Clinical Indications of CTO Recanalization

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## Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

<table>
<thead>
<tr>
<th>Affiliation/Financial Relationship</th>
<th>Company</th>
</tr>
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<tbody>
<tr>
<td>Grant/Research Support</td>
<td>None</td>
</tr>
<tr>
<td>Consulting Fees/Honoraria</td>
<td>Abbott, Cordis, St. Jude, W.L. Gore, Boston Scientific Corp. Terumo</td>
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<tr>
<td>Major Stock Shareholder/Equity</td>
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<td>Royalty Income</td>
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<td>Ownership/Founder</td>
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<td>Intellectual Property Rights</td>
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<td>Other Financial Benefit</td>
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CTO–PCI: The Final Frontier

- Dispel misconceptions
- Safe and suitable treatment option
- Reproducible and teachable
CTO Prevalence and Treatment

Coronary Angiograms
N = 14,439

Only 10% of PCI involved the CTO, with 70% success rate!

Feer et al. JACC 2012.
CTO Prevalence and Treatment

Translating the results of the Canadian Registry

Variability in Current Treatment

CTO treatment strategies in 3 Canadian centers

- CTO identified in 18.4% of 1,697 pts
- CTO-PCI attempt rate varied among hospitals from 1% to 16%

Hospital Center

*p < 0.001; **p = NS; °p < 0.001.
Fefer et al. JACC 2012.
CAD Treatment Strategies

**CTO-PCI disproportionately low**

BARI Registry Substudy

CABG is Not Always an Option
SYNTAX CTO substudy

266 CTO patients randomized to receive CABG

Reason not bypassed:
- Not intended to treat (n=12)
- Diseased (n=11)
- Inadequate conduit (n=2)
- Too small (n=19)
- Unable to find (n=1)
- Other (n=36)

ITT, per lesion. 49.6% overall complete revascularization in CTO subset. Courtesy Patrick Serruys, Syntax CTO substudy, TCT 2008.
Why are CTO–PCI Attempt Rates So Low?

**Common misconceptions**

- There is no clinical justification
- CTOs are stable and benign
- The procedure is too complex
- Success rates are low
- We don’t have time for long procedures
- Results are not reproducible or teachable
- CTO-PCI is cost-prohibitive

“If you really want to do something, you’ll find a way. If you don’t, you’ll find an excuse.”

–Jim Rohn
There is No Clinical Justification
Clinical Indications

Why open a chronically occluded coronary artery?

- SYMPTOM CONTROL\(^1\) and INCREASED QUALITY OF LIFE\(^2\)
- IMPROVED LV FUNCTION\(^3\)
- IMPROVED SURVIVAL\(^4\)

1 Grantham JA et al., Circulation: Cardiovascular Quality and Outcomes 2009.
2 Safley D, Grantham JA, Jones P, and Spertus JA, ACC 2012
3 Kirschbaum SW et al. American Journal of Cardiology 2008
Impact of Successful CTO-PCI: Angina

Long-term angina benefit favors CTO-PCI success

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>PCI success</th>
<th>PCI failure</th>
<th>Odds Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angioli et al.</td>
<td>10</td>
<td>28</td>
<td>0.34</td>
<td>[0.16, 0.75]</td>
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<tr>
<td>Aziz et al.</td>
<td>12</td>
<td>36</td>
<td>0.12</td>
<td>[0.06, 0.24]</td>
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<tr>
<td>Drozd et al.</td>
<td>10</td>
<td>12</td>
<td>0.42</td>
<td>[0.18, 1.00]</td>
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<tr>
<td>Finci et al.</td>
<td>7</td>
<td>37</td>
<td>0.13</td>
<td>[0.05, 0.31]</td>
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<td>Hoye et al.</td>
<td>71</td>
<td>117</td>
<td>0.23</td>
<td>[0.16, 0.32]</td>
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<tr>
<td>Nanhoe et al.</td>
<td>41</td>
<td>59</td>
<td>0.26</td>
<td>[0.17, 0.41]</td>
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<tr>
<td>Naguchi et al.</td>
<td>9</td>
<td>26</td>
<td>0.18</td>
<td>[0.08, 0.41]</td>
</tr>
<tr>
<td>Olivari et al.</td>
<td>7</td>
<td>13</td>
<td>0.14</td>
<td>[0.05, 0.35]</td>
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<tr>
<td>Valenti et al.</td>
<td>7</td>
<td>13</td>
<td>0.21</td>
<td>[0.08, 0.53]</td>
</tr>
<tr>
<td>Warren et al.</td>
<td>3</td>
<td>7</td>
<td>0.20</td>
<td>[0.04, 0.95]</td>
</tr>
</tbody>
</table>

Total (95% CI) 2524 1325 100.0% 0.22 [0.17, 0.27]

Total events 177 348

Heterogeneity: Tau² = 0.01; Chi² = 9.90, df = 9 (P = .36); I² = 9%
Test for overall effect: Z = 13.41 (P < .00001)

Impact of Successful CTO-PCI: Mortality
Long-term survival benefit favors CTO-PCI success

Joyal D, Afilalo J, Rinfret S. 
Re-opening of CTO: 20 years Experience

Suero, et al. JACC 2001;38:409-414
Impact of Successful CTO-PCI on All Cause Mortality


<table>
<thead>
<tr>
<th>Study</th>
<th>PCI success n/N</th>
<th>PCI failure n/N</th>
<th>RR(95%CI)</th>
<th>%Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angioli</td>
<td>1/93</td>
<td>6/108</td>
<td>0.19(0.02-1.58)</td>
<td>0.76</td>
</tr>
<tr>
<td>Arslan</td>
<td>9/117</td>
<td>37/115</td>
<td>0.50(0.31-0.82)</td>
<td>6.77</td>
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<tr>
<td>Aziz</td>
<td>9/377</td>
<td>12/166</td>
<td>0.33(0.14-0.77)</td>
<td>3.56</td>
</tr>
<tr>
<td>Borgia</td>
<td>19/237</td>
<td>9/65</td>
<td>0.58(0.28-1.22)</td>
<td>4.24</td>
</tr>
<tr>
<td>de Labriolle</td>
<td>7/127</td>
<td>2/40</td>
<td>1.10(0.24-5.01)</td>
<td>1.35</td>
</tr>
<tr>
<td>Drozd</td>
<td>7/280</td>
<td>5/149</td>
<td>0.74(0.24-2.31)</td>
<td>2.28</td>
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<tr>
<td>Jolicouer</td>
<td>22/213</td>
<td>24/133</td>
<td>0.57(0.34-0.98)</td>
<td>6.20</td>
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<tr>
<td>Finci</td>
<td>5/100</td>
<td>3/100</td>
<td>1.67(0.41-6.78)</td>
<td>1.58</td>
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<tr>
<td>Hoye</td>
<td>37/567</td>
<td>36/304</td>
<td>0.55(0.36-0.85)</td>
<td>7.45</td>
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<tr>
<td>Ivanhoe</td>
<td>3/317</td>
<td>6/158</td>
<td>0.25(0.06-0.98)</td>
<td>1.64</td>
</tr>
<tr>
<td>Lee</td>
<td>8/251</td>
<td>4/82</td>
<td>0.65(0.20-2.11)</td>
<td>2.14</td>
</tr>
<tr>
<td>Mehran</td>
<td>74/1226</td>
<td>49/565</td>
<td>0.70(0.49-0.98)</td>
<td>8.75</td>
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<tr>
<td>Noguchi</td>
<td>7/134</td>
<td>15/92</td>
<td>0.32(0.14-0.76)</td>
<td>3.49</td>
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<tr>
<td>Oliverl</td>
<td>3/286</td>
<td>3/83</td>
<td>0.29(0.06-1.41)</td>
<td>1.28</td>
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<tr>
<td>Prasad</td>
<td>220/914</td>
<td>101/348</td>
<td>0.83(0.68-1.01)</td>
<td>10.90</td>
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<tr>
<td>Sathe</td>
<td>3/116</td>
<td>4/62</td>
<td>0.40(0.09-1.73)</td>
<td>1.46</td>
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<tr>
<td>Chen</td>
<td>2/132</td>
<td>3/20</td>
<td>0.10(0.02-0.57)</td>
<td>1.09</td>
</tr>
<tr>
<td>Suero</td>
<td>395/1491</td>
<td>179/514</td>
<td>0.76(0.66-0.88)</td>
<td>11.58</td>
</tr>
<tr>
<td>Valenti</td>
<td>17/344</td>
<td>17/142</td>
<td>0.41(0.22-0.78)</td>
<td>5.08</td>
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<tr>
<td>Yang</td>
<td>7/87</td>
<td>10/49</td>
<td>0.39(0.16-0.97)</td>
<td>3.25</td>
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<tr>
<td>YiX</td>
<td>135/1202</td>
<td>24/130</td>
<td>0.61(0.41-0.90)</td>
<td>8.05</td>
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<tr>
<td>Jones</td>
<td>26/582</td>
<td>44/254</td>
<td>0.26(0.16-0.41)</td>
<td>7.12</td>
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<tr>
<td>Warren</td>
<td>0/26</td>
<td>0/18</td>
<td>(Excluded)</td>
<td></td>
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<tr>
<td>D+L pooled</td>
<td>1156/9219</td>
<td>593/3697</td>
<td>0.54(0.45-0.65)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Heterogeneity chi-squared = 47.03 (d.f. = 21) p = 0.001
I-squared (variation in RR attributable to heterogeneity) = 55.3%
Estimate of between-study variance Tau-squared = 0.0745

Favors successful PCI   Favors failed PCI
Clinical Event Rates
All-cause Mortality for Successful versus Failed PCI of a CTO

Clinical Event Rates
Cumulative Cardiac Mortality for Successful versus Failed PCI of a CTO

Clinical Event Rates
Cumulative Incidence of CABG for Successful versus Failed PCI of a CTO

Improvement of LV function with CTO-PCI

MRI assessment at baseline and at 6 months shows an improvement in EF and SWT in patients who had successful CTO-PCI

Long Term LV Function Improvement with CTO-PCI

<25% infarcted has most significant improvement

• Improvements in LV volume maintained at 3 years
• Degree of transmurality of scar by MRI

Kirschbaum SW et al. *American Journal of Cardiology* 2008
Medical Therapy may not be enough!

_Higher ischemic burden correlated to mortality_

Shaw et al, *Circulation* 2008;117

<table>
<thead>
<tr>
<th>Ischemic Burden</th>
<th>Death or MI Rate (n)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (n=23)</td>
<td>0.0%</td>
<td>p=0.063</td>
</tr>
<tr>
<td>1%-4.9% (n=141)</td>
<td>15.6%</td>
<td></td>
</tr>
<tr>
<td>5%-9.9% (n=88)</td>
<td>22.3%</td>
<td>p=0.023</td>
</tr>
<tr>
<td>≥10% (n=62)</td>
<td>39.3%</td>
<td>p=0.002</td>
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</table>
CTO-PCI appropriateness is based on patient risk and angina, assuming maximum medical therapy.

But not all CTOs are appropriate

<table>
<thead>
<tr>
<th>Risk</th>
<th>Class 0</th>
<th>Class I/II</th>
<th>Class III/IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Risk No Rx</td>
<td>I</td>
<td>U</td>
<td>U</td>
</tr>
<tr>
<td>Int Risk No Rx</td>
<td>I</td>
<td>U</td>
<td>U</td>
</tr>
<tr>
<td>Low Risk No Rx</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
</tbody>
</table>

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<tr>
<th>Risk</th>
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<th>Class III/IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Risk No Rx</td>
<td>I</td>
<td>U</td>
<td>A</td>
</tr>
<tr>
<td>Int Risk No Rx</td>
<td>I</td>
<td>U</td>
<td>U</td>
</tr>
<tr>
<td>Low Risk No Rx</td>
<td>I</td>
<td>I</td>
<td>U</td>
</tr>
</tbody>
</table>

If maximum medical therapy is absent, CTO–PCI may not be appropriate.

Modified from Patel et al *J Am Coll Cardiol* 2009;53:530–553
Chronic Total Occlusions

PCI of a CTO in patients with appropriate clinical indications and suitable anatomy is reasonable when performed by operators with appropriate expertise.
Controlled, randomized trial needed

**OPEN CTO Registry Coming**

![OPEN CTO Logo](image)

| **Primary Investigators** | • J. Aaron Grantham (PI)  
• William L. Lombardi (Co-PI) |
|---------------------------|-------------------------------|
| **Overview**              | • 10 US sites  
• 1000 patients  
• Multi-center, prospective, single arm observational registry |
| **Aims**                  | • Safety, success, efficiency of hybrid approach  
• Health status effects of CTO-PCI  
• Indications and appropriateness of CTO-PCI  
• Economic analysis |
| **Status**                | • Enrolling 2014 |
| **Sponsorship**           | • Saint Luke’s Mid-America Heart Institute  
• Investigator Sponsored Research trial made possible by a grant from Boston Scientific |
CTOs are Stable and Benign
Ischemia in “Adequately Collateralized” CTOs

No CTOs are adequately collateralized
FFR in 59 pts after successful wire crossing of a CTO

Werner GS et al, European Heart Journal 2006.
CTO Impact on Non-CTO vessel AMI Mortality

Higher 1-year mortality rate w/ CTO

CTO is an independent predictor of mortality

Van der Schaff RJ et al. Am J Cardiol
CTO and Cardiogenic Shock

CTO is independent predictor of mortality

The Procedure is Too Complex
Evolution of CTO-PCI

Increasing success rates related to technique evolution

- **2004**: Antegrade Wires and IVUS
- **2007**: Rudimentary Retrograde
- **2010**: Early Antegrade Dissection Re-Entry
- **2012**: Hybrid
New Approach to Treat CTOs
The Hybrid Strategy

HYBRID STRATEGY PRINCIPLES
- Consistent evaluation approach
- Emphasizes procedural safety, success, and efficiency
- Minimizes radiation and contrast
- Quick transition to alternate plans when failure mode occurs

FOUR ANGIOGRAPHIC CHARACTERISTICS DICTATE STRATEGY
- Proximal cap ambiguity
- Lesion length
- Quality of distal target
- Suitability of “interventional” collaterals

- Antegrade Dissection Re-Entry
- Antegrade Wiring
- Retrograde Techniques
The Hybrid Algorithm

Clear Proximal Cap
Good Distal Target

Antegrade

- YES
  - Wire Escalation
  - Dissection Re-Entry (CrossBoss™–Stingray™)
  - FAIL
  - Dissection Re-Entry (Reverse CART)

- NO
  - Length < 20mm
    - YES
      - Wire Escalation
      - Dissection Re-Entry (Reverse CART)
    - NO
      - FAIL

Retrograde

- NO
  - Wire Escalation
  - Dissection Re-Entry (Reverse CART)
  - FAIL
# Guidewire Selection

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Guide-wire</th>
<th>Commercial name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antegrade micro-channel or soft tissue probing</strong></td>
<td>A hydrophilic and/or polymer-jacket 0.014-inch guidewire, low gram-force, with <strong>tapered</strong> 0.009-In</td>
<td>Fielder XT wire (Asahi Intecc, Nagoya, Japan) &amp; Runthrough taper wire (Terumo Corporation, Tokyo, Japan)</td>
</tr>
<tr>
<td><strong>Knuckle techniques</strong></td>
<td>A hydrophilic and/or polymer-jacket 0.014-inch guidewire, low gram-force, with <strong>tapered</strong> 0.009-inch tip</td>
<td>Fielder XT wire (Asahi Intecc, Nagoya, Japan)</td>
</tr>
<tr>
<td><strong>Retrograde collateral channel crossing</strong></td>
<td><strong>Nontapered</strong>, polymer-jacket hydrophilic 0.014-inch guidewire</td>
<td>Fielder FC wire (Asahi Intecc) and Pilot 50 wire (Abbott Vascular, Santa Clara, California)</td>
</tr>
<tr>
<td><strong>Complex lesion crossing</strong></td>
<td>Moderately high-gram-force (4 to 6 g), polymerjacket, <strong>nontapered</strong> 0.014-inch High-gram-force 0.014-inch guidewire, with a <strong>tapered</strong> 0.009-inch nonjacketed tip</td>
<td>Pilot 200 guidewire (Abbott Vascular) (for tortuous vessels)</td>
</tr>
<tr>
<td><strong>Long lesions</strong></td>
<td>Moderately high-gram-force (4 to 6 g), polymerjacket, <strong>nontapered</strong> 0.014-inch</td>
<td>Pilot 200 guidewire (Abbott Vascular)</td>
</tr>
<tr>
<td><strong>Dissection/re-entry</strong></td>
<td>Moderately high-gram-force (4 to 6 g), polymerjacket, <strong>nontapered</strong> 0.014-inch High-gram-force 0.014-inch guidewire, with a <strong>tapered</strong> 0.009-inch nonjacketed tip</td>
<td>Confianza Pro 12 wire (Asahi Intecc)- straight vessels</td>
</tr>
<tr>
<td><strong>Penetration techniques</strong></td>
<td>High-gram-force 0.014-inch guidewire, with a <strong>tapered</strong> 0.009-inch nonjacketed tip</td>
<td>Confianza Pro 12 wire (Asahi Intecc)</td>
</tr>
<tr>
<td><strong>Cap puncture</strong></td>
<td>High-gram-force 0.014-inch guidewire, with a <strong>tapered</strong> 0.009-inch nonjacketed tip</td>
<td>Confianza Pro 12 wire (Asahi Intecc)</td>
</tr>
</tbody>
</table>
Micro-catheters

- Corsair microcatheter- 2.7 Fr
- Small outer diameter, over-the-wire (OTW) microcatheters- V and Quickcross, finecross-2.6 to 1.8Fr
- Small OTW balloons for wire support and exchange- 1.0 to 1.5 balloons
- Tornus microcatheter
Antegrade Dissection Re-Entry

CTO crossing through the subintimal space, advancing across the occlusion, re-entering into the distal true lumen
Coronary CTO Crossing and Re-entry System

CrossBoss™ Catheter
Designed to quickly and safely deliver a guidewire via true lumen or subintimal pathways

Stingray™ Catheter
Designed to accurately target and re-enter the true lumen from a subintimal position

1

2

3
Bilateral Transradial Access

7 Fr JR Guide RTRA
6 Fr Jackie LTRA
Post balloon angioplasty
Final Angio
Patient sent home to return in 6-8 weeks
RCA Crossbow with a Fielder XT Wire
Crossbow redirect with a “knuckle” wire technique
Mini-loop Subintimal
Verify the placement of Stingray catheter subintimally
Stingray Wire Crossing 2
Dilating Site of Re-entry
Retrograde Techniques

Retrograde collateral wiring

Essential tools for retrograde
1. Microcatheters
2. Wires

Illustration by Dr J C Spratt / VascularPerspectives
Retrograde Techniques

Once septal collaterals allow access to distal cap...

the distal cap should then be tackled like proximal cap.

Follow the Hybrid approach.
Retrograde Techniques

Dissection Re-Entry Techniques: Reverse CART

Illustration by Dr J C Spratt / VascularPerspectives
Success Rates are Low
Procedural Success Rates Over Time

Operators with retrograde skills >90% success

Dartmouth–North Cascade Multicenter CTO Registry, Thompson CA, Lombardi WL
Hybrid CTO Registry Results
More Complex Lesions Overall by J-CTO Score

Hybrid Registry

J-CTO Score

Royal Brompton Registry

% Cases

J-CTO Score

Daniels D, CTO/LM Summit 2013
J-CTO Score

- Developed from the J-CTO registry
- Derivation and Validation
- Predictor of wiring time < 30 minutes
- Procedural success

Morino et al. JACC CI 2011;4:213-21

Source: Dave Daniels, MD; CTO/LM Summit 2013
Hybrid CTO Registry Results

Most successful strategy for complex lesions

Success by J-CTO score

- Success Hybrid
- Success J-CTO
- Success Royal Brompton

% Cases

- J-CTO 0-1
- J-CTO 2
- J-CTO ≥ 3

More Complex Lesions

Daniels D, CTO/LM Summit 2013
CTO-PCI takes too much time
Procedural Efficiency

*Hybrid showed lowest procedure time and contrast used*

Data on procedure time from J-CTO was not published.

Presented by Daniels, D at TCT 2013

*Gallasi et al. Eurointervention 2011;7:472-49*
Hybrid CTO Registry Results
Complex Lesions Crossed Quickly in More Cases

J CTO ≥ 2 - Lesions Crossed in Less than 30 Minutes

<table>
<thead>
<tr>
<th></th>
<th>% Cases</th>
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</thead>
<tbody>
<tr>
<td>Hybrid Registry</td>
<td>50%</td>
</tr>
<tr>
<td>J-CTO Registry</td>
<td>29%</td>
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</table>

p - 0.0002
The procedure is not reproducible or teachable
### Training & Education

<table>
<thead>
<tr>
<th>Training</th>
<th>2012</th>
<th>2013</th>
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<tbody>
<tr>
<td>Training Sites</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Physician Attendees</td>
<td>167</td>
<td>359</td>
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<tr>
<td>Proctors</td>
<td>13</td>
<td>18</td>
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<tr>
<td>Training Events</td>
<td>14</td>
<td>18</td>
</tr>
</tbody>
</table>
North America Training Course Participation

*Data does not include international training numbers*
CTO-PCI Adoption Curve

Total Number of Centers Performing CTO-PCI

- 2011: 90
- 2012: 173
- 2013: 252

Proctoring Success

*Hands-off proctoring*
Hybrid CTO Registry Results

Complex Lesions Crossed Quickly in More Cases

Presented by Daniels, D at TCT 2013

Procedural Success J–CTO ≥ 3

P<0.001*

Success Rate

Hybrid CTO
Royal Brompton Registry
J–CTO Registry

* Hybrid vs. RBR and Hybrid vs. J-CTO
The procedure is cost-prohibitive
The Piedmont Study on Economic Outcomes of CTOs showed that both charges and payments were higher in the CTO group, and overall hospital contribution margins were similar.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>CTO</th>
<th>Non CTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reimbursement</td>
<td>$16,013</td>
<td>$13,166</td>
</tr>
<tr>
<td>Procedure Cost (non device related)</td>
<td>$4,640</td>
<td>$4,376</td>
</tr>
<tr>
<td>Device Cost</td>
<td>$6,230</td>
<td>$3,060</td>
</tr>
<tr>
<td>Contribution Margin</td>
<td>$5,173</td>
<td>$5,730</td>
</tr>
</tbody>
</table>

1 Piedmont Study: CTO, n=154; non CTO, n=1847
CTO Revascularization: Economic Outcomes

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>CTO, N=154</th>
<th>Non-CTO, N=1,847</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Direct Costs</td>
<td>$10,870</td>
<td>$7,436</td>
</tr>
<tr>
<td>Procedural Costs</td>
<td>$7,436</td>
<td>$6,230</td>
</tr>
<tr>
<td>Contribution Margin</td>
<td>$5,173</td>
<td>$5,730</td>
</tr>
</tbody>
</table>

\( P < 0.001 \)
\( P = 0.58 \)
Why are CTO–PCI Attempt Rates So Low?

Common misconceptions

- There is no clinical justification
  - CTOs are stable and benign
  - The procedure is too complex
  - Success rates are low
  - We don’t have time for long procedures
  - Results are not reproducible or teachable
  - CTO-PCI is cost-prohibitive

- Quality of life benefit is indisputable
- Mortality benefit is a reasonable hypothesis being tested
- Underutilization exists and should be addressed
- Controlled, randomized trials are coming
Why are CTO–PCI Attempt Rates So Low?

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- CTO is an independent predictor of mortality
Why are CTO–PCI Attempt Rates So Low? *Common misconceptions*

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- Hybrid approach helps direct decision-making
Why are CTO–PCI Attempt Rates So Low? *Common misconceptions*

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- Historical CTO success rates are low
- Expert CTO operators have >90% success rates
- Hybrid algorithm is most successful strategy for complex lesions
Why are CTO–PCI Attempt Rates So Low?

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- Hybrid algorithm vs other CTO algorithm
  - >20% less time to treat CTOs
  - More complex lesions treated in under 30 minutes
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• CTO–PCI training programs rapidly expanding pool of operators

• With dedicated training and proctoring on the Hybrid Approach, trainee success rates are >80%

• CTO-PCI is cost-prohibitive
Why are CTO–PCI Attempt Rates So Low?

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• Contribution margin between CTO–PCI and standard PCI is not significant
Thank You!