CTO Complication

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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>
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<tbody>
<tr>
<td>Consulting Fees/Honoraria:</td>
<td>Abbott Vascular</td>
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<td>Asahi Intec</td>
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<td></td>
<td>Boston Scientific</td>
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<td>Cordis, Johnson &amp; Johnson</td>
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<td>AstraZeneca</td>
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<td>Daiichi-Snakyo/Eli Lilly</td>
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<td>Sanofi-Aventis</td>
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<td>Zio software</td>
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Key points of this talk

- Introduction of contemporary CTO
- Understanding CTO specific complications
- How to deal those complications
- How to avoid them
## Stream of CTO-PCI

<table>
<thead>
<tr>
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<th>General</th>
<th>Detail</th>
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| 1980’s | Germination | Very few operators  
Very limited equipment |
| 1990’s | Early spreading | More physician & equipment  
New concepts  
(Parallel wire / IVUS guidance) |
| 2000’s | New concept | Retrograde approach  
Image support: CT  
New Equipment |
| 2010’s | More spreading | Retrograde approach  
Image support: CT  
New Equipment |
What is the contemporary CTOPCI?

- Histopathologic aspect
- Imaging modalities support
- Developed devices
- Sophisticated strategies
Typical young and aged CTO

1.5 yrs

5 yrs

Sumitsuji et al. JACC Intv 2011; 9:941–51
Subintima: histopathology vs. IVUS
Feature of Subintima

A

B

C

D
Subintimal tracking in antegrade
Subintimal tracking in antegrade
Subintimal tracking in retrograde
Calcium information from CT
Structure

X-treme
- 16cm Polymer Sleeve & SLIP COAT®
- 16cm Radio-opaque spring coil
- Stainless Steel Core
- PTFE Coating

Fielder FC
- 11cm Spring Coil
- 3cm Radio-opaque Coil
- Stainless Steel Core
- PTFE Coating

Fielder
- 12cm Spring Coil
- 3cm Radio-opaque Coil
- Stainless Steel Core
- PTFE Coating

20cm Polymer Sleeve & SLIP COAT®

22cm Polymer Sleeve & SLIP COAT®
My CTO-PCI strategy (2008/4 - )

CTO - PCI

Heart CT

Antegrade technique

Retrograde technique

IVUS guide penetration

Success

Failure

- Single wire
- Parallel wire
- IVUS entry search
- Retrograde Wire (w IVUS)
- Kissing Wire
- CART
- Stent reverse CART
CTO specific complications 2012

General and new complications

- **General Complications**
  - Radiation / Renal dysfunction
  - Thrombus trouble

- **More CTO-PCI related Complications**
  - Wire perforation intra-CTO & distal coronary
  - Device perforation intra-CTO
  - Distal embolization
  - Donor artery trouble = thrombus + dissection
  - Retrograde channel perforation
Complications in CTO-PCI

- CIN: contrast induced nephropathy
  - Check used contrast, hydration
  - No definite effective solution
  - Option: minimum Contrast CTOPCI with retrograde approach

- Radiation dermatitis
  - Check Fluoro time, Air Karma data
  - Dermatologist care, transplantation

- Radiation pneumonia
  - Respiratory symptom (dry cough)
  - Steroid, never BAL (bronchoalveolar lavage) >> ARDS
Thrombus formation

✔ Prevention
  ✔ Heparinization
  ✔ Flushing
    • ACT 300sec = 5min means that clot can be made in 15min

✔ Treatment
  ✔ Do not push thrombus into coronary
  ✔ Taking all system out
  ✔ Deep consideration of ruling out dissection
Problem of no dye injection in case of RETRO or minimum Contrast PCI
Thrombus due to forgetting Heparin
Thrombus due to forgetting Heparin
CTO specific complications 2012

General and new complications

- General Complications
  - Radiation / Renal dysfunction
  - Thrombus trouble

- More CTO-PCI related Complications
  - Wire perforation intra-CTO & distal coronary
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Wire perforation
intra-CTO & distal coronary

✔ Prevention
  ✔ Honestly difficult

✔ Treatment
  ✔ Intra-CTO
    ✔ Sealing with plaque
    ✔ Prolonged ballooning or Covered stent
  ✔ Distal coronary
    ✔ Coiling
    ✔ Embolization using fat / special material
Entry CTO wire perforation
Long ballooning (~10min)
Intra-CTO wire perforation
Intra-CTO wire perforation
Intra-CTO wire perforation
Intra-CTO wire perforation
Intra-CTO wire perforation
Intra-CTO wire perforation
Distal wire perforation
Coils and compatible micro-catheter

Embolic coils
Left: 10mm C, right: 20mm Tornade
For me personally, 0.018 compatible and Finecross compatible embolic coils are so important.
Device perforation intra-CTO

✔ Prevention
  ✔ IVUS perforation high risk sign

✔ Treatment
  ✔ Prolonged ballooning
  ✔ Covered stent
Schema of coronary perforation

- IVUS image is maybe predictable...???
Type 1: severe eccentric calcified plaque with weak segment in opposite side

9 in 28 lesions showed type 1 IVUS image.
Type 2: severe eccentric fibrous plaque with weak segment in opposite side

8 in 28 lesions showed type 2 IVUS image.
Type 3: severe superficial calcium with weak segment in opposite side

4 in 28 lesions showed type 3 IVUS image.
Case: without trouble in high risk lesion

- 76yo Female, AMI anterior
- Bended calcified lesion with IVUS perforation high risk sign.
dissection

RGMС: 0504027
How to do for these high risk lesion?

- Reducing stretch ratio
  - Make dissection
  - Modify plaque

Risk of perforation: B₁/A₁ >>> B₂/A₂ or B₃/A₃
Distal embolization

✔ Prediction & Prevention
  ✔ CT and IVUS high risk sign
  ✔ Distal protection devices

➔ Treatment
  ➔ Nitorates
  ➔ Flow support; IABP
### Slow flow incidence

<table>
<thead>
<tr>
<th></th>
<th>Attenuation (+)</th>
<th>Attenuation (-)</th>
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</thead>
<tbody>
<tr>
<td>Minus HU (+)</td>
<td>15/51 (29.4%)</td>
<td>0/58 (0%)</td>
</tr>
<tr>
<td>Minus HU (-)</td>
<td>1/59 (1.7%)</td>
<td>1/687 (0.1%)</td>
</tr>
</tbody>
</table>

**Table:**

<table>
<thead>
<tr>
<th>Tissue Type</th>
<th>Minus HU (+)</th>
<th>Minus HU (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLAP</td>
<td>-1000 ~ 0</td>
<td></td>
</tr>
<tr>
<td>LAP</td>
<td>1 ~ 50</td>
<td></td>
</tr>
<tr>
<td>Fibrous</td>
<td>51 ~ 250</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- n=855
- Attenuation (+)
- Attenuation (-)
Donor artery dissection

✓ Prevention
  ✓ Assessment of donor artery stenosis

➡ Treatment
  ➡ Stenting
Donor artery dissection
Donor artery dissection
Donor artery dissection
Retrograde channel perforation

✔ Prevention
  ✔ Careful angiographic assessment
  ✔ Check difficulty of micro-catheter cross in channel
  ✔ Final selective angiogram
  ✔ Not to be optimistic

✔ Treatment
  ✔ Septal channel: leaving in almost all cases
  ✔ Epicardial channel: coiling
Channel Perforation (troubled)
Channel Perforation (troubled)
Channel Perforation (troubled)
Channel Perforation (managed)
Channel Perforation (managed)
Channel ...
Channel ...
Channel ...
Do NOT use TORNUS for SEPTAL
2011/2012 Essential CTO Update
What is published in the field of Chronic Total Occlusions

Gerald S. Werner, MD, FESC, FACC, FSCAI
Medizinische Klinik I
Klinikum Darmstadt - Germany
CTO and Ventricular Arrhythmia: ICD indication

718 ICDs implantation
- 387 Non-ischaemic Patients
- 155 Secondary prevention
- 11 Primary prevention before 2002

165 Ischemic Patients
- 3 Coronary Angiogram information non-available

162 Patients included

71 CTO
- 0 lost to follow-up
- 71 Followed

91 No CTO
- 1 lost to follow-up
- 90 Followed

Prevalence of CTO among recipients of primary prevention: 44%

CTO and Ventricular Arrhythmia: ICD indication

ICD intervention

Mortality

Log rank < 0.01

Log rank = 0.02

Long-term (3 yrs) mortality in CR/IR group

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>No. of Patients</th>
<th>Unadjusted HR Compared With CR (95% CI)</th>
<th>Adjusted HR Compared With CR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>6817</td>
<td>1.00 (0.87–1.15)</td>
<td>1.00 (0.87–1.15)</td>
</tr>
<tr>
<td>1 IR vessel with no total occlusion</td>
<td>8518</td>
<td>1.20 (1.04–1.38)</td>
<td>1.00 (0.87–1.15)</td>
</tr>
<tr>
<td>≥2 IR vessels and at least 1 total occlusion</td>
<td>1321</td>
<td>2.77 (2.29–3.35)</td>
<td>1.36 (1.12–1.66)</td>
</tr>
<tr>
<td>1 IR vessel is totally occluded</td>
<td>3232</td>
<td>1.81 (1.53–2.13)</td>
<td>1.35 (1.14–1.59)</td>
</tr>
<tr>
<td>≥2 IR vessels with no total occlusions</td>
<td>2057</td>
<td>1.88 (1.57–2.27)</td>
<td>1.25 (1.03–1.50)</td>
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</tbody>
</table>

Adjusted by age, ejection fraction, stroke, carotid artery disease, aortoiliac disease, femoral/popliteal disease, shock, hemodynamic instability, cardiopulmonary resuscitation, congestive heart failure, chronic obstructive pulmonary disease, diabetes, renal failure, and left ventricular hypertrophy.

Impact of Completeness of Percutaneous Coronary Intervention Revascularization on Long-Term Outcomes in the Stent Era
Edward L. Hannan, PhD; Michael Racz, PhD; David R. Holmes, MD; Spencer B. King III, MD; Gary Walford, MD; John A. Ambrose, MD; Samin Sharma, MD; Stanley Katz, MD; Luther T. Clark, MD; Robert H. Jones, MD

(Circulation. 2006;113:2406-2412.)
ONE YR MORTALITY AFTER PCI FOR AMI: 1437 PATIENTS

Van der Schaaf. AJC 2006;98:1165
Impact of CTO within AMI case (2yr survival)

<table>
<thead>
<tr>
<th>Freedom From (%)</th>
<th>SVD N=345</th>
<th>MVD N=285</th>
<th>p-value</th>
<th>MVD No CTO N = 201</th>
<th>MVD + CTO N = 84</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac Death</td>
<td>91</td>
<td>84</td>
<td>0.002</td>
<td>88</td>
<td>77</td>
<td>0.02</td>
</tr>
<tr>
<td>Death</td>
<td>88</td>
<td>82</td>
<td>0.003</td>
<td>84</td>
<td>77</td>
<td>0.09</td>
</tr>
<tr>
<td>Reinfarction</td>
<td>95</td>
<td>94</td>
<td>0.380</td>
<td>94</td>
<td>93</td>
<td>0.39</td>
</tr>
<tr>
<td>TVR</td>
<td>92</td>
<td>88</td>
<td>0.028</td>
<td>90</td>
<td>84</td>
<td>0.09</td>
</tr>
<tr>
<td>Total Events</td>
<td>81</td>
<td>71</td>
<td>&lt;0.001</td>
<td>75</td>
<td>63</td>
<td>0.006</td>
</tr>
</tbody>
</table>
Case: ACS+VF > cardiac death (61M)
known LAD-CTO + RCA-ACS
Case: ACS+HF > Cardiac death (87M)
known LAD-CTO + LCX-ACS, RCA severe stenosis
CPA case: MVD+AMI, in-hospital CPA 3vessel occlusions
CPA case: 60M died...
2 vessels almost occlusion
CPA case: 91M died...
2 vessels occlusion, 1 vessel severe stenosis
CPA case: 60M died...
2 vessels occlusion
CPA case: 75M died...

2 vessels occlusion, 1 vessel severe stenosis
8.6% of patients with STEMI had a CTO

Claessen BE et al. Eur Heart J, 2012; epub
More on CTOs and STEMI


136 patients with STEMI and CTO underwent staged PCI of CTO (within 7-10 days)

In 87 successfully recanalized patients, cardiac mortality was 8.0% vs. 20.4% (p<0.05) in patients with unsuccessful procedure for a 2 year observation period.
CTO long-term outcome in 1791 patients 1998-2007

Failed vs. successful PCI

Improved mortality, less need for CABG

Unfavorable impact of Diabetes on prognosis

Mehran R et al. JACC Interv, 2011; 4: 952-61

Claessen BE et al. Am J Cardiol, 2011; 108:924-31
CTO and CTO complication

- Nowadays CTO-PCI has became more popular, more reproducible, and more reliable.
- On the other hand with treating more difficult lesions and patients and with more complicated strategies, we still face problems including complication during CTO-PCI.
- Good understanding and management of complication increase the level of your CTO-PCI.