUS 3.0x32mm

LITA distal anastomosis

Distal LAD
PCI for CTO

Conclusion

- Evolving techniques leading better success rates (90%).
- Some getting standardised.
- Careful evaluation of angiograms.
- Familiarity with a variety of catheters and wire.
- Switch approach early.
- Contrast and radiation dose.
- Patient comfort.
Progress with CTOs over the years

For the past 5-10 years, guided by our Japanese colleagues, the “art” of CTO therapy has become more generalized, now with dedicated equipment and increasing success!
PCI for CTO
Retrograde approach

- Bilateral approach in majority of CTO”s.
- Antegrade wiring fails in 20-30%.
- Retrograde wiring fails in 5-10%.
- Remaining cases both wires are subintimal.
- Connect both spaces with CART/reverse CART with IVUS guidance.
Predictors of Procedural Success

Guidewire Selection

**Fielder XT (X-treme)**
- Radiopacity: 3 cm
- Coil: 12 cm
- Diameter: 0.014 inch
- Tip Diameter: 0.009 inch
- Hydrophilic coated guidewire with polymer sleeve
- Tapered tip to 0.009
- (Tip load: 8G)

**Miracle 3/6/9**
- Radiopacity: 11 cm
- Coil: 11 cm
- Diameter: 0.014 inch
- Non-tapered tip
- (Tip load: 6.0G)

**Confianza Pro 12**
- Radiopacity: 20 cm
- Coil: 20 cm
- Diameter: 0.014 inch
- Tip Diameter: 0.009 inch
- Tapered tip to 0.009
- (Tip load: 12.0G)
# Micro Catheters

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<tr>
<th></th>
<th>Distal</th>
<th>Proximal</th>
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<tbody>
<tr>
<td></td>
<td>O.D.</td>
<td>I.D.</td>
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<tr>
<td>FineCross MG</td>
<td>1.8Fr</td>
<td>0.018''</td>
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<tr>
<td></td>
<td>(0.60mm)</td>
<td>(0.45mm)</td>
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<tr>
<td>Excelsior (BSC)</td>
<td>2.0Fr</td>
<td>0.019''</td>
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<td></td>
<td>(0.67mm)</td>
<td>(0.48mm)</td>
</tr>
<tr>
<td>Transit (Cordis)</td>
<td>2.3Fr</td>
<td>0.021''</td>
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<td></td>
<td>(0.76mm)</td>
<td>(0.50mm)</td>
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[Images of FineCross MG, Excelsior, and Transit catheters]
Other Specialized Microcatheters

- Venture
- Twin-pass
CTO: Key Starting Points

Excellent Guide Support and distal vessel visualization
Select Your Guiding Catheter Carefully

- Use: 7-8F for LCA, and 8F in RCA with optimal alignment
- Curve 1 size larger for CTO (e.g., Voda 4 EBU 4.5 – AL 0.75 for RCA…)
- Sideholes recommended for RCA – rarely necessary in LCA
- But ......care with proximal disease (RCA) sometimes an R4 with an anchor is safer
Twin-pass dual lumen catheter (Vascular Solutions)

- Separate RX and OTW lumens
- Maintain distal access with ability to introduce second wire (or contrast)
Simplified Concepts

- Support, Support, Support
  - Guide Catheter
  - Support catheter: 1.5 mm OTW balloon, microcatheters (Transit, Finecross), Tornus, Corsair
  - Anchor techniques: Wire, balloon
IVUS guidance in CTO
Distinguish false lumen from true lumen