Integration of Imaging Modalities
(Case Based)

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Outlines

- Case presentation
- **Plaque Calcification** as a Marker of Future Events
- **Limitations** of Different Imaging Modalities.
- Accuracy of Assessment of Vulnerable Plaques by Combined Imaging Modalities
- Conclusion & Take Home Message
Case Presentation

- 53 year old male, with morbid obesity
  
  Weight: 116.4 kg  Height: 163 cm
  (BMI = 43.7 Kg/m²)

- DM, HTN, Dyslipidemia, OSA

- H/O Resection of pituitary adenoma (on replacement ttt)

- Recurrent chest discomfort

- Early positive ETT

- Echo: significant concentric LVH, no RWMA
Initially, the pt. was referred for CABG

Preoperative Assessment
- Endocrinology consultation
- Pulmonology consultation & PFTs.
- ENT & sleep studies (OSA)
- Pre-operative anesthesia consultation.

Turned down by surgeon

Heart Team decision: IVUS guided PCI
IVUS Guided PCI

Spotty Calcification

Mid shaft LM MLA= 8.2 mm²

LAD PCI
LAD PCI

4 Months Later

Staged PCI for other lesions
Functional Assessment of LCX lesion

FFR value = 0.82

2 Month later

(Two moths after FFR & 6 moths after IVUS study of the LM)

➢ Admitted with ACS, NSTEMI
6 Months after LAD PCI

LM Intervention
LM Stenting

POT

LM Stenting (TAP)
### Final Angiogram

### Possible Explanations

| LM Plaque Disruption | Intimal Injury by intracoronary tools in the prior PCI  
| ??? Interval > 6 month |
|-----------------------|-------------------------------------------------------------|
| **FFR Technical Issues** | Insufficient Hyperemia  
| - Adenosine dose  
| - Severe LVH  
| - Effect of downstream lesions  
| - IC vs IV adenosine  
| - GC disengagement |
| **Limitations of Imaging** | Tissue characterization with grayscale IVUS  
| "Failure to detect a Plaque with high risk characteristics in a Vulnerable patient" |
Tissue Characterization with Different Imaging Modalities
(Technical Aspects & Limitations)

Plaque Calcification & Future Ischemic Events

IVUS study 6 month before ACS
MLA= 8.2 mm
Baseline Clinical Characteristics

1347 pts with Angiographic CAD

Kataoka et al. 2012

Baseline Atheroma Burden

Serial Change in Atheroma Burden

Kataoka et al. 2012
Plaque Calcification is a Dynamic Process

Coronary Artery Calcification and its Progression
What Does it Really Mean?

Type of Calcification by Histology (Section Level)

- Erosion
- TCFA
- Rupture
- Healed Rupture
- Fibrocalcific Plaque
Unstable Plaque
(Spotty Calcification & Attenuated Signal)

Attenuated Plaque
(Black Holes, Echo Signal Attenuation)

Shadowing in spite of no visible calcium

293 ACS patients: 26% with attenuated plaque (40% STEMI, 18% NSTEMI)
Two attenuated plaques 6.4 mm apart were seen in this RCA.

JACC Interv 2009;2:65-72
Virtual Histology

(A) Pathological intimal thickening.
(B) Thin-capped fibroatheroma (vulnerable plaque).
(C) Thick-capped fibroatheroma.
(D) Fibrotic plaque.
(E) Fibrocalcific plaque.

Plaque Burden, VH and Outcomes

PROSPECT Trial

- A ≥ 70% plaque burden lesion by grayscale IVUS has a risk of 9.2% at three years.
- A ≥ 70% plaque burden lesion defined as VH TCFA has an elevated risk of 15.3% at three years.
- A ≥ 70% plaque burden lesion defined as PIT has a reduced risk of only 2.6% at three years.
- VH Definitions in PROSPECT can swing the risk profile.

same lesions by grayscale IVUS (Plaque Burden ≥ 70%) have dramatically different risk profiles when analysed by VH.
OCT Analysis
OCT-derived TCFA defined as a plaque with lipid content in >1 quadrant with a fibrous cap measuring <65 μm

Grayscale IVUS
1) a plaque burden of >50% & remodeling index of >1.0 and
2) the presence of >180 degree of US attenuation without dense Ca or > 90 degree of lipid pool-like images in at least 5 consecutive frames

Histological Study as the gold standard

Diagnostic Accuracy of Grayscale IVUS Derived TCFA-Like Image

Fuji et al. 2015
Accuracy of OCT to Diagnose Histological TCFA

False positive diagnoses of OCT for TCFA
Diagnostic Accuracy of Combined Imaging Modalities for TCFA

Usefulness of Grayscale IVUS in Addition to OCT for Diagnosis of TCFA

Low-Intensity Area with a Diffuse Border

Remodeling index = 0.91

Remodeling index = 1.31
Conclusion

- Neither OCT nor IVUS were optimal to accurately identify coronary vulnerable plaques due to the existence of several false positive examples.

- The combined use of these complementary imaging modalities may result in more accurate identification of vulnerable plaques in clinical setting

Fujii et al. 2015

Integrated IVUS-OCT catheter

Fujii et al. 2015

Li et al. 2014
Integrated IVUS-OCT for Real-Time Imaging

- Fibrous
- Calcified
- Lipid Plaque

Summary & Conclusion

- Accurate assessment of coronary plaque characteristics & subsequent tailoring of optimal therapy holds great promise for preventing life threatening cardiac events.

- Combined use of OCT and IVUS is a potential method for accurate assessment of plaque vulnerability.

- The synergistic advantages of both modalities include deeper tissue penetration of IVUS & superior resolution and near-field image quality of OCT.
Summary & Conclusion

➢ This is the time, to move away from pathologic correlation to clinical outcomes studies, to provide the clinician with a robust, easy to use diagnostic tool with positive impact on patient outcomes.

Thanks
Different MLA Threshold for LM Intermediate Lesions

Variability of IVUS Cutoff Values

6 MM² TOO SMALL?
- 6 mm²
- 55% stenosis
- FFR = 0.60

6 MM² SUFFICIENT?
- 6 mm²
- 10% stenosis
- FFR = 0.90
Different MLA Threshold for LM Intermediate Lesions

- The Spanish Working Group on Interventional Cardiology study:
  - MLA of 5.9 mm with 2-year cardiac death–free survival of 97.7% in deferred group & 94.5% in revascularized group (p = 0.5)

- Kang et al.: MLA < 4.8 mm correlating with an FFR < 0.80 (89% sensitivity and 83% specificity) (BMI no accounted)

- Park et al.: MLA < 4.5 mm to predict an FFR < 0.80 with 77% sensitivity & 82% specificity (Mean body mass index 24.5 ± 3.2 Kg/m²)

BMI = 43.7 Kg/m²
MLA = 7.9

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