The Role of MSCT in Coronary Revascularization

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MSCT Coronary Angiography

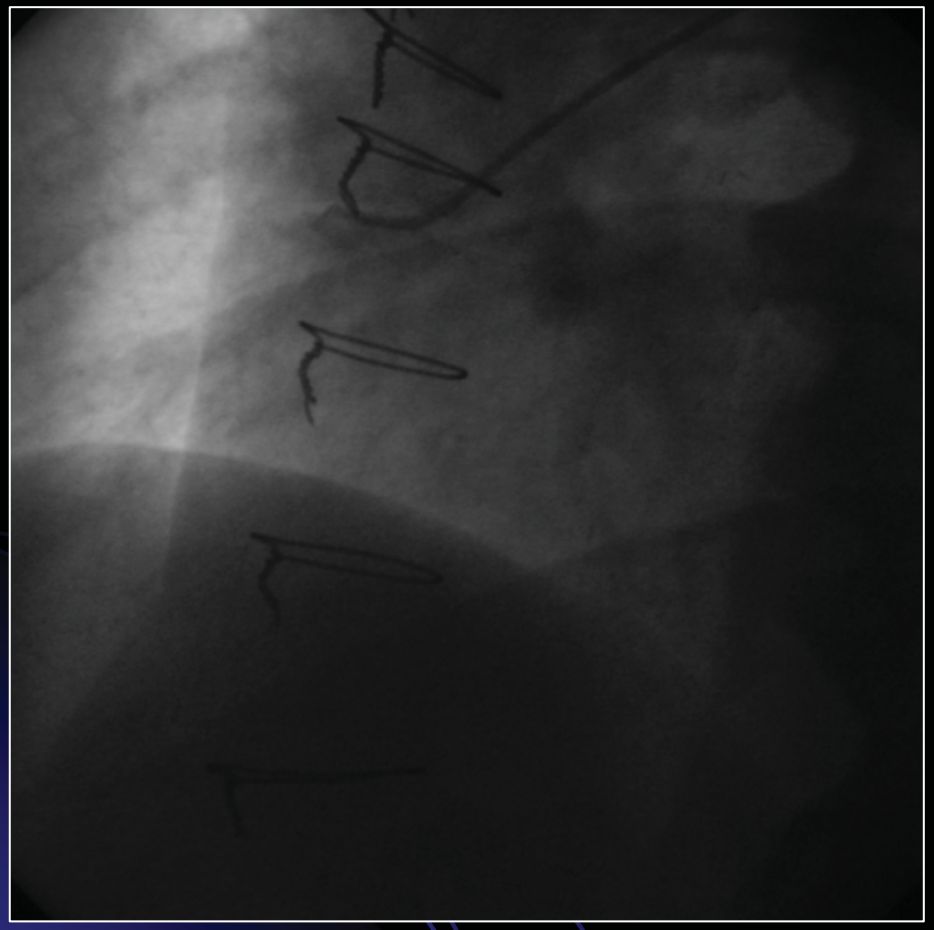
- Catheter based selective coronary angiography is regarded as the gold standard investigation for coronary artery disease. It is invasive, costly and fails to provide information on vessel wall and atherosclerotic plaque.

- Multislice Computed Tomography (MSCT) has the capability to perform non-invasive coronary angiography as well to as assess patency of coronary stents and bypass grafts.

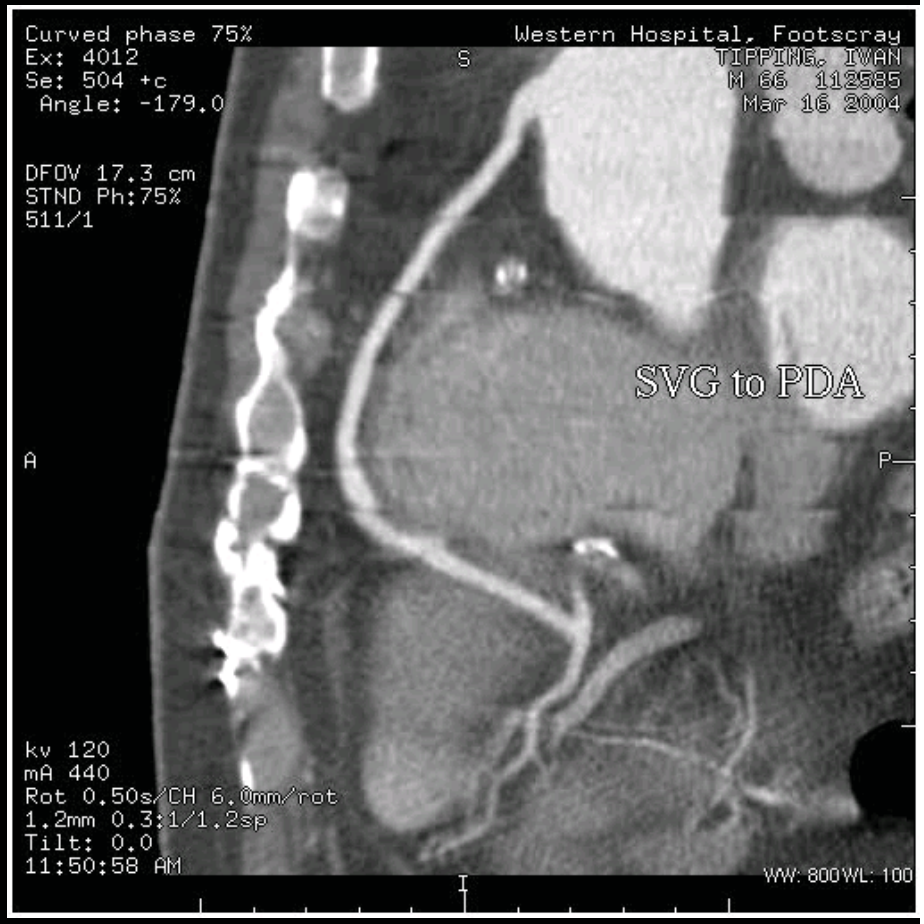
Comparison of MSCT & Conventional Coronary Angiography

Conventional CA	MSCT CA
Invasive	***Non-invasive***
Diagnostic & Therapeutic	***Diagnostic***
Lesion diagnosis	***Disease diagnosis***
Whole Vasculature	***Reconstructed Vasculature***
Lumen	***Wall & Lumen***
Flow Information	No Flow Information
High Resolution	Low Resolution
Less Contrast	More Contrast
High Cost	Low Cost

Comparison of MSCT vs Conventional CA
Grafted Distal RCA Disease



Conventional Coronary Angio

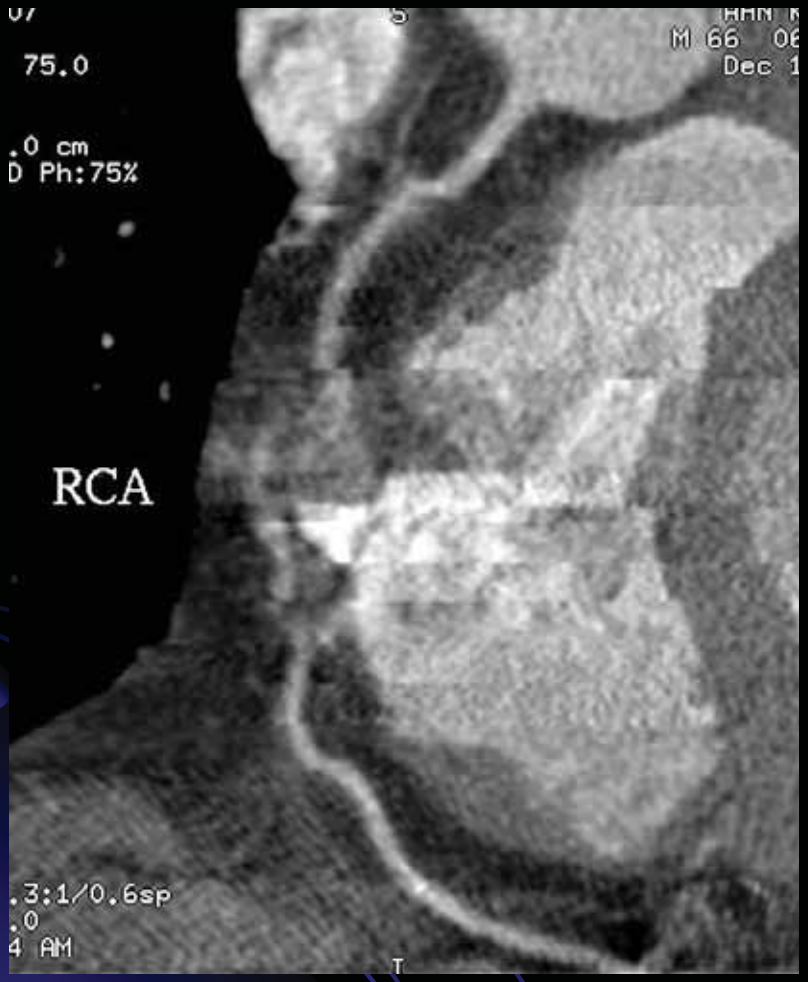


16 Slice CT Coronary Angio

Technical Details to achieve High Quality MSCT CA Scan

- Patient selection:
  - Sinus rhythm (< 60/min)
  - Unimpaired Renal Function (Cr < 0.14)
- Patient preparation
  - Single Breath-hold
  - B-blockade & Sedation
- Thickness of slice
- Target ROI & bolus capture
- Expertise in Image Reconstruction (% Phase)

Heart Rate



HR = 70-74

HR = 61-64

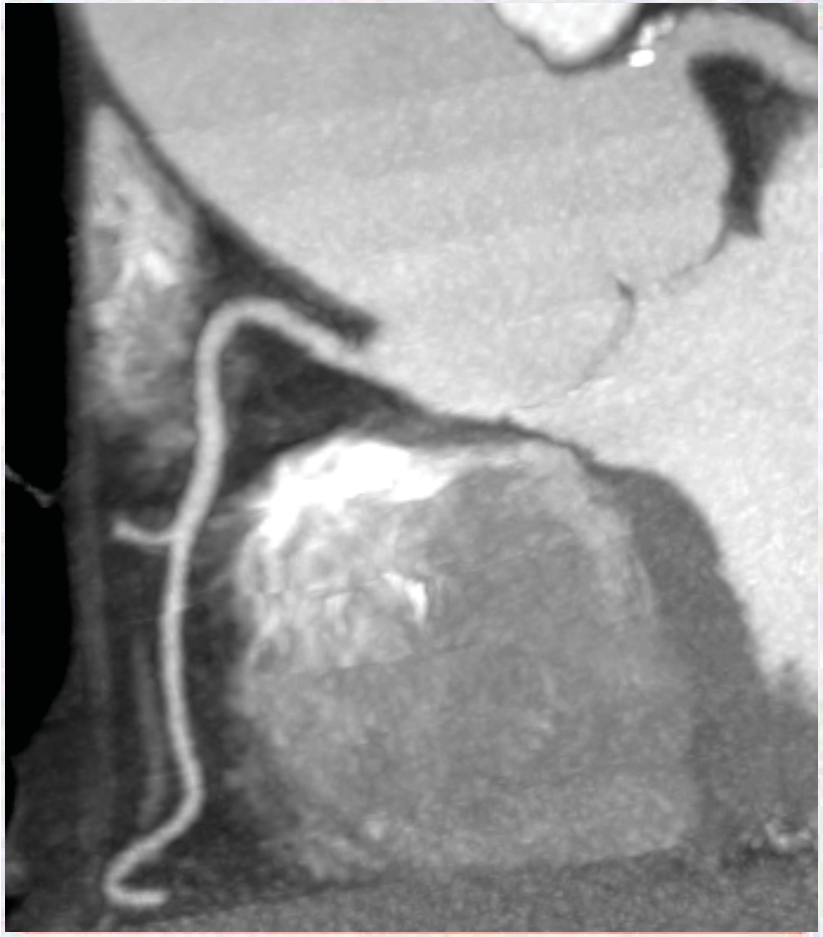
Phase 45% for RCA

45%

75%

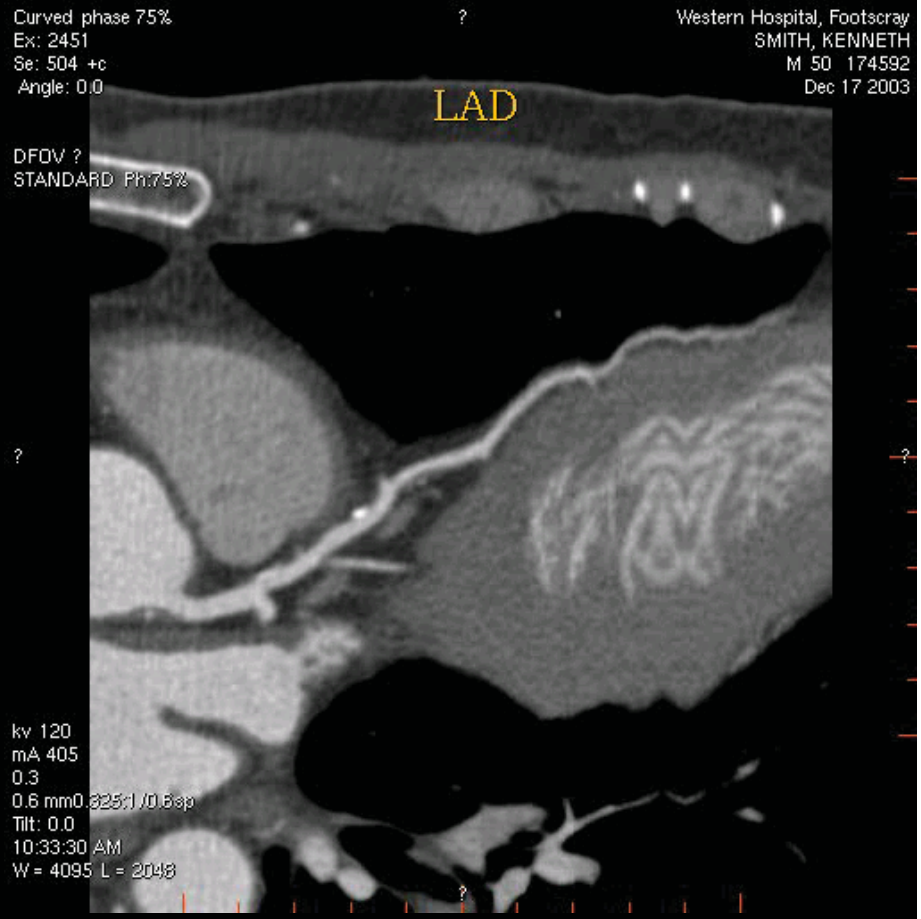
Large patient done at 1.25mm, 120 kvp, 770 mA

Review Techniques

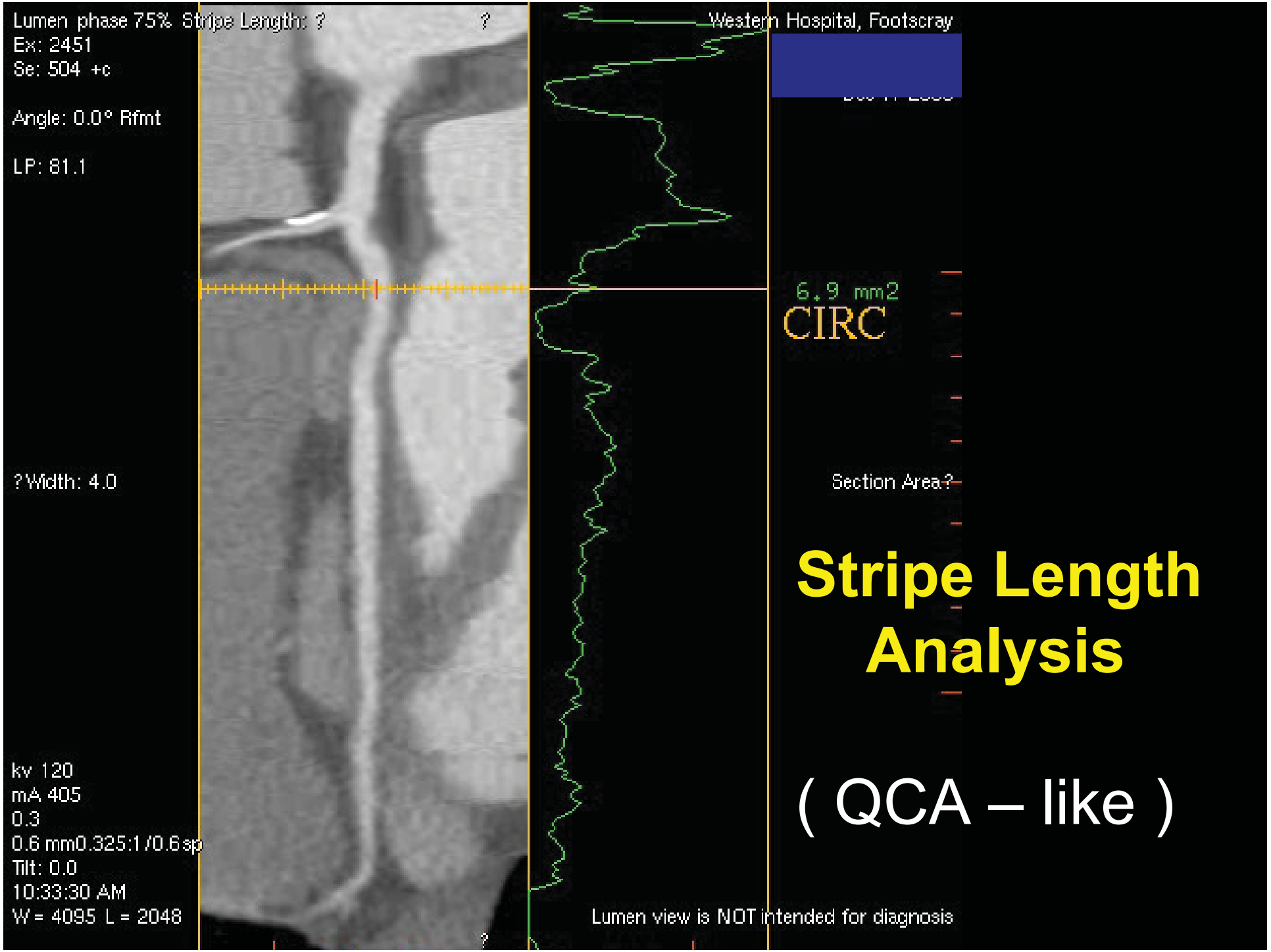


1. Curved Multiplanar
2. Volume Rendered (3D)
3. Stripe Length Analysis
4. 4D Reconstruction
5. Maximal Intensity Projection (MIP)
6. Angioscopy

Curve Multi-planar Reconstruction

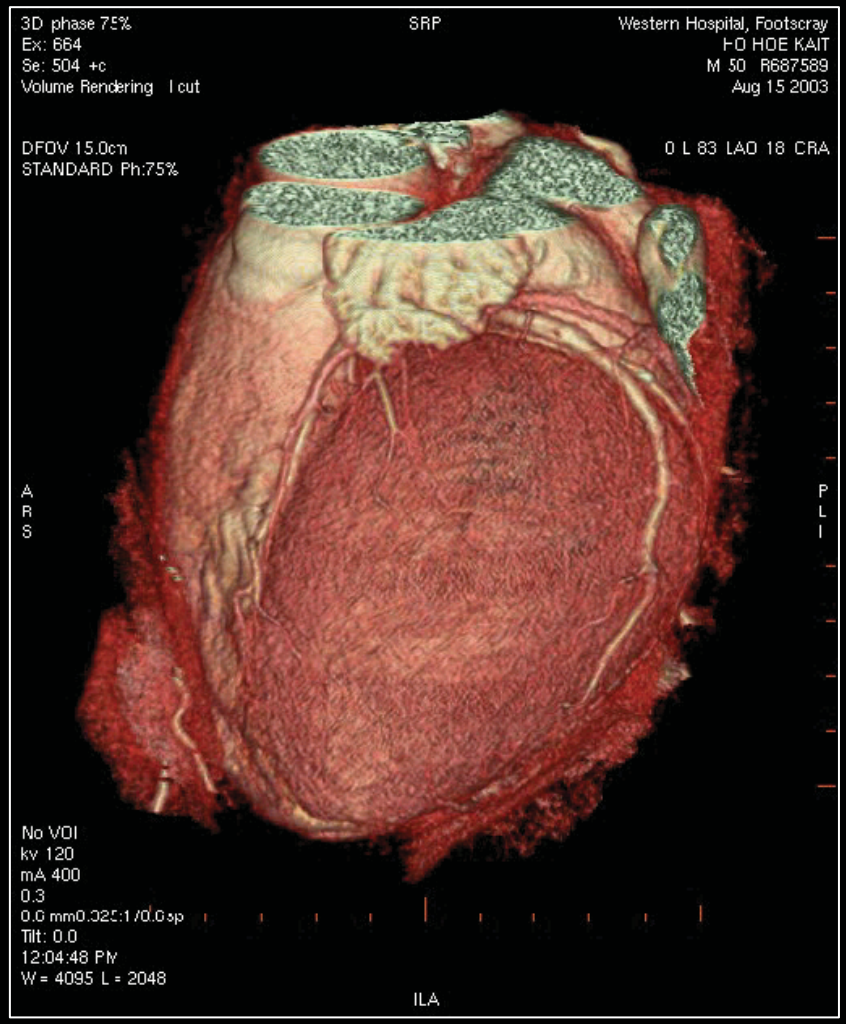


Normal Left Coronary Artery


Lumen phase 75% Stripe Length: ?
Ex: 2451
Se: 504 +c
Angle: 0.0° Rfmt
LP: 81.1
?Width: 4.0
kv 120
mA 405
0.3
0.6 mm0.325:1/0.6sp
Tilt: 0.0
10:33:30 AM
W = 4095 L = 2048
Western Hospital, Footscray
6.9 mm2
CIRC
Section Area?
Lumen view is NOT intended for diagnosis
Stripe Length Analysis
(QCA – like)

3D volume rendering

- Graft study
  - Clear the bones and soft tissues
- Course of artery
  - Anomalous artery
  - Branches
  - Bifurcation angle
- Graphic display for reports



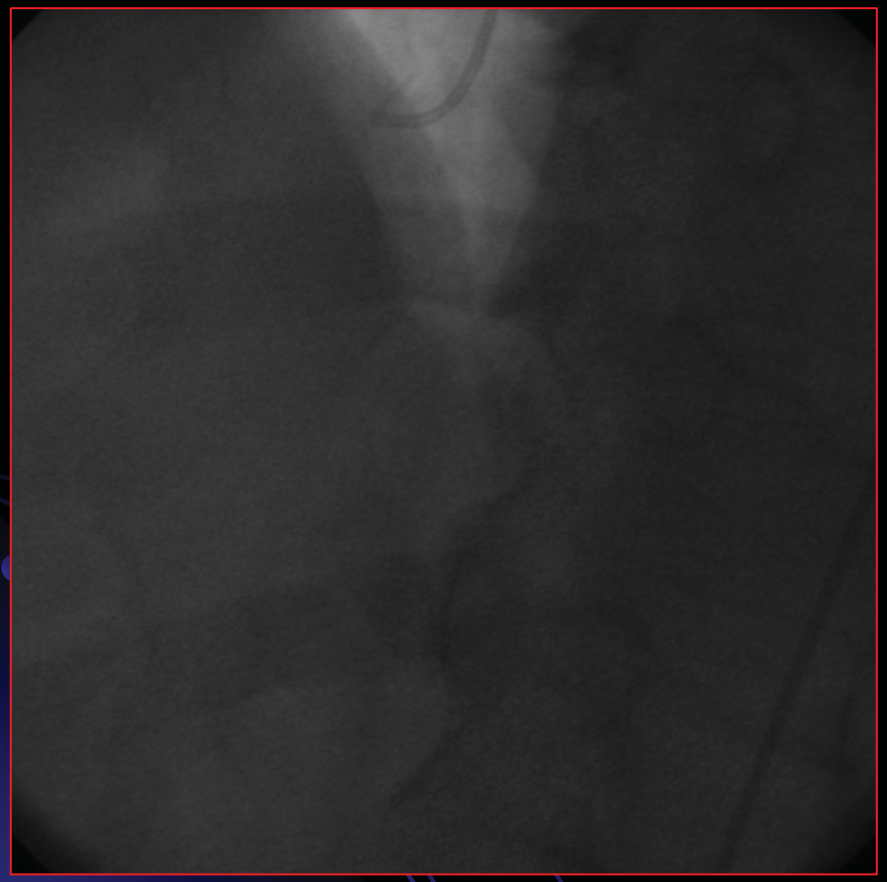
CLINICAL APPLICATIONS OF MSCT (16 SLICE) CORONARY ANGIOGRPAHY

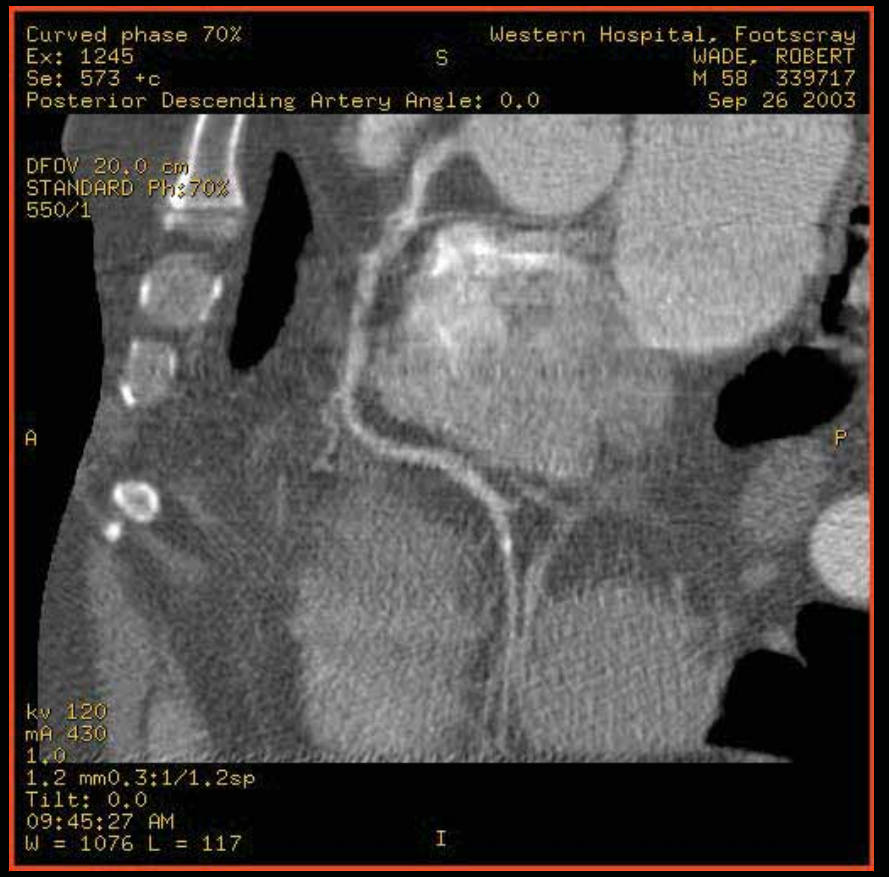
1. Diagnosis of CAD & Coronary Stenosis
2. Evaluation of PCI (stenting)
3. Plaque characterization, regression & Prophylactic stenting of *vulnerable plaques*
4. Bypass Grafts localization and evaluation
5. Anamalous Coronary Artery imaging

Clinical Application-1

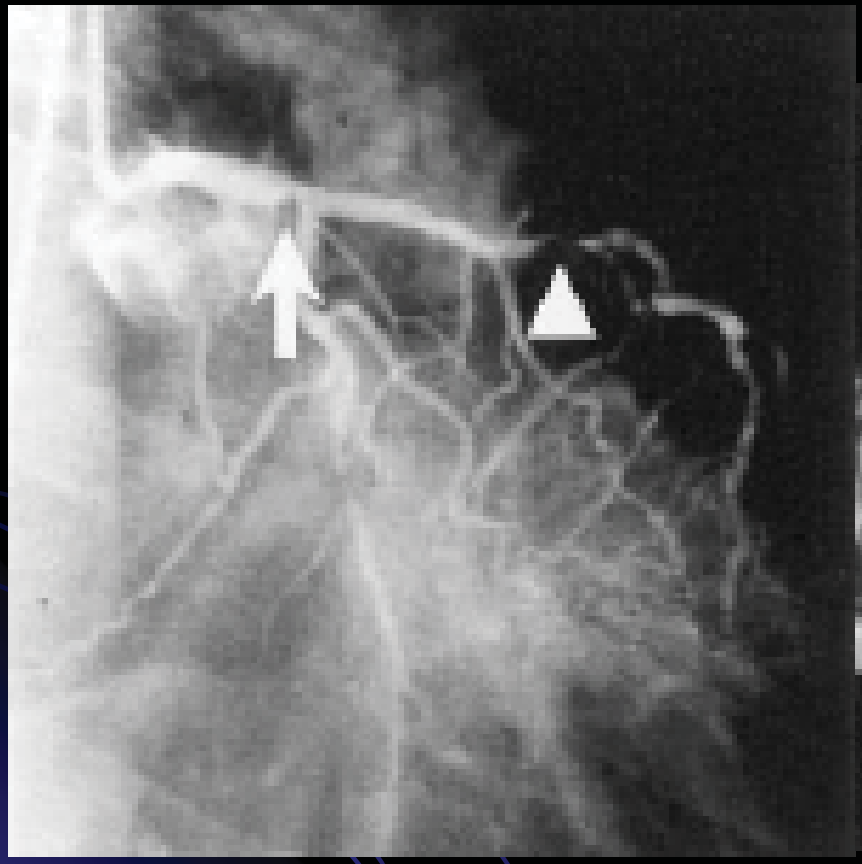
Diagnosis of CAD & Coronary Stenosis

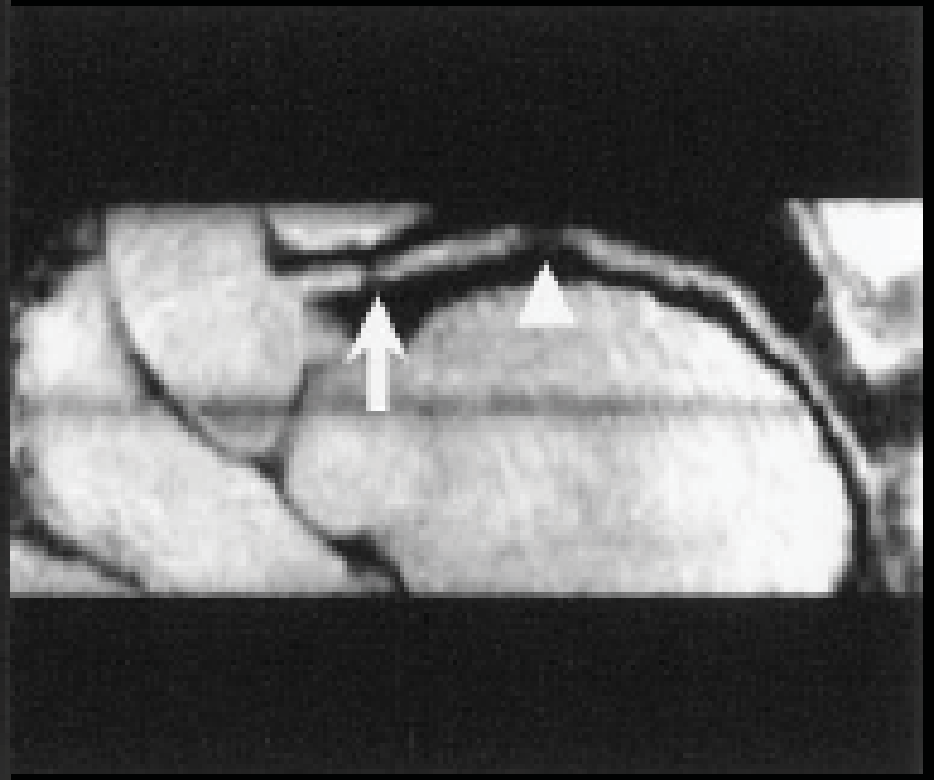
Coronary Artery Disease
Mid- RCA Disease





Coronary Artery Disease
LM & LAD Disease

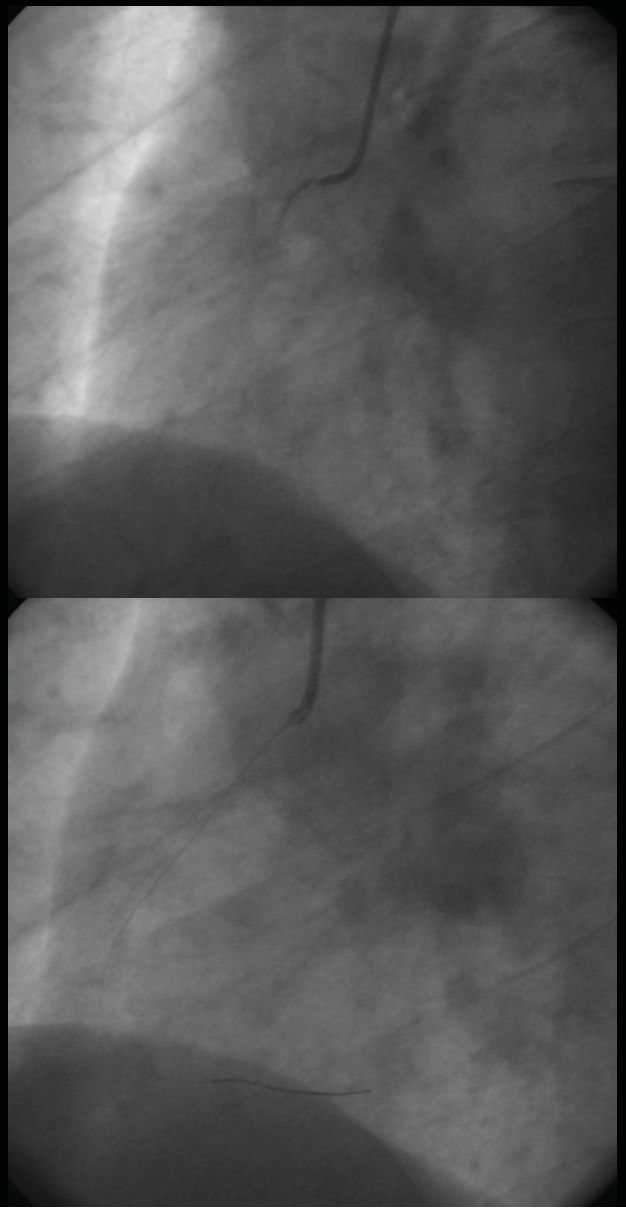




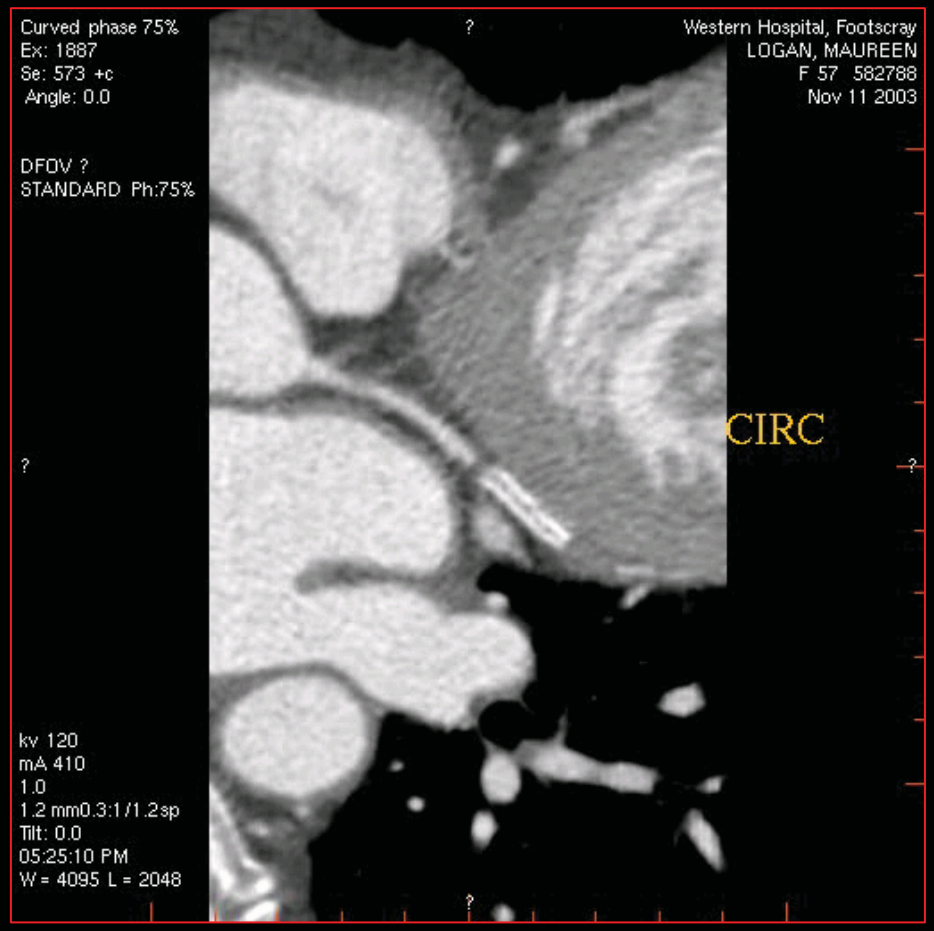
Clinical Application 2

Various roles of MSCT
Coronary Angiography in PCI

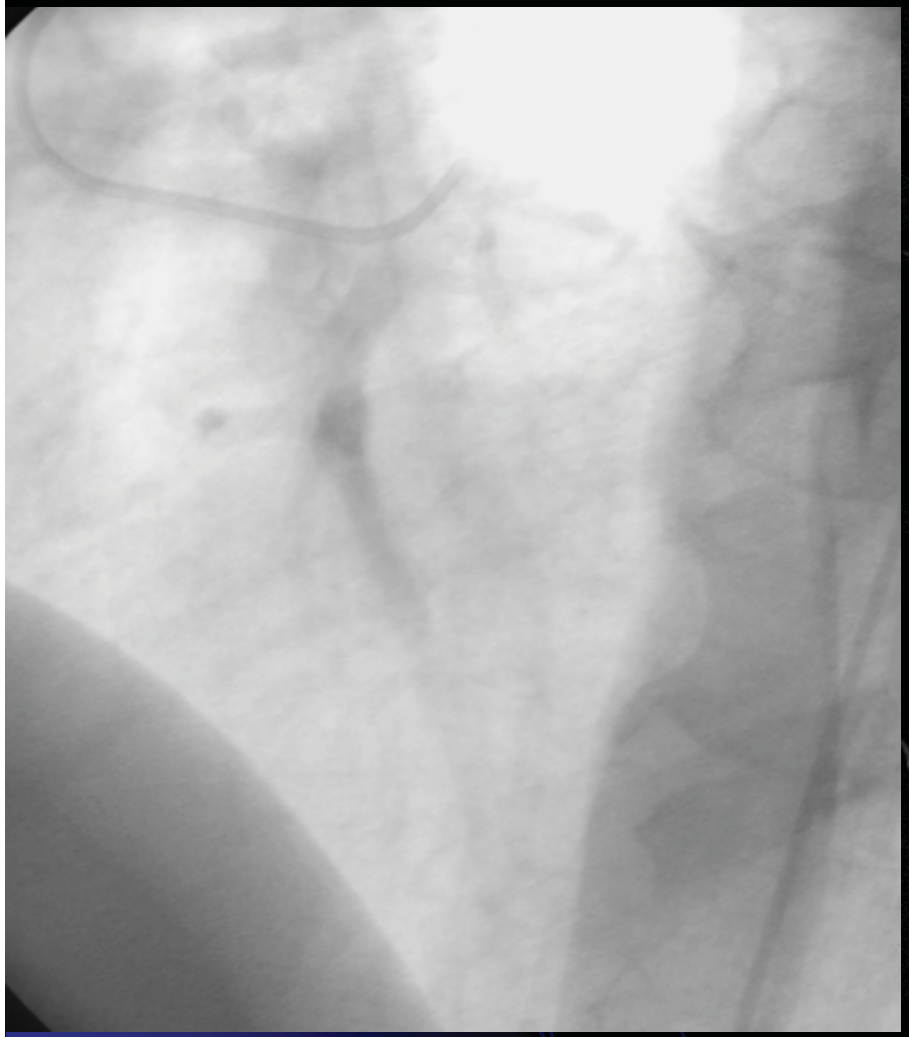
MSCT Evaluation of Stent Patency



Patency of LCx stent with Edge Restenosis

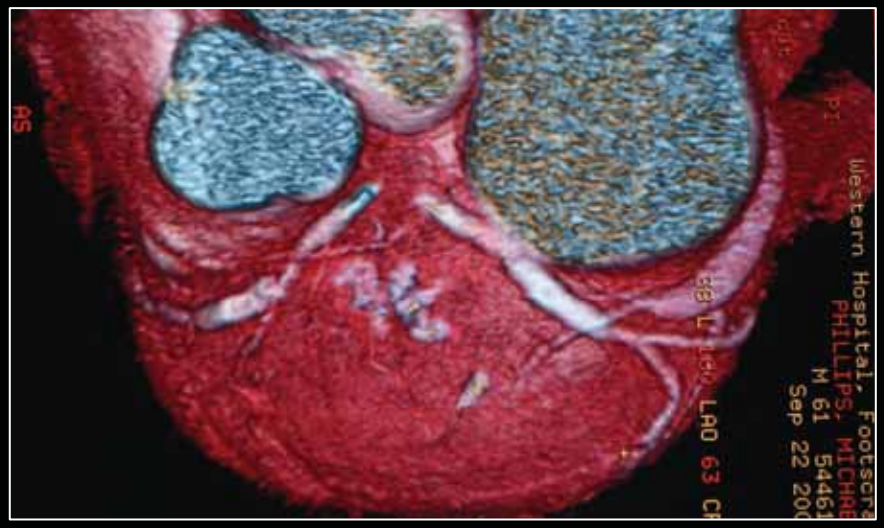


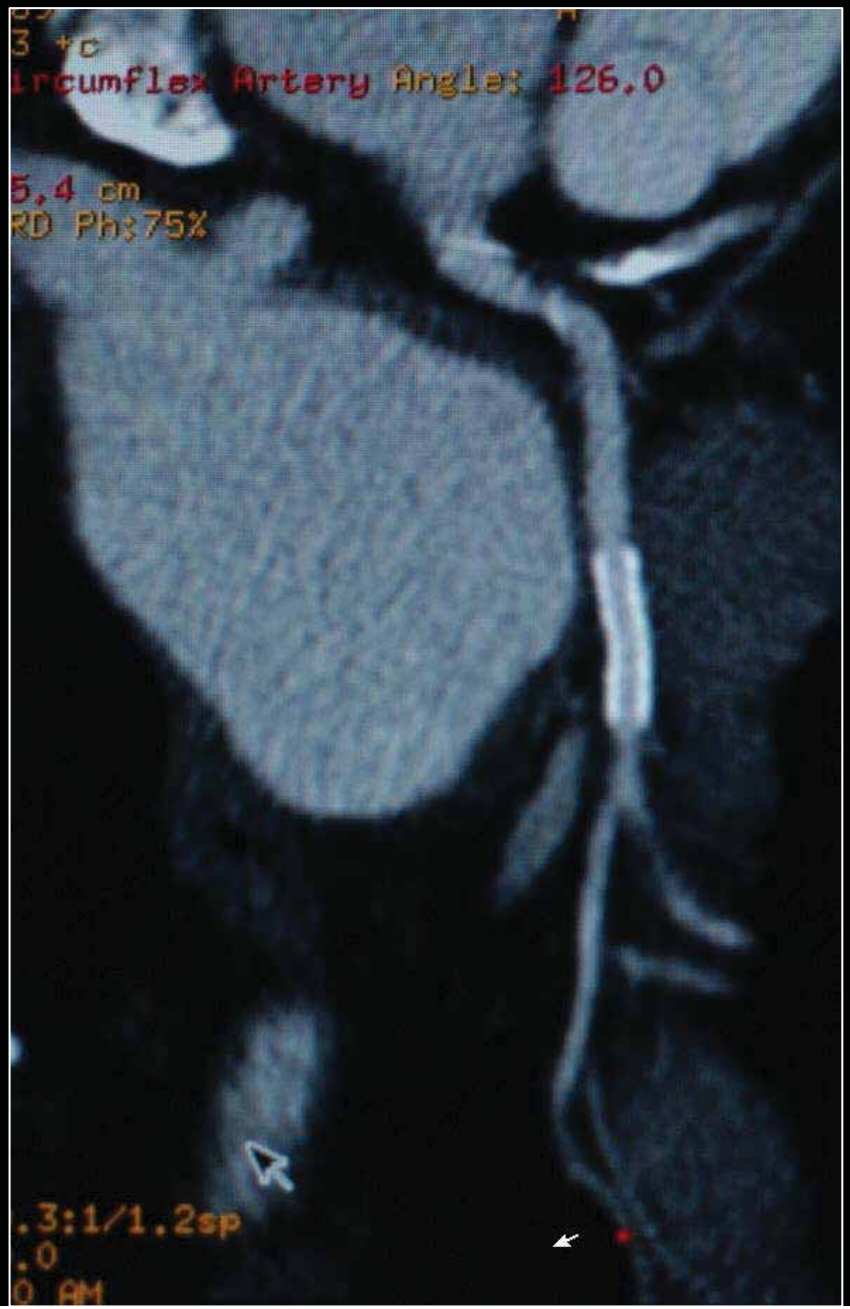
Pre-Stenting Strategy
Role of "Non-invasive IVUS"



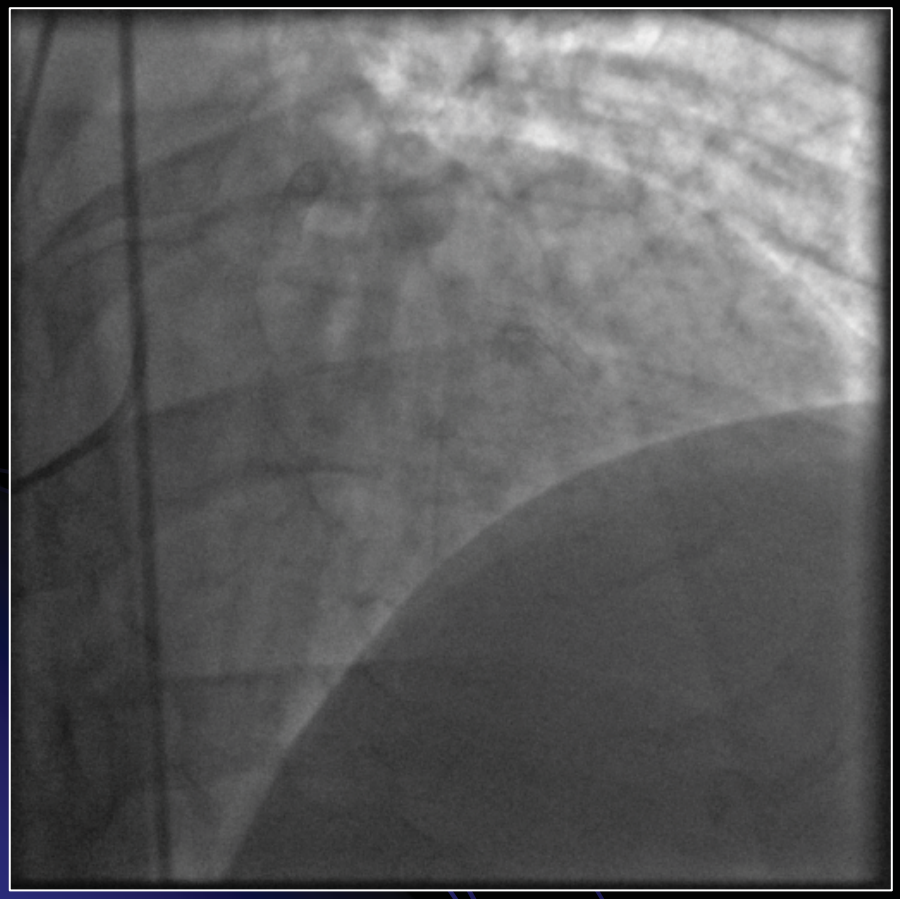
Post-Stenting of LADD Ostial Lesion

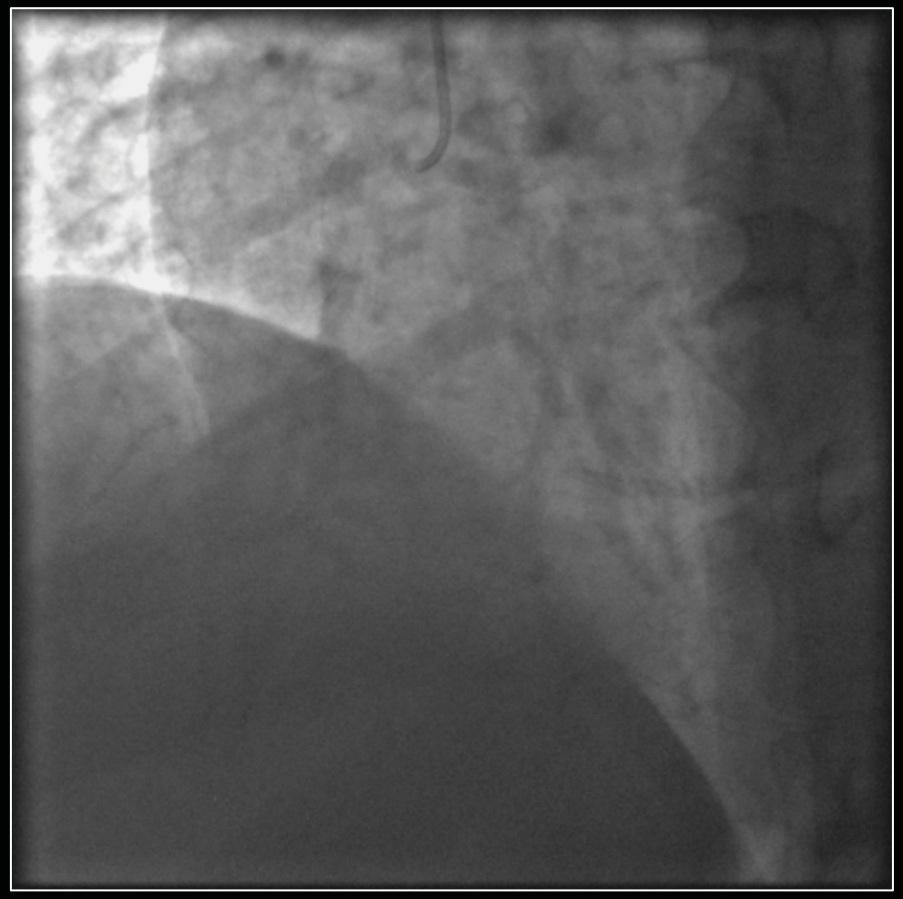
Coronary Stenting of LAD and LCX





Subsequent Coronary Angiography





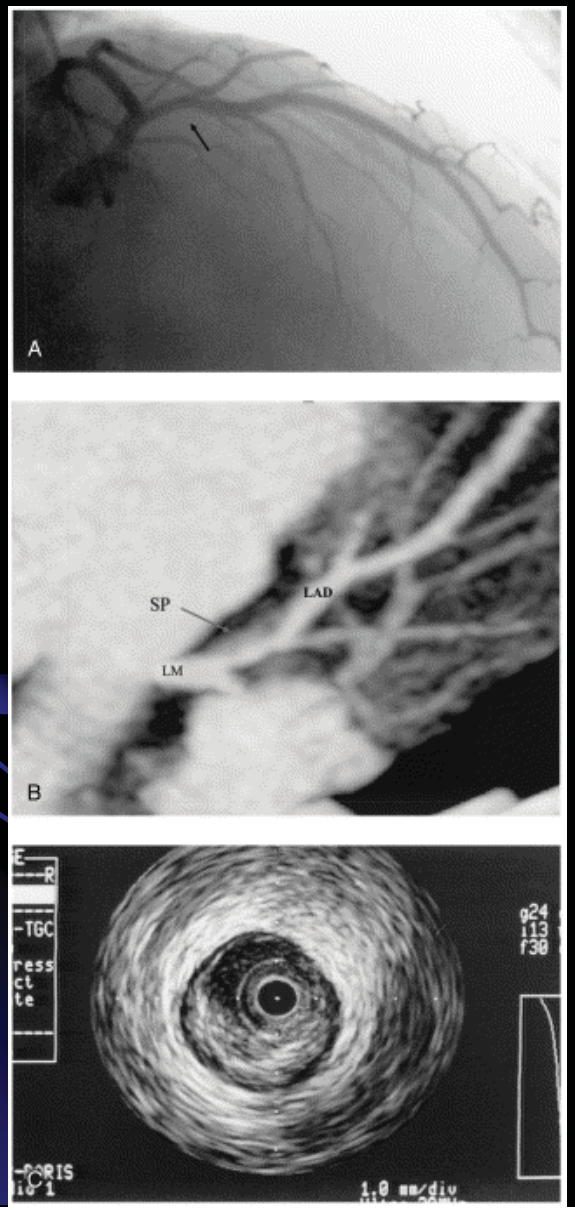
Clinical Application 3

Plaque Characterization

Plaque Regression

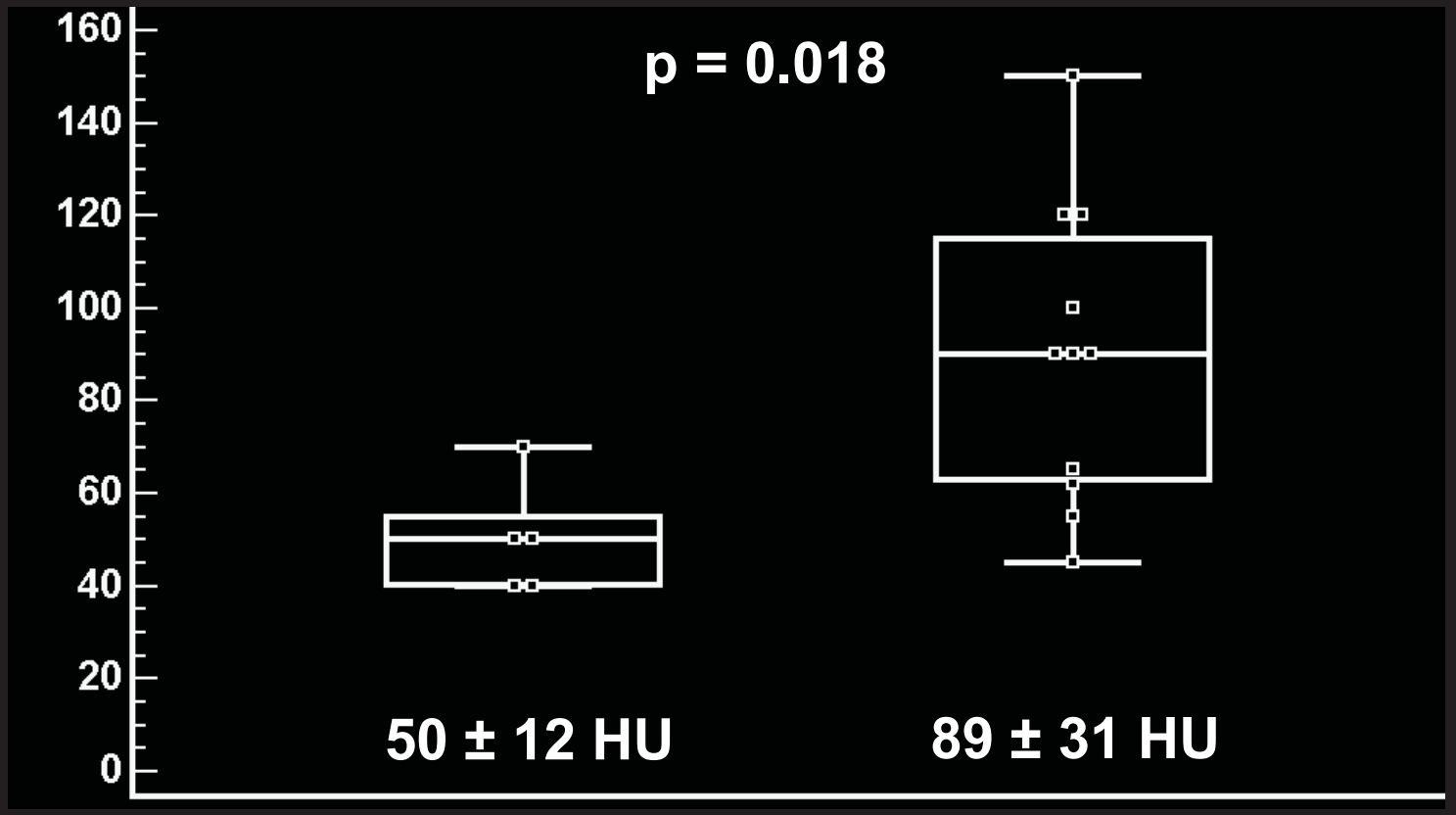
? Prophylactic Stenting of Vulnerable Plaque

Vulnerable Plaque

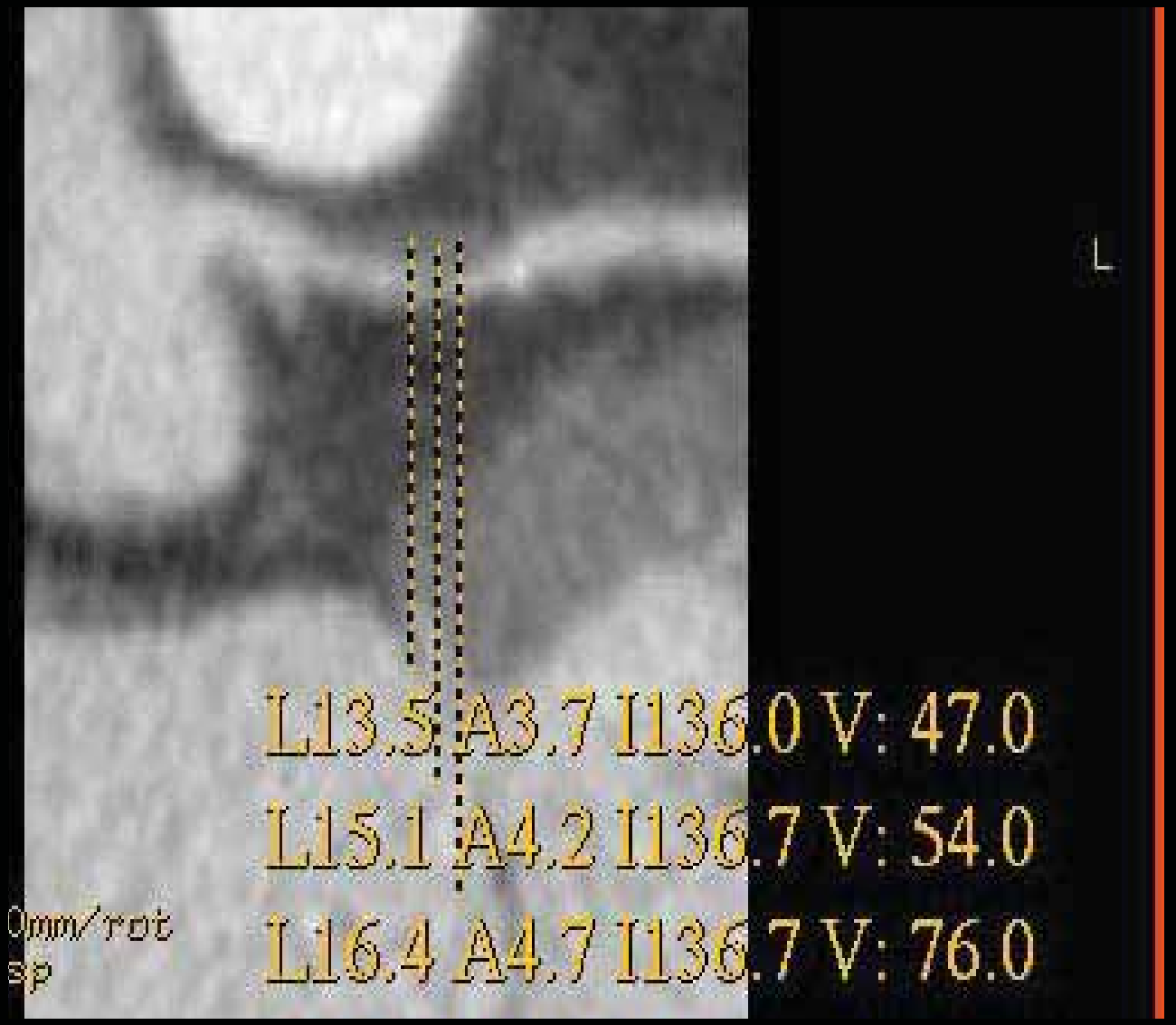


- Anterior MI
- Anteroseptal hypokinesia
- Mild prox LAD 50% on QCA
- MSCT-soft plaque in prox LAD: 60-70%
- IVUS: eccentric plaque

CT Plaque Density



Same LAD lesion - enlarged



c

Plaque Regression after Statin Therapy

30/4/2002

- Plaque = 13.6mm long
- Long area=19.8sq.mm
- Tr. Area=5.0sq.mm.
- Prox. Fornix= 79 HU
- Dist. Fornix=73 HU
- Prox. Crater=221 HU
- Dist. Crater=403 HU

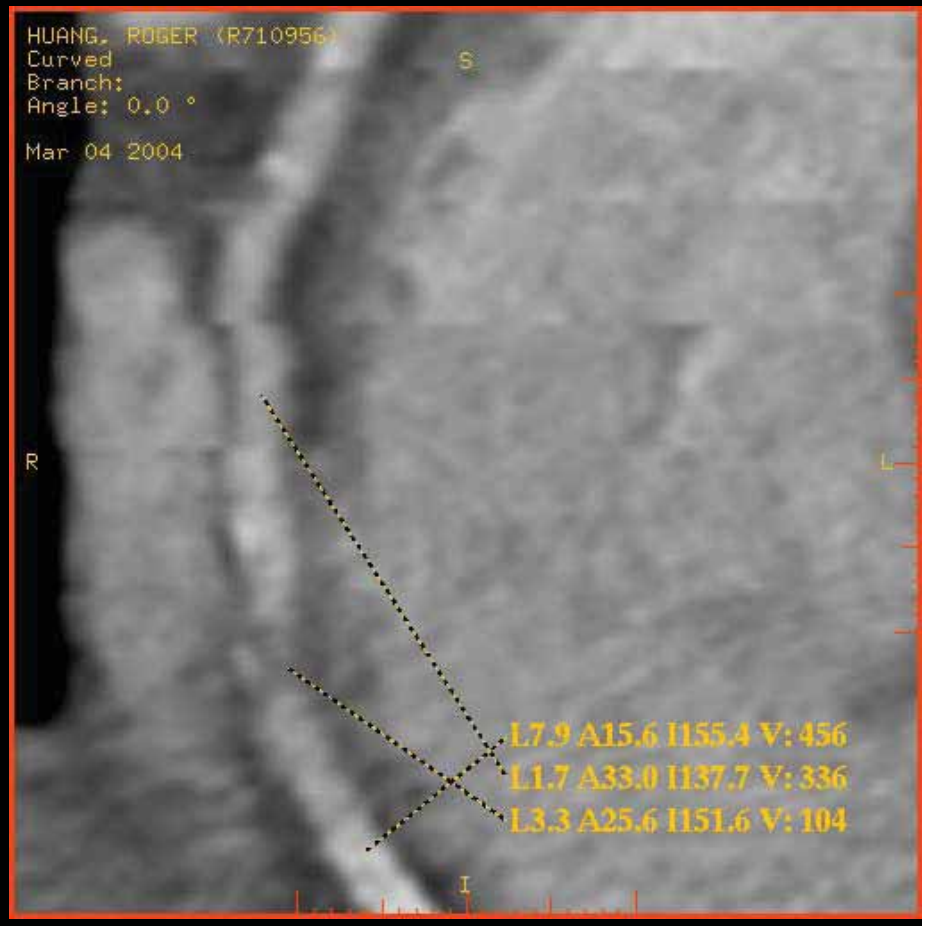
9/6/2003

- Plaque= 13.2mm long
- Long area=13.7sq.mm
- Tr. Area=4.5sq.mm
- Prox.Fornix= 91 HU
- Dist. Fornix=87 HU
- Prox. Crater= 218 HU
- Dist. Crater= 413 HU

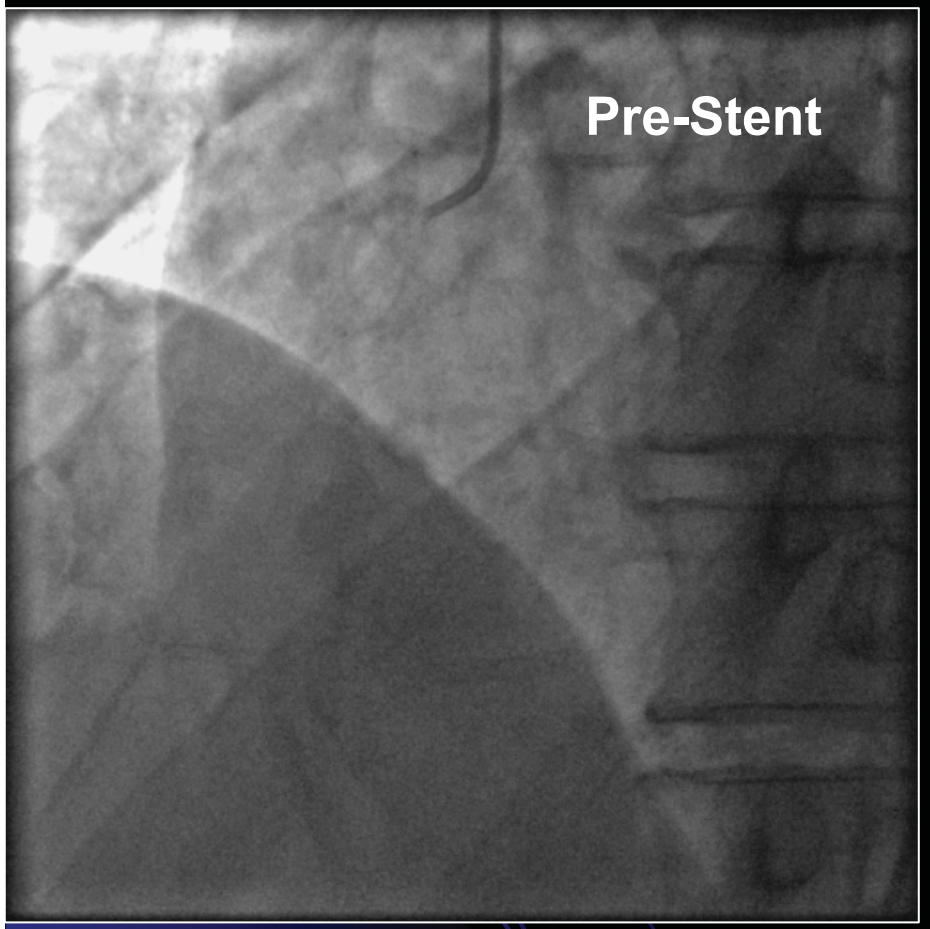
Prophylactic Stenting

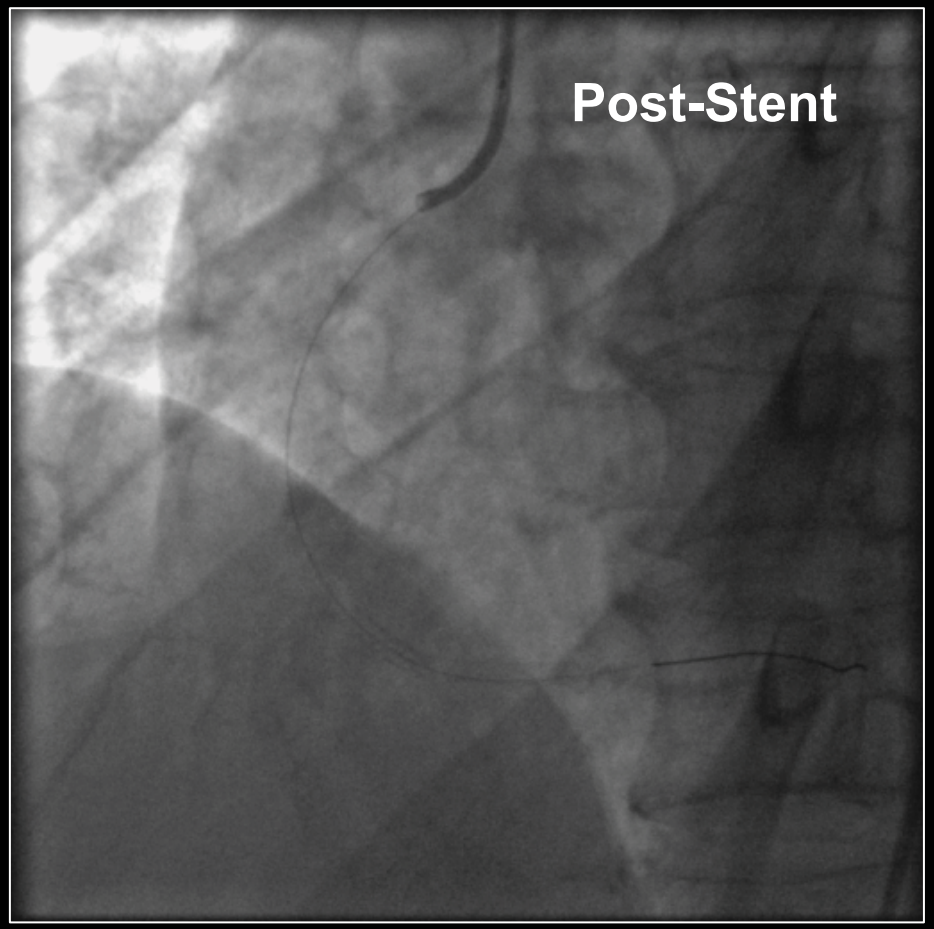
Stenting of Vulnerable Plaque

Ulcerated Soft Plaque



C. Angio. of soft plaque detected by MSCT and stented with Cypher stent

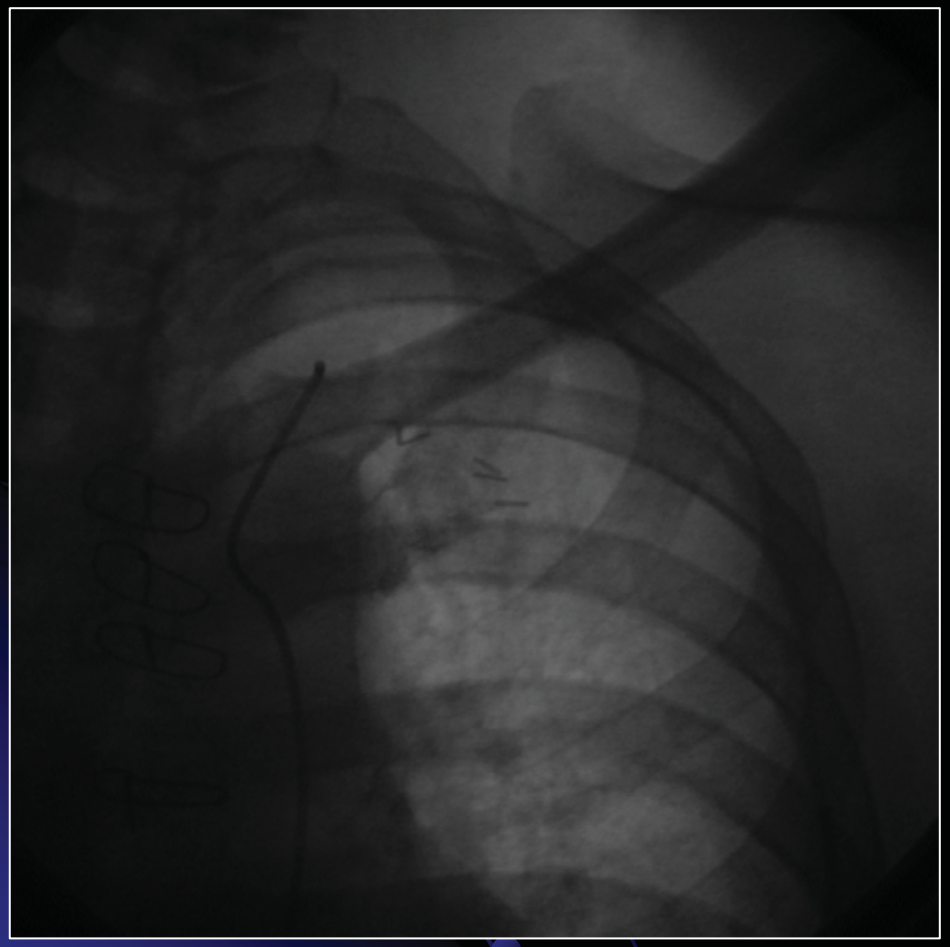


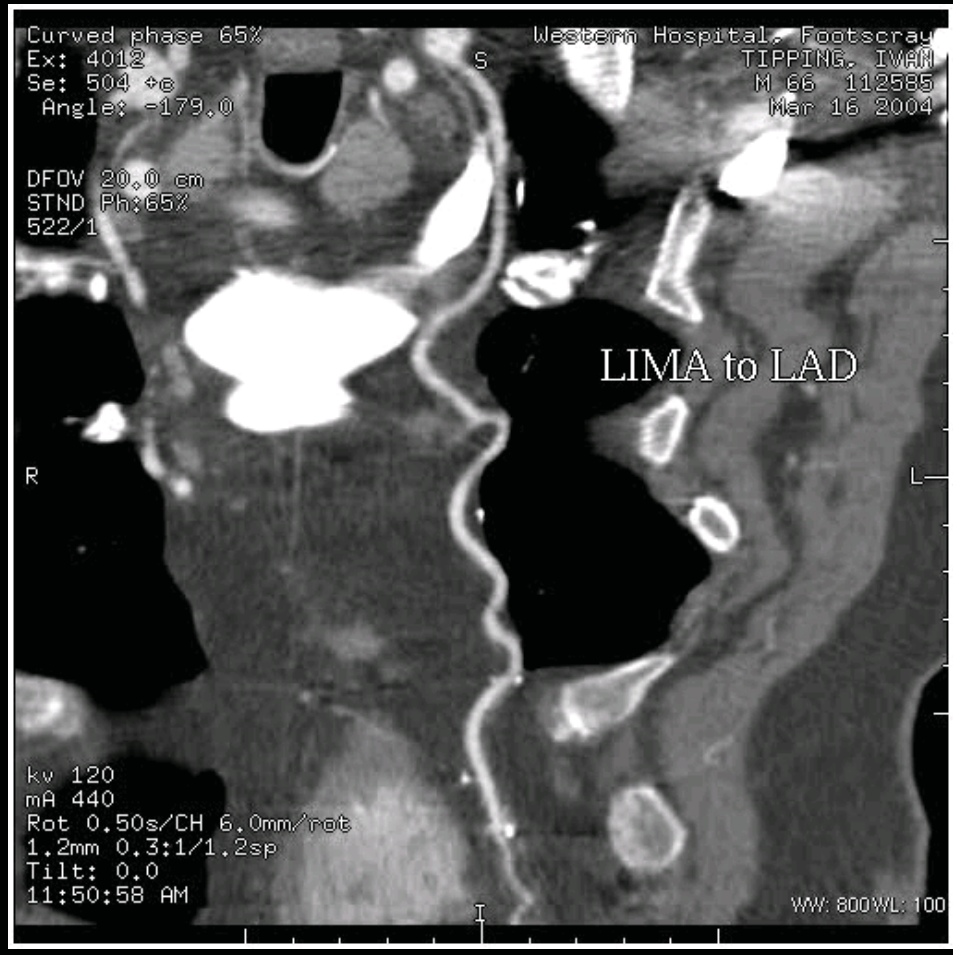


MSCT Bypass Graft Evaluation

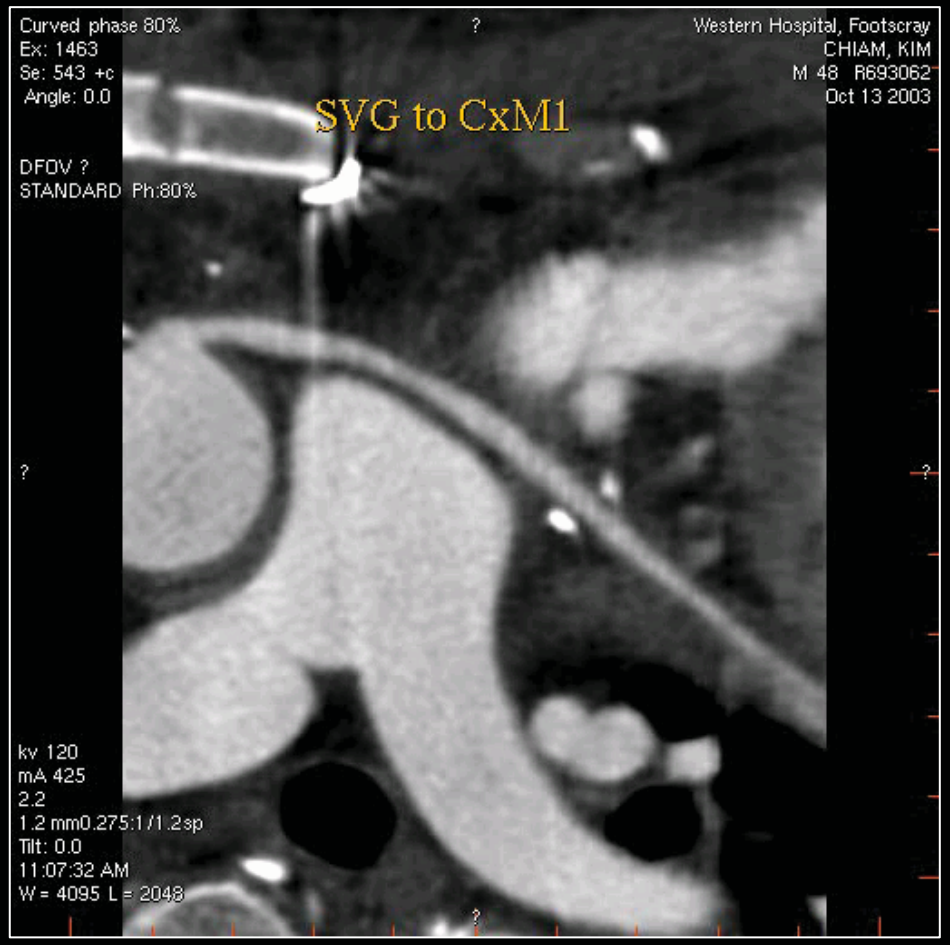
- Bypass Graft course perpendicular to scan plan
- Larger luminal diameter of bypass graft
- Less motion of the bypass graft segments
- Absence of masking effects by surrounding cardiac structures

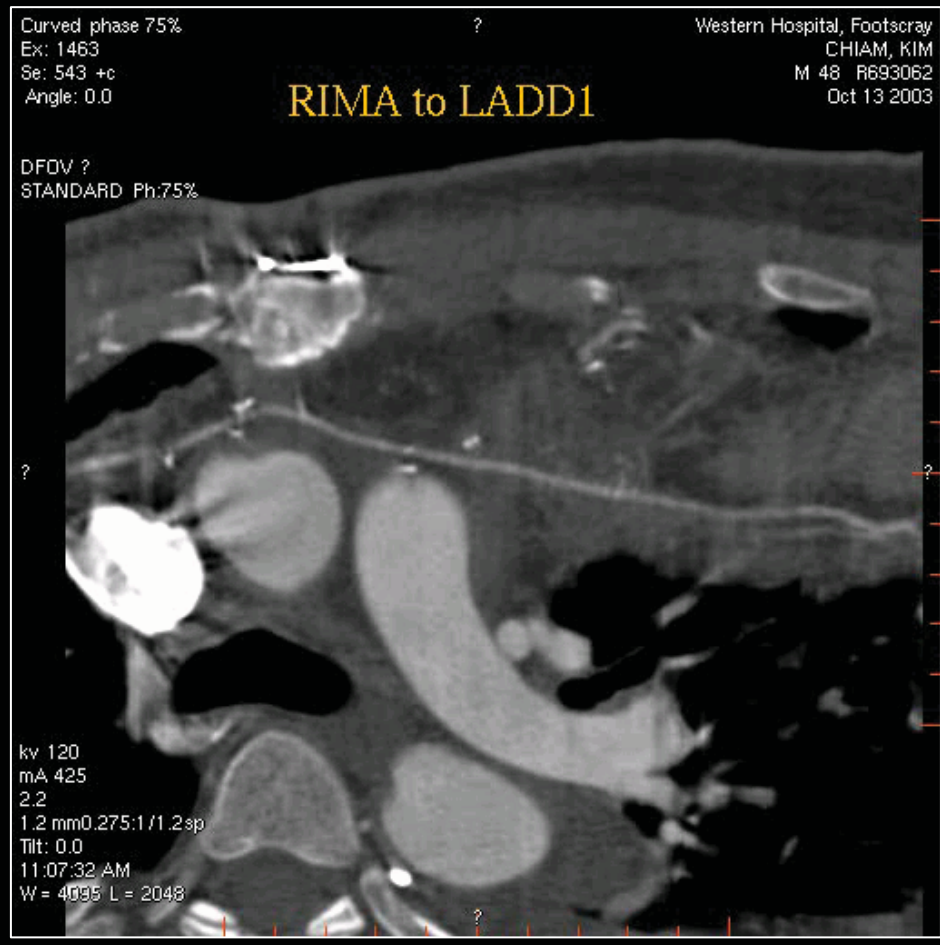
Non-engaged LIMA graft visualized with MSCT



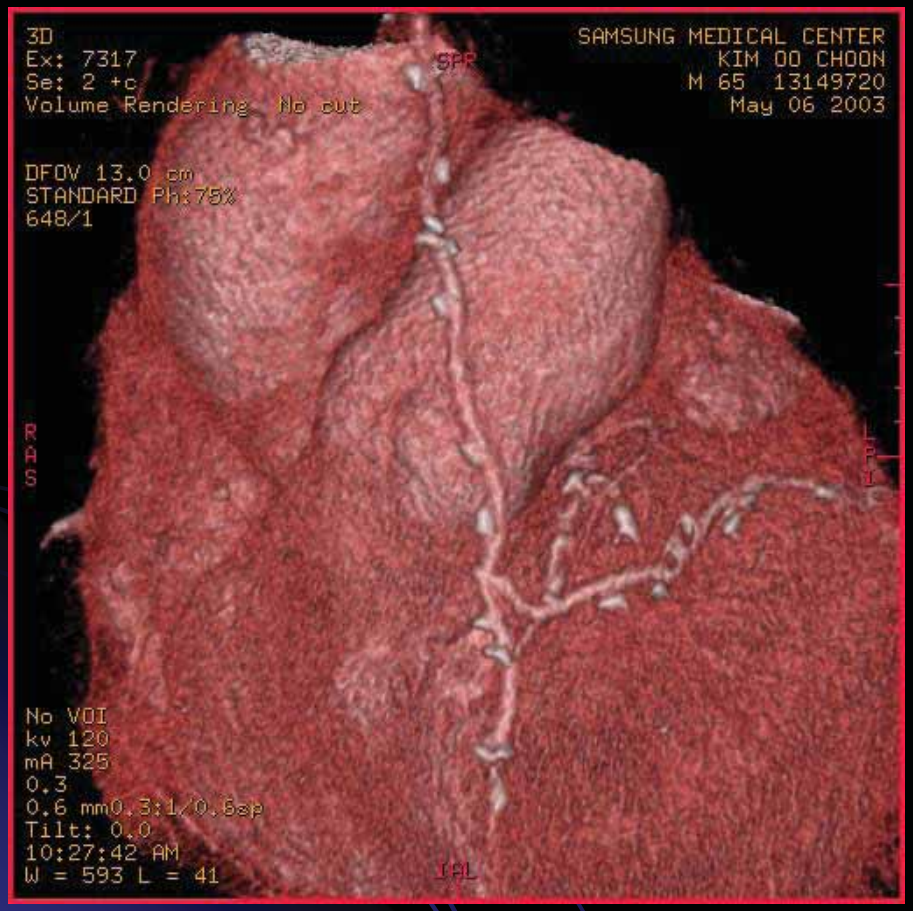


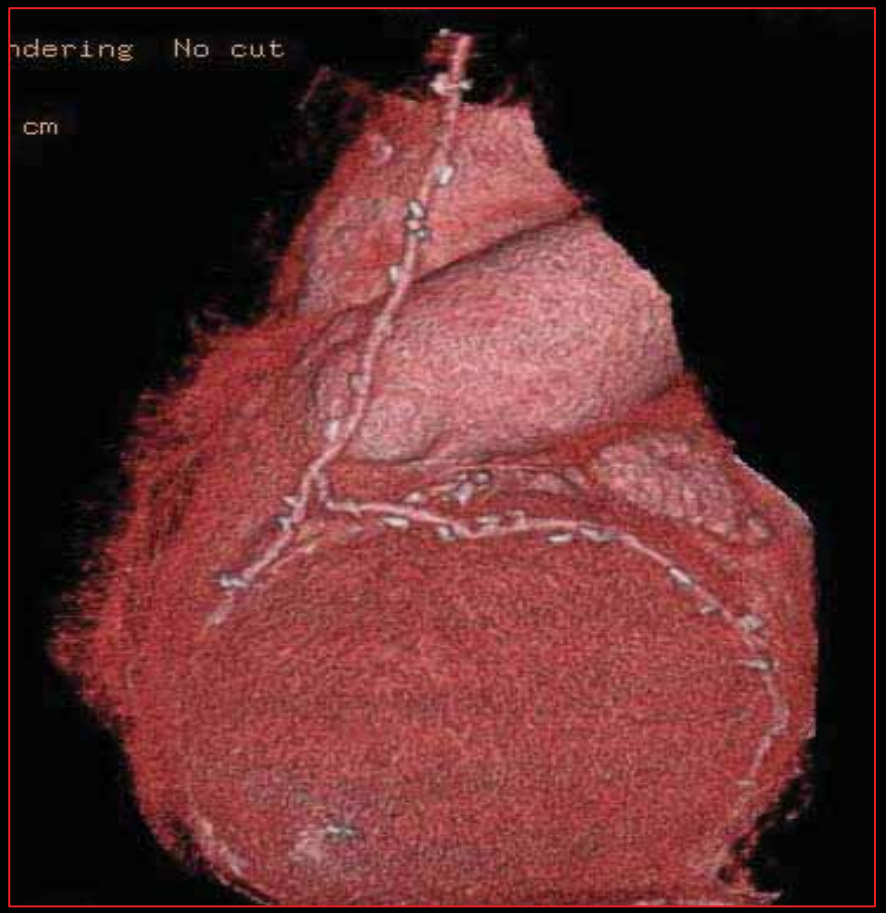
MSCT GRAFT IMAGING



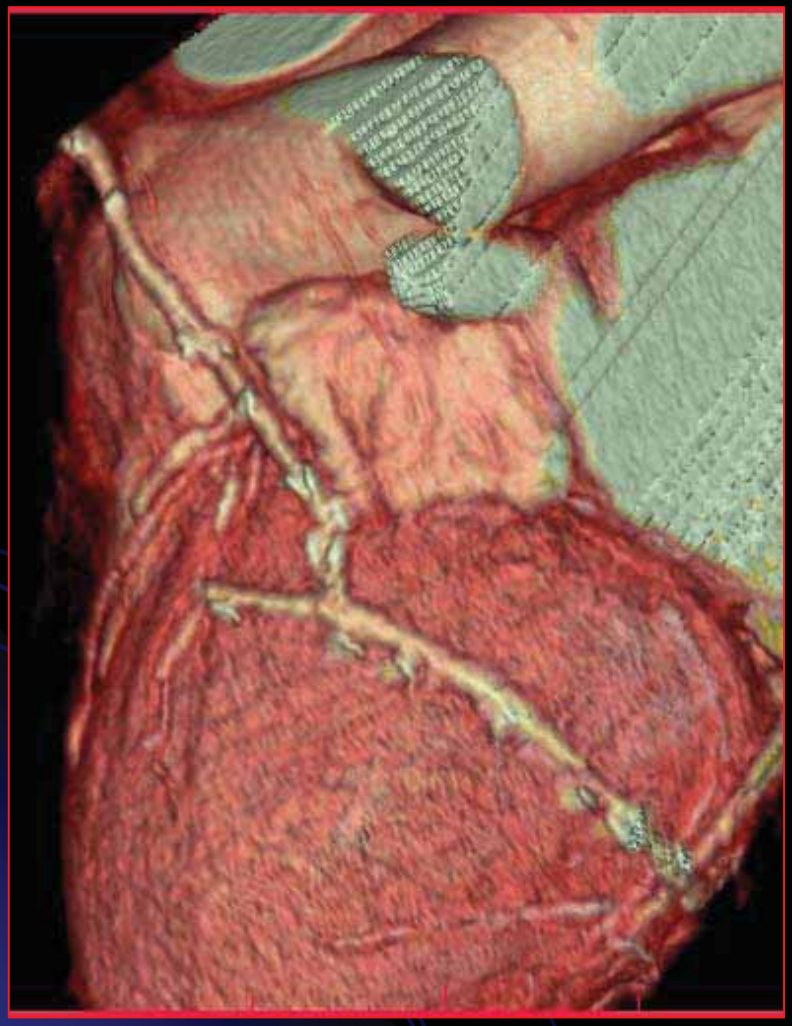


Y Graft to LAD and PDA





T Graft to D1 and PDA



Early Experience of 16 Slice – CT Coronary Angiography at the Centre for Cardiovascular Therapeutics University of Melbourne

Methodology & Preliminary Results in 29 patients
10 for Stent & 19 Graft patency evaluation

Methodology 1: Scanning of Patient

- Oral Blocker/ iv esmolol to achieve heart rate (HR) 60/min.
- GE Light Speed 16 slice spiral CT.
- Timing bolus scan with 20 mls of contrast (Ultravist-300) to determine peak flow in the coronary arteries.
- Contrast enhanced scan (130ml of Untravist-300) with a 16 slice CT scanner set at 120kV, 400-440mA, a pitch of 0.3- 0.325 and collimation of 16 x 0.625 mm-1.25 mm.

Methodology 2 : Coronary Segment Analysis

- Reconstructions on GE AW-4.2 workstation, multi-planar reconstruction, strip-length luminal views & 3 D volume-rendered images for analysis.
- The data set was reconstructed at 70% to 80% of R-R cycle for left coronary system and 30-80% for right coronary system.
- The AHA 15-segment coronary artery model was used for reporting coronary artery disease.
- A cardiologist or radiologist experienced in MSCT coronary angiography was blinded to the results of SCA and asked to report the findings of MSCT coronary angiography.

Coronary segment Analysis (ctd) :

- 201 segments of native coronary arteries were assessed (43 segments were not assessable due to motion artifacts, small calibre of vessel, occlusion in proximal artery or heavy calcification).
- Of those 158 assessable segments, sensitivity and specificity of MSCT coronary angiography were determined.
- 46 coronary artery bypass grafts were examined; 13 were LIMA grafts; 6 were RIMA grafts, 5 were radial artery grafts, 20 were SVGs and 2 were skip LIMA grafts .

Methodology 3: Sensitivity & Specificity of MSCT CA

- A significant coronary stenosis was defined as stenosis >50% diagnosed on MSCT in any of the major coronary arteries and branches.

- The findings of MSCT coronary angiography for the diagnosis of coronary artery and patency of grafts and stents were compared to the findings of SCA (“gold standard”).

Results

Preliminary Results: 29 Patients Sept. 2003 to April 2004

MSCT	coronary stenosis	stent patency	graft patency
Assessability	158/201 (79%)	10/11(91%)	46/46 (100%)
Sensitivity	30/37 (81%)	9/9 (100%)	42/42 (100%)
Specificity	117/121 (97%)	1/1 (100%)	4/4 (100%)
PPV	30/34 (88%)	9/9 (100%)	42/42 (100%)
NPV	117/124 (94%)	1/1 (100%)	4/4 (100%)

MSCT Diagnostic Accuracy

Author	Target	Sens	Spec
Nieman 2002	CAD	82%	93%
Roper 2001	BPG	97%	98%
Lau 2003 (PC)	CAD	77%	88%
Achenbasch			
• 4 slice	CAD	72-91%	71-98%
• 16 slice*	CAD	92-95%	86-93%

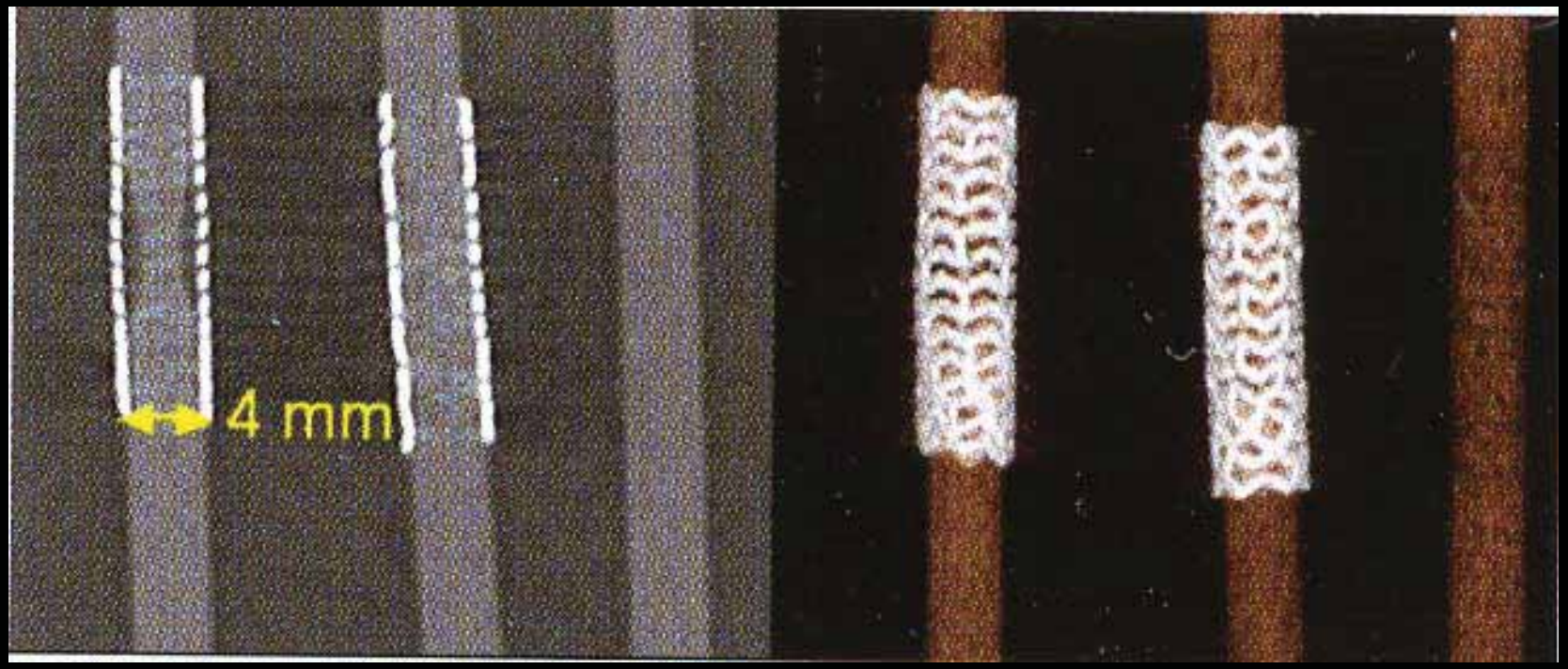
* 2 studies; Unevaluable arterial seg (0-12%)

4 slice CT-CA & Bypass Graft Study SENSITIVITY AND SPECIFICITY

	Bypass Occlusion	Stenosis of Patent Graft
Evaluation Possible	100% (1820182)	63% (770124)
Sensitivity	97% (56/58)	73% (12/16)
Specificity	96% (122/124)	92% (56/61)
Positive Predictive value	98% (56-58)	71% (12/17)
Negative Predictive value	98% (122/124)	93% (56/60)
Diagnostic Accuracy	98% (128/132)	88% (68/77)

Dieter Ropers et al. **The American Journal of Cardiology**
Volume 88, Issue 7 , 1 October 2001, Pages 792-795

FUTURE TECHNICAL IMPROVEMENT in MSCT Coronary Angiography



Flat-Panel CT Prototype *Courtesy Siemens at MGH*

FUTURE RECONSTRUCTION OF MAXIMAL INTENSITY OF PROJECTION (MIP) IMAGES

A 3D type Image on a single plane, similar to conventional angiography, formed from images of the opacified coronary vessels, highlighted by the subtraction of contrast signal coming from the cardiac cavities and other structures with different absorption.

CONCLUSIONS

Current MS (16-slice) CT (2004) :

1. Clinically accurate non-invasive diagnosis of coronary disease
2. Assists in the planning of invasive strategies of PCI, including prophylactic stenting
3. Useful in the assessment of stent & graft patency