CT Assessment of Bypass Grafts and Stents

Charles S. White, MD

CTA ASSESSMENT OF CORONARY ARTERY BYPASS GRAFTS AND STENTS

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CORONARY ARTERY BYPASS GRAFTS

- First performed in US in 1960
- 350,000 per year
- Indications
  - L main disease
  - 3-vessel disease
  - Refractory symptoms

Bypass grafting uses a conduit harvested from the patient to bypass an atherosclerotic lesion in a coronary vessel.

CORONARY ARTERY BYPASS GRAFTS

- Two major options
  - On-Pump
    - Traditional technique
    - Requires open sternotomy
  - Off-Pump (Beating heart)
    - Can be done open or through "keyhole"
    - Associated with fewer complication/shorter length of stay

CORONARY ARTERY BYPASS GRAFTS

- GRAFT OPTIONS
  - Internal Mammary (thoracic) Artery Graft (IMA)
    - Left
    - Right
  - Saphenous Vein Graft (SVG)
  - Radial Artery Graft
  - Gastroepiploic Artery Graft

CORONARY ARTERY BYPASS GRAFTS

- INTERNAL MAMMARY ARTERY (IMA)
  - Gift of choice
  - Best patency (85%-90% @ 10 years)
  - Using grafted to LAD (L>R)
  - Grafting options
    - Dissected from sternum – retains connection with subclavian
    - Free graft – aortocoronary

Courtesy: A. Frazier MD
**Coronary Artery Bypass Grafts**

**Saphenous Vein Graft (SVG)**
- From leg - most available for multiple bypass grafting
- Lower patency – 50% @ 5 years
- Largest caliber
- Bypases: Diagonal, obtuse marginal, PDA (occ LAD)

**Radial Artery**
- Third choice
- Intermediate patency rate
- Spasm
- Gastroepiploic Artery
- Technically difficult – fourth choice
- Usually RCA

**Scanning Protocols**

**Bypass Graft**
- Similar to coronary CTA
- Extends from apices
- FOV restricted to heart
- Retrospectively or prospectively gated (BMI < 32)

**LIMA and SVG**

**Radial and Gastroepiploic**

**Coronary Bypass Grafts**
CORONARY BYPASS GRAFTS
ACUTE COMPLICATION

GLOBAL SVG STENOSIS
Perioperative
1 year F/U
Neointimal hyperplasia

Courtesy: Dr. Choi

CORONARY BYPASS GRAFTS
STENOSIS
Coronary bypass graft occlusion

The "nubbin" sign

The nubbin sign

Coronary bypass grafts

Chronic graft complication ectasia

Coronary bypass graft occlusion
CHRONIC GRAFT COMPLICATION

CHRONIC GRAFT COMPLICATION

Courtesy: L. Haramati MD

CHRONIC GRAFT COMPLICATION

CHRONIC GRAFT COMPLICATION

CORONARY BYPASS GRAFTS

<table>
<thead>
<tr>
<th></th>
<th>Pts</th>
<th>Grafts</th>
<th>Occlusion (Se,Sp)</th>
<th>Stenosis (Se)</th>
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</thead>
<tbody>
<tr>
<td>EBCT</td>
<td>50</td>
<td>135</td>
<td>(80%-100%)</td>
<td>N/A</td>
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<tr>
<td>SSCT</td>
<td>985</td>
<td>2200</td>
<td>(81%,89%)</td>
<td>N/A</td>
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<tr>
<td>4-DCT</td>
<td>441</td>
<td>1246</td>
<td>(93%,96%)</td>
<td>74%</td>
</tr>
<tr>
<td>16DCT</td>
<td>144</td>
<td>416</td>
<td>(99%,98%)</td>
<td>88%</td>
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</table>

Adapted from Slatt PD-AJC 2005

CORONARY BYPASS GRAFTS

Diagnostic Performance of 44-Slice Computed Tomography in Evaluation of Coronary Artery Bypass Grafts

Sixty-four-slice CT angiography can be used for accurate exclusion of greater than 50% graft stenosis, but detection of distal anastomotic stenosis is limited, and the degree of stenosis can be overestimated.

Fauchtner G. AJR 2007;189:574

REOPERATIVE STERNOTOMY
**CORONARY STENTS**

Initial human use in 1986
- Reduced restenosis compared with 30% rate of angioplasty
- 1M implanted yearly in US
- Two main types:
  - Bare metal stents
  - Drug eluting stents

**CORONARY STENTS**

Bare metal stents
- Initial type of stent
- Eliminated risk of immediate artery collapse seen with angioplasty
- Due to scarring, had a 25% rate of restenosis at 6 months

**Drug-eluting stents**
- Impregnated with drugs to retard restenosis process
- Associated with much lower rate of restenosis (<10%)
- Rarely, develop late potentially fatal restenosis from blood clot
- Require long term anticlotting drugs

**CORONARY STENT TYPES**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Drug-eluting stents</td>
<td>Impregnated with drugs to retard restenosis process</td>
</tr>
<tr>
<td>bare metal stents</td>
<td>Reduced risk of immediate artery collapse seen with angioplasty</td>
</tr>
<tr>
<td>Drug-eluting stents</td>
<td>Reduced risk of restenosis (&lt;10%)</td>
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<tr>
<td>Require long term anticlotting drugs</td>
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</table>

**CORONARY STENTS – CT FACTS**

- CT is effective for thrombosis in larger stents (3.5 mm and greater)
- Good for occlusion vs non-occlusion
- Difficult to assess in-stent restenosis
EFFECT OF STENT SIZE

4 mm stent  3.0 mm stent  2.25 mm stent

STENT ASSESSMENT

STENT ASSESSMENT

BLOOMING

CORONARY STENTS - INGROWTH

OCCLUSION?
In selected patients with previous stent implantation, 64-section CT can be used to evaluate in-stent restenosis with high accuracy.

**Evaluation of Patients with Previous Coronary Stent Implantation with 64-Section CT**

**Evaluation of Coronary Stents With 64-MDCT: In Vitro Comparison of Scanners From Four Vendors**

"For longitudinal reformations, scanners from the four leading vendors do not differ in artificial luminal narrowing, but there are differences in artificial luminal attenuation and image noise. The quality of images of the in-stent lumen is better on longitudinal reformations and for stents with a diameter greater than 3 mm."

<table>
<thead>
<tr>
<th></th>
<th>Pts</th>
<th>Stents</th>
<th>Slices</th>
<th>Se, Sp, PPV, NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitagawa (IJC)</td>
<td>42</td>
<td>61</td>
<td>16</td>
<td>89, 95, 94, 90</td>
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<tr>
<td>Gilard (Heart)</td>
<td>143</td>
<td>232</td>
<td>16</td>
<td>86, 100, 100, 99</td>
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<tr>
<td>Rist (AR)</td>
<td>25</td>
<td>45</td>
<td>64</td>
<td>75, 92, 67, 94</td>
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<tr>
<td>Oncel (Rad)</td>
<td>30</td>
<td>39</td>
<td>64</td>
<td>99, 95, 94, 90</td>
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</table>
ITERATIVE RECONSTRUCTION
FIRST GENERATION

ITERATIVE RECONSTRUCTION
SECOND GENERATION

"MODEL-OPTIMIZED"
IMR- ITERATIVE MODEL RECONSTRUCTION

ITERATIVE RECONSTRUCTION
SECOND GENERATION - IMR

ITERATIVE RECONSTRUCTION
SECOND GENERATION - IMR

Courtesy of Amar Dhanantwari, Philips Medical Systems

NEWER APPROACHES

Multienergy Photon-counting K-edge Imaging: Potential for Improved Luminal Depiction in Vascular Imaging

Radiology 2008;249:1010
TECAB – DAVINCI ROBOTIC SURGICAL SYSTEM

TECAB

HYBRID REVASCULARIZATION

Broadly speaking, hybrid revascularization entails performing both a PCI procedure and the surgical grafting of the LIMA to the LAD, using a minimally invasive approach, typically within one to two days of each other. No interventional

Two approaches
1) PCI first – permits fallback to open procedure if complications arise
2) CABG first – permits cath verification that LIMA graft is patent

PUTTING IT TOGETHER

Hybrid Procedure (High risk pt)
- Bypass Graft – cardiac surgeon
  - Often LIMA-LAD
- Stent placement - cardiologist
  - Variable – often LCX

CONCLUSIONS

- We see bypass grafts well with CCTA
- We don’t see stents so well with CCTA

THANK YOU