CONSENSUS ON DEFINITION

Lesions can be classified as CTOs when there is TIMI 0 flow within the occluded segment and an occlusion duration $>3$ months.
**Rationale for angioplasty**

**Indications:**
- Medically refractory Angina (I.B)
- Positive Stress Test with large burden of ischemia (I, B)
- LV dysfunction with ischemic myocardium (IIb, B)

**Proven Benefits:**
- Symptom improvement
- Decreased need for CABG
- Reduced LV remodeling

**Purported benefits:**
- Increased survival
- Favorable risk profile

Stone et al. Circulation 2005

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**ACCF/SCAI/STS/AATS/AHA/ASNC 2012**

**Appropriateness Criteria for Coronary Revascularization**

**Chronic Total Occlusions: Indications for PCI**

<table>
<thead>
<tr>
<th>INDICATION</th>
<th>CCS Angina Class</th>
<th>Appropriateness Score (1-9)</th>
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</thead>
<tbody>
<tr>
<td>• Chronic total occlusion of 1 major epicardial coronary artery, without other stenoses</td>
<td>Asymptomatic</td>
<td>1</td>
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<tr>
<td>• Low-risk findings on noninvasive testing</td>
<td>I</td>
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*Patel et al. JACC 2012;53:530-553*
Tips For Antegrade CTO PCI

- **Procedure setup:**
  - Planning and Mindset
  - Proper Angiography
- **Wire Shaping and handling**
- **Wire selection and escalation strategy**
- **Supportive microcatheters**
- **Advanced Techniques for Chronic Total Occlusion** *Japanese Specialized Techniques:*
  - Parallel wire technique
  - Mother-Child catheter technique
  - Subintimal tracking and re-entry
  - IVUS guidance

CTOs: First, Do No Harm!

- There’s only ONE way you can help:
  - Successful recanalization
- There are MANY ways you can hurt the patient:
  - Dissection
  - Perforation
  - Disrupt functioning collaterals
  - De-recruit collaterals
  - Distal embolization
  - Sidebranch injury
  - Long procedures → bleeding, vascular problems
The concept of hybrid CTO PCI implies the strategy of having sequential and adaptable plans prepared in advance, with changing from failing strategy early without getting stuck in failure mode.
The J-CTO score can predict the overall success rate and the wiring time of CTO lesions classifying these CTO lesions into 4 risk groups with success rates of 100% in less than 30 minutes for the easy CTO group as compared to a success rate of about 67% with prolonged wiring time in the very difficult CTO group.

Common reasons for failed antegrade attempts

1. use of only one antegrade guiding catheter
   - without contra-lateral injections to visualize the distal target
2. performance of excessive antegrade injections
   - leading to dissections and hematomas
3. Wrong and excessively long curve on the tip of the CTO guidewire
4. Wrong guidewire selection for the type of lesion attempted
5. Finally, misunderstand the probability to succeed with an antegrade wiring strategy in complex cases that would mandate a primary antegrade and dissection or retrograde strategy
CTO PCI: Technical Considerations

- Planned procedure
  - Not >1-2 in a day
  - Careful assessment of symptoms, and target site
    viability + ischemia based on the appropriateness criteria
- Proper views
  - Must visualize stump, collaterals and distal parent vessel
    beyond the CTO segment (consider contra-lateral injection)
- Strong guiding catheter support
  - 6-8 Fr, trans-femoral preferred
  - Long sheaths, short guides for retrograde
- Bilateral angiography from the outset in essentially ALL
  cases
- Time limit of radiation exposure and contrast volume
- Initial floppy wire passage for distal or angulated CTOs
- Increasing stiffness of the wires
- Support/transit catheters or small OTW balloon

Tips For Antegrade CTO PCI

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Microcatheters and balloons used in CTO PCI

- **Microcatheters:**
  - Finecross (TERUMO)
  - Transit (Cordis)
  - Excelsior (Boston)
- **Penetration catheter:**
  - Tornus and -Pro (ASAHI)
- **OTW balloons**
  - Ryujin 1.25mm (TERUMO)
  - Maverick 1.5mm (Boston)
  - Voyager 1.5mm (Abbott)

- **Nice balloons**
  - TAZUNA 1.25mm (TERUMO)
  - Legend 1.25mm (Medtronic)
  - Lifespear 1.20mm (JLL)
  - Lacross 1.3mm (Goodman)
  - Voyager 1.5mm (Abbott)
  - Apex 1.5mm (Boston)

Corsair Micro-catheter
Also for antegrade crossing as support catheter

*Rotation Resistance Reduction*

SHINKA-Shaft's spiral structure transmits rotation to the distal tip. This rotation gives CORSAIR its crossing performance through tortuous channels.

**The Advantage of Corsair**

- For Channel Tracking
  - Excellent cross-ability through collateral channel
  - No need of channel dilatation
  - Less channel injury
  - Expanded indication for epicardial channel
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CTO Guidewires – Tip Shaping

For penetrating the entry point

For reentering to the true lumen from the subintima

Penetration vs. Controlled Drill

Thompson CA, Cardiac Interventions Today 2009
Tips For Antegrade CTO PCI

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CTO Pathology

- CTO lesions can be classified according to the presence of micro-channels into soft CTOs and hard CTOs.

- Micro-channels increases success of CTO recanalization and hydrophillic wires and low profile tip facilitate crossing.

- While hard homogenous are associated with low success rate and sub-intimal dissections are more likely.
CTO Wire *Escalation* Techniques

“Hybrid” Sliding-Drilling-Penetration

- Hydrophilic GW (Fielder FC or XT)
  - Not cross
- Stiff GW (0.014 inch – MB 3 gm)
  - Not cross
- Stiff tapered + hydrophilic coating
  (Confienza pro 9, 12 gm)

Four CTO Summits (2004–2007)
Wire Selection and Success
(After Catheter Delivery or Device Attempt)

First wire selection (n=57)
- Floppy
- Hydrophilic
- Cross-it
- Miracle 3
- Miracle 4.5-6
- Miracle 12
- Confienza 9
- Confienza 12
- Persuader

Wire that crossed (n=46)
Guide Wires for CTO Recanalization

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Guide Extension: An Indispensable Tool

Guide extension using rapid exchange promotes:

- Deep-seating for added back-up support
- Coaxial alignment in guide placement
- Distal device placement
- Reduced contrast injection

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Fundamental dissection-reentry concepts

- **Dissection** is no longer a complication, but a mode of treatment
- **Sub-intimal stenting** is feasible, safe and associated with good long term results (probably better than a closed artery), although data is largely lacking
  - Increased restenosis?

Guidewire Re-entry from Subintimal Space

- Small false lumen: difficult to make re-entry
- Large false lumen: easy to make re-entry
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Wire Technique
IVUS

T. Suzuki, Toyohashi Heart Center

IVUS-guided PCI for CTO

- Side-branch IVUS guidance:
  - Put the IVUS catheter into the side branch proximal to the CTO.
  - Identify the entry of CTO and confirm the wire being in the CTO.

- Co-axial IVUS guidance:
  - If the 1st wire went into the false lumen, dilate the lumen by a 1.5-mm balloon and put the IVUS into the lumen.
  - We can identify at which o'clock the true lumen exists.
  - By looking at the IVUS image, try to put a stiff wire into the true lumen.
CTO - Procedural Considerations
When to STOP!

- Wire or device perforation with pericardial effusion
- Hemodynamic instability
- Collateral vessel compromise
- Extensive dissection compromising distal runoff
- Contrast threshold
- Radiation threshold
- “CSP” = CTO Saturation Point – futility threshold
  - Stage for second attempt
  - Refer to more experienced operator

THANK YOU