Basic Concept & Interpretation NIRS: Near Infrared Spectroscopy

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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

Affiliation/Financial Relationship

Grant/ Research Support:

Consultant:

Speaker Fee:

Boston Scientific Corp. Boston Scientific Corp. St Jude Medical, Volcano Corporation

Company





NIR can Distinguish Lipid-rich from Fibrotic Plaques



Generation of chemogram from human coronary artery autopsy specimen









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Selection of Near-infrared Spectroscopy

NIR Spectroscopy is feasible for in vivo use and provides specific chemical information based on overtones of molecular IR vibrations



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NIR Spectroscopy

•Necrotic Core>0.2mm thick, >60°, Cap<0.45mm



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Process of NIR Spectroscopy







Deconstructing the chemogram

Lipid Core Burden Index (LCBI)=# of pixel ≥0.6 of provability/total variable pixel ×1000

Chemogram



Block Chemogram

Application of Chemogram Colors





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Simultaneous IVUS and NIR Imaging of a Coronary Autopsy Specimen



В

NIR Indicates Fibrous Plaque at A and Lipid Core at B



A

Histology Confirms Calcified Fibrous Plaque at A And Lipid Core Plaque at B

Data on File. InfraReDx, Inc.

Formation of the Cap Thickness Prediction Image









28mm =0

6mm







Ability to Predict Thin Cap (<0.065mm)



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NIRS cannot differentiate the depth of each information (Necrotic core or collagen)



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Lipid core burden index

- Lesion LCBI
 -28499/178923*1000 -159
- Max_{4mm} LCBI =8515/13951=610





Necrotic Core /TCFA

Near Infrared Spectroscopy



Attenuated Plaque

Pathology



OCT

Radio-Frequency IVUS

VH











NIRS and post-PCI MI







Goldstein et al. Circ Intv 2011

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Near-Infrared Spectroscopy and Inadequate Flow



STEMI STEMI/UAP Stable AP

Author	# of pt	Symptom	Morphological Predictor	Endpoint
Goldstein	62		LCB I max4mm≥500	Trop or CK- MB>3UNL
Raghunathan	30		Lesion LCBI 145 vs 110	CK- MB>UNL

Goldstein et al Circ Cardiovasc Interv 2011;4:429-37, Ragunathan D et al. AJC 2011;107:1613-8





Is there a characteristic signal of lesions that cause STEMI?

Near infrared spectroscopy (InfraReDx) was performed immediately after infarct artery recanalization in 20 pts with STEMI

The NIRS chemograms of all 20 STEMI pts. The culprit segments contain LCP in 19 cases (95%), all with large plaque burden.





Madder RD. JACC Interv 2013

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Is there a characteristic signal of lesions that cause STEMI?

Near infrared spectroscopy (InfraReDx) was performed immediately after infarct artery recanalization in 20 pts with STEMI

Ability of NIRS (maxLCBI_{4mm}) and IVUS (plaque burden and calcification) to distinguish the culprit segment from nonculprit segments of the STEMI culprit vessel:

- AUC for maxLCBI_{4mm} = 0.90
- AUC for plaque burden = 0.86







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Relationship between Lipid Rich Plaque detected by NIRS and Outcomes

- Prospective Single Center Study, 206 patients (ACS47%)
- Primary Endpoint: Composite of all-cause mortality, nonfatal ACS, stroke and unplanned PCI during one-year FU
- >40mm non culprit segment of NIRS

Lipid Core Burden Index (LCBI)=188







Oemrawsingh RM et al, ESC2003

Relationship between Lipidic Plaque detected by NIRS and Outcomes





Oemrawsingh RM et al, ESC2003

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PROSPECT: Non-FA Lesions



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Dohi et al, JACC Img 2013; 6: 908-16.





Case Example

Baseline

FFR: 0.74



Plaque Area 5.6mm²





Plaque Area 5.5mm²



Kini A et al. *JACC* 2013; 62: 21-9.

Summary

- 1. NIRS uses scattering and identify the absorption pattern in relation to the wave length which is unique for each plaque type.
- 2. Algorithm was validated for lipid rich plaque (LRP) and show the distribution of LRP.
- **3.** Analysis is easy and seems to have high negative predictive value for stable plaque.
- 4. NIRS shows good reproducibility and robust for evaluation of evolution of LRP.



