08:30 - 10:00 S13 - Novel Coronary Imaging Hall F

Chairs: **R. Ilia**
Y. Rozenman

08:30 **Native Coronary Artery Vulnerable Plaque Distribution Assessed by Virtual Histology - Potential Implications for Interventional Strategy**

S. Fuchs [1,2], I. Lavi [2], O. Tzang [2], S. Fuchs [2], D. Brosh [1,2], T. Bental [1], D. Dvir [1], S. Einav [2], R. Kornowski [1,2]
[1] Petach Tikva, [2] Tel Aviv

08:45 **Association Between Three-Dimensional Geometrical Configuration of the Coronary Arteries and Plaque Characteristics Using IVUS-VH Analysis.**

D. Dvir [1], I. Lavi [2], S. Fuchs [1], A. Assali [1], S. Einav [2], A. Battler [1], R. Kornowski [1]
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09:00 **Should Angiographically Intermediate Lesions Be Treated? FFR vs Visual Anatomic Assessment**

R. Jaffe, N. Khader, A. Merdler, M. Flugelman, A. Danon, R. Wolff, Y. Goldstein, D. Weiss, D. Halon, B. Lewis
Haifa

09:15 **Optical Coherence Tomography and Angioscopic Evaluation of a Novel Sirolimus-Eluting Stent Coated with Bioabsorbable Salicylate-Based Polymer**

D. Matsumoto [1], T. Shinke [1], N. Chronos [1], K. Robinson [1], R. Jabara [1,2]
[1] Atlanta, GA, [2] Jerusalem

09:30 **The Relations between Coronary Plaque Calcium Deposition and Vulnerable Plaques - Advanced Virtual Histology Analysis**

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09:45 **Three-Dimensional Quantitative Coronary Angiography versus 'Gold-Standard' Intravascular Ultrasound Assessment: A Comparative Lesion Analysis**

D. Dvir, I. Lavi, S. Fuchs, A. Assali, S. Einav, A. Battler, R. Kornowski
Tel-Aviv

Native Coronary Artery Vulnerable Plaque Distribution Assessed by Virtual Histology - Potential Implications for Interventional Strategy

Shmuel Fuchs [1,2], Ifat Lavi [3], Omer Tzang [3], Shir Fuchs [3], David Brosh [1,2], Tamir Bental [1], Danny Dvir [1], Shmuel Einav [3], Ran Kornowski [1,2]

[1] *Cardiology Department, Interventional Cardiology, Rabin Medical Center, Petach Tikva,* [2] *Sackler School of Medicine, Tel Aviv University, Tel Aviv,* [3] *Biomedical Engineering, Faculty of Engineering, Tel Aviv University, Tel Aviv, Israel*

Background – Pathology data indicate that distribution of vulnerable plaques, characterized by thin cup fibroatheroma (TCFA) overlying a large necrotic core (NC), is varied along the coronary tree, preferentially located in proximal segments. Similar data was also shown in clinical setting using intravascular radiofrequency virtual histology analysis (IVUS-VH). Accordingly, we hypothesized that vulnerable atherosclerotic plaques may be located away from the minimal luminal area sites.

Methods - Fifty patients (stable angina 42%, unstable angina 58%) with de-novo coronary lesions defined as angiographic stenosis of >50% underwent IVUS-VH assessment. Off-line IVUS-VH advanced analysis was performed on 69 segments (2735 slices).

Results – The mean segment length was 19.8 ±13.7 mm, luminal volume 267.5 ±179.5 mm^3, vessel (EEM) volume 113.4 ±67.8 mm^3 and plaque volume 55.3 ±9.2 mm^3. Maximal NC area was located in MLA site in only 12 (17%) and away from the MLA site in 57 (83%) of the lesions. Slices containing maxNC area were found as far as 26 mm proximal and 22 mm distal to the MLA site (average 4.6 ± 5.3 mm). In those 57 segments, maxNC sites were more frequently characterized by morphological and compositional measures of vulnerable plaque compared to MLA sites (Table)

IVUS Measures	MLA @ non-Max NC (n=57)	MaxNC @ non-MLA (n=57)	P-value
Luminal area (mm2)	3.65 ± 1.25	5.10 ± 2.2	<0.001
Area stenosis (%)	59.5 ± 10.7	32.69 ± 24.6	<0.001
Plaque burden (%)	76.02 ± 10.5	64.57 ± 11.22	<0.001
Remodeling index	0.89 ± 0.15	1.039 ± 0.17	<0.001
Fibrotic (%)	54.8 ± 13.85	47.7 ± 13.43	<0.001
Fibrofatty (%)	14.3 ± 11.28	9.4 ± 8.6	<0.001
Dense calcium (%)	11.9 ± 10.3	15.3 ± 10.8	<0.001
Necrotic core (%)	19.1 ± 11.48	27.7 ± 11.3	<0.001
TCFA (n, %)	14, 24.5	23, 40	0.11

Conclusions – In patients with intermediate lesions, vulnerable plaques are often located away from the MLA sites. This observation may have impact, in certain circumstances, on the interventional strategy.

Association Between Three-Dimensional Geometrical Configuration of the Coronary Arteries and Plaque Characteristics Using IVUS-VH Analysis.

Danny Dvir [1], Ifat Lavi [2], Shmuel Fuchs [1], Abid Assali [1], Shmuel Einav [2], Alexander Battler [1], Ran Kornowski [1]

[1] *Cardiology Department, Rabin Medical Center, Petach Tikva, Sackler Faculty of Medicine, Tel-Aviv University, Petach Tikva,* [2] *Biomedical Engineering, Tel-Aviv University, Tel-Aviv, Israel*

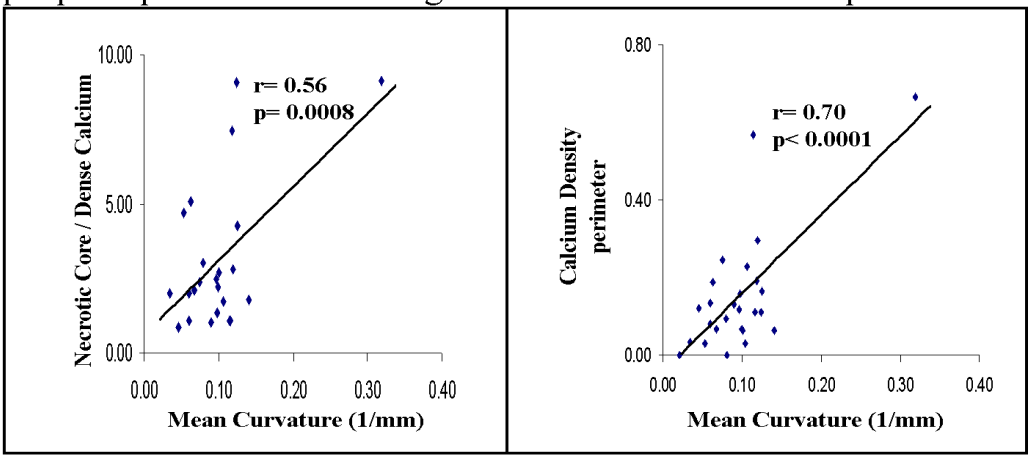
Background: Vascular geometry mediates fluid dynamics and shear stress and may thereby predispose coronary arteries to atherosclerosis. However, the association between advanced three-dimensional geometrical features and vulnerability to plaque rupture has not been investigated.

Objectives: To examine the potential relationship between arterial curvature, torsion and tortuosity and indicators of plaque vulnerability using IVUS-VH (intravascular ultrasound-virtual histology).

Methods: We have evaluated 32 de-novo coronary lesions using conventional coronary angiography and used CardiOp-B package (Paieon Inc) for simple three-dimensional reconstructions. For advanced geometrical analysis we have developed a novel algorithm for high-resolution continuous-point evaluation of curvature, torsion and tortuosity, along a segment. All segments were further evaluated by IVUS-VH (Volcano Corp.). Plaque components were examined on the basis of tissue characteristics, sizes and densities of various components: Necrotic-Core (NC), Dense-Calcium (DC), Fibrotic and Fibrofattic.

Results: Several advanced geometrical features were significantly correlated with plaque vulnerability as measured by the sectional NC/DC ratio: mean and maximal curvature ($r=0.56$, $p=0.0008$; $r=0.61$, $p<0.0001$), mean and maximal torsion ($r=0.51$, $p=0.002$; $r=0.45$, $p= 0.008$), and segment tortuosity ($r=0.44$, $p= 0.011$). A trend-level correlation was found between plaque thickness and maximal torsion ($r=0.34$, $p=0.058$) and between NC thickness and median torsion ($r=0.33$, $p=0.063$). Calcium density was correlated with mean curvature and maximal torsion ($r=0.70$, $p<0.0001$; $r=0.55$, $p= 0.001$).

Conclusions: Three-dimensional geometrical features of the coronary arteries are correlated with IVUS-VH indicators of plaque vulnerability. This data provides insight into the role of mechanical stimuli in the localization of atherosclerotic plaque formation and tendency to plaque rupture. This novel algorithm should be further explored in clinical outcome studies.



Should Angiographically Intermediate Lesions Be Treated? FFR vs Visual Anatomic Assessment

Ronen Jaffe, Nader Khader, Amnon Merdler, Moshe Flugelman, Asaf Danon, Rafael Wolff, Yaakov Goldstein, Dov Weiss, David Halon, Basil Lewis

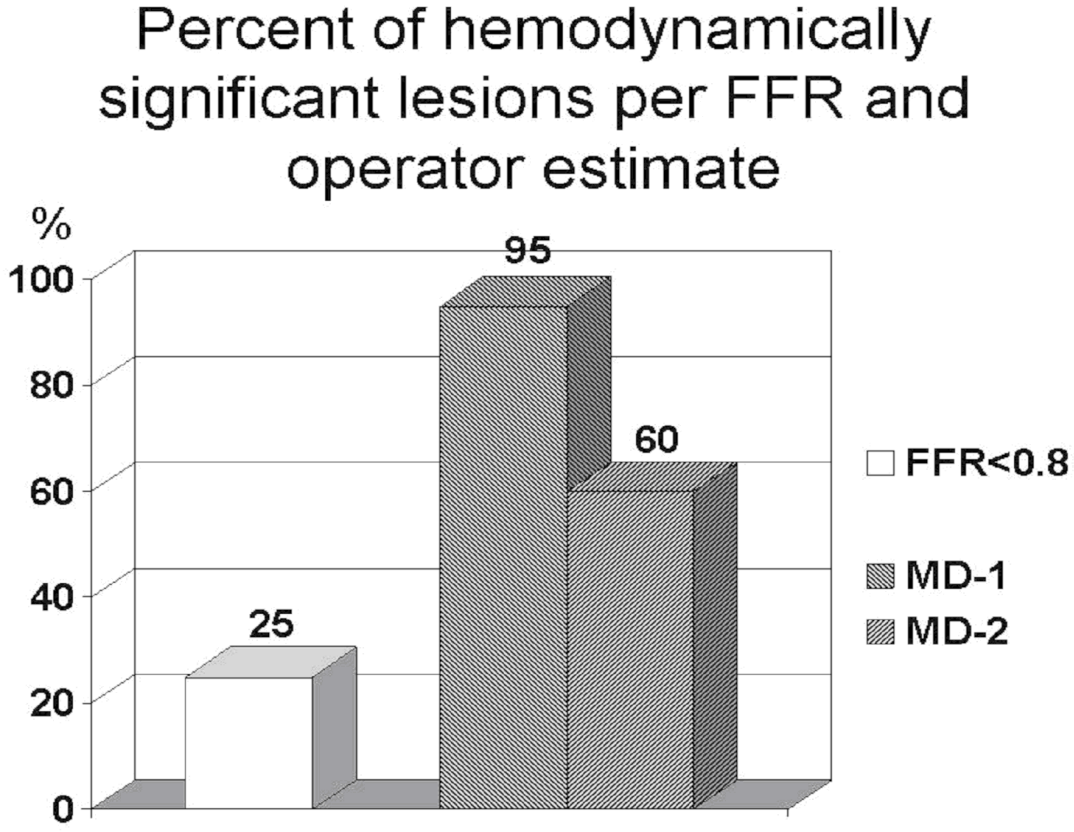
Cardiology, Lady Davis Carmel Medical Center, Haifa, Israel

Background: Percutaneous coronary intervention (PCI) in flow-limiting coronary stenoses improves myocardial perfusion and reduces ischemia but is of doubtful value in non-obstructive lesions. Performance of PCI is commonly based on the angiographic findings, however the hemodynamic significance of coronary stenoses can be directly assessed by measurement of fractional flow reserve (FFR). We estimated the reduction in number of PCI procedures which might be achieved by routine measurement of FFR before decision for PCI in angiographically borderline stenoses.

Methods: FFR was measured for 20 lesions in 15 consecutive patients with angiographically borderline coronary stenoses who were candidates for PCI. FFR measurement (Volcano BrightWire II) was performed with incremental intracoronary injections of adenosine (mean final adenosine dose 112±24 mcg, range 36-120) or achievement of FFR<0.80.

Results: Mean FFR was 0.85±0.08 (range 0.71-1.00). FFR<0.80 was measured in only 5 stenoses (25%). In contrast, 2 experienced interventional cardiologists who were blinded to the FFR results considered 12 (60%) and 19 (95%) of these lesions respectively to be clinically significant by visual estimation.

Conclusions: Visual assessment overestimated the clinical significance of coronary stenoses by 35-70%. Routine assessment of angiographically borderline coronary stenoses by FFR may prevent the "oculostenotic reflex" and avoid unnecessary coronary interventions.



Optical Coherence Tomography and Angioscopic Evaluation of a Novel Sirolimus-Eluting Stent Coated with Bioabsorbable Salicylate-Based Polymer

Daisuke Matsumoto [1], Toshiro Shinke [1], Nicolas Chronos [1], Keith Robinson [1], Refat Jabara [1,2]

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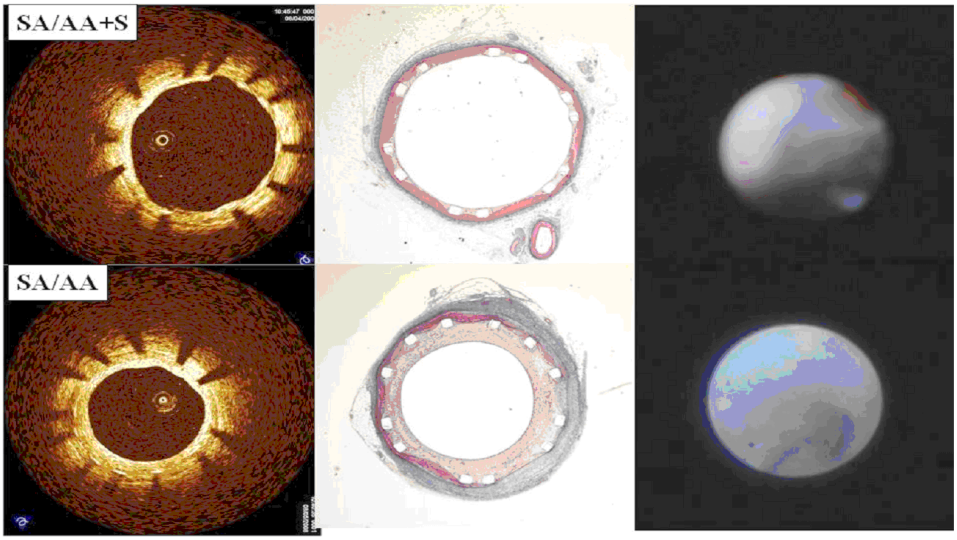
Background: Permanent polymers used in current DES can trigger chronic inflammation and hypersensitivity reactions, which may contribute to late thrombosis and rebound restenosis. We evaluated sirolimus-eluting stent coated with novel bioabsorbable salicylate-based polymer using OCT, angioscopy and histology.

Methods: Bare metal stents (BMS, n=14), salicylic acid/adipic acid bioabsorbable polymer-only coated metal stents (SA/AA, n=15), biostable polymeric sirolimus-eluting stents (Cypher, n=13) and SA/AA containing sirolimus (SA/AA+S, n=17) were randomly implanted in pig coronary arteries using QCA to optimize stent apposition. Diameter stenosis (DS) was evaluated by angiography, OCT and histology (aDS, oDS, and hDS). Intimal area was assessed by OCT and histology (oIA and hIA). Angioscopic and histological mural thrombus (aMT and hMT) was also assessed.

Results: aDS was significantly lower in SA/AA+S (-13.2±4.3%) than the other groups (BMS: 6.7±5.6%, SA/AA: 8.1±4.2%, and Cypher: -3.4±6.2%, respectively, P=0.01). oIA and hIA were lower in SA/AA+S and Cypher compared to SA/AA group (SA/AA+S: 1.65±0.18mm2, BMS: 2.11±0.32mm2, SA/AA: 2.99±0.36mm2, and Cypher: 1.88±0.34mm2, P=0.017). aMT and hMT were observed slightly higher in SA/AA+S and Cypher compared to BMS and SA/AA.

Conclusions: This sirolimus-eluting stent coated with novel bioabsorbable salicylate-based polymer showed favorable vascular compatibility and suppression of neointimal growth by different modalities



The Relations between Coronary Plaque Calcium Deposition and Vulnerable Plaques - Advanced Virtual Histology Analysis

Shmuel Fuchs [1,2], Ifat Lavi [3], Omer Tzang [3], Shir Fuchs [3], David Brosh [1,2], Tamir Bental [1], Danny Dvir [1], Shmuel Einav [3], Ran Kornowski [1,2]

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Background – The magnitude of coronary artery calcification (CAC) is associated with presence of atherosclerosis and predicts increased myocardial infarction and mortality rates. The potential mechanism linking CAC to cardiovascular events, however, have not been fully elucidated. Accordingly, we sought to investigate the relations between dense calcium deposition (DC) and major components of vulnerable plaque – the necrotic core (NC) area and thin cup fibroatheroma (TCFA).

Methods – We studied 50 non-MI patients with intermediate angiographic coronary artery stenosis (56.9% ± 15.2%). A dedicated, newly developed application was used to evaluate the plaque area and its component based on intravascular virtual histology (IVUS-VH) images (69 segments, 2735 slices). NC/DC ratio was defined as the ratio of necrotic core area to calcium. area.

Results – A significant correlation was noted between NC and DC deposition areas (r=0.7, p=0.0001). NC/DC ratio was similar in proximal reference, MLA and MaxNC sites (2.7±2.6, 3.0±3.8 and 3.2±4.3, p=NS). Interestingly, analysis of maxNC sites with and without VH-TCFA (high and moderate vulnerable plaques, respectively) suggests increased DC deposition in the more vulnerable sites (Table)

	MaxNC non-TCFA (n=43)	**MaxNC TCFA (n=25)**	**P-value**
IVUS analysis			
Luminal area (mm^2)	4.8 ± 2.2	4.9 ± 2.4	0.86
EEM area (mm^2)	14.6 ± 3.6	14.4 ± 4.1	0.85
Plaque Burden (%)	67.4 ± 11.9	64.4 ± 11.6	0.323
VH analysis			
Dense calcium (mm^2)	0.9 ± 0.8	1.2 ± 0.8	0.16
Dense calcium (%)	12.8 ± 10.1	19.1 ± 10.7	0.01
Necrotic core (mm^2)	1.7 ± 1.0	1.9 ± 1.2	0.46
Necrotic core (%)	25.3 ± 11.9	30.1 ± 8.6	0.08
NC/DC ratio	3.8 ± 5.3	2.0 ± 1.1	0.042

Conclusions – In coronary lesions of non-acute patients, DC is significantly correlated with the amount of NC. In addition, VH-defined high vulnerable sites contain increased amount of calcium. These observations may suggest that calcium, at least in certain patients, may predict worse cardiac outcome by being a marker for the presence of high vulnerable plaques.

Three-Dimensional Quantitative Coronary Angiography versus 'Gold-Standard' Intravascular Ultrasound Assessment: A Comparative Lesion Analysis

Danny Dvir [1], Ifat Lavi [2], Shmuel Fuchs [1], Abid Assali [1], Shmuel Einav [2], Alexander Battler [1], Ran Kornowski [1]

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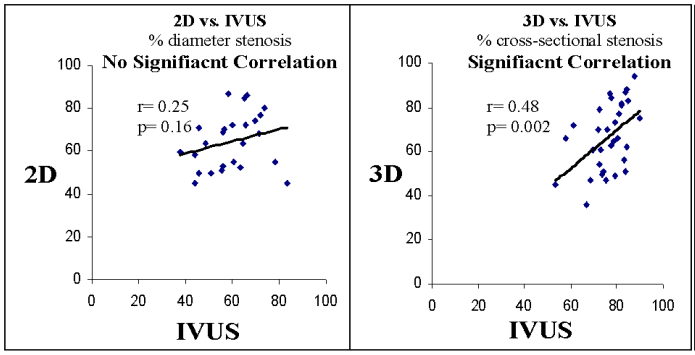
Background: In recent years, several types of three-dimensional (3D) reconstruction softwares have been developed to assess the coronary vasculature. However, 3D reconstruction measurements have not been evaluated against intravascular ultrasound (IVUS), currently the "gold-standard" modality for coronary lesion analysis.

Objectives: To investigate the accuracy of 3D coronary reconstruction vs. IVUS measurements and to identify its possible merits compared to conventional two-dimensional (2D) analysis.

Methods: Thirty-two de-novo coronary lesions were evaluated using conventional coronary angiography. 2D quantitative coronary angiography analysis was performed with the McKesson™ Telemedicine QCA system. For 3D reconstructions, the CardiOp-B package (Paieon Inc.) was used. All segments were further evaluated with IVUS (Volcano Corp.).

Results: When IVUS was used as the reference modality, 3D reconstruction was more accurate than 2D analysis, which poorly correlated with IVUS measurements of lesion length and minimal lesion diameter (r=0.14, p=0.92 and r=-0.25, p=0.16, respectively). There was no significant difference between 3D and IVUS in measurements for minimal lesion diameter and minimal lesion area (p=0.92, p= 0.90, respectively), although the correlations were not significant (r=0.11, p=0.95 and r=0.20, p=0.32, respectively). In all relative stenosis evaluations (diameter. cross-section, plaque-volume), 3D analysis yielded significantly lower values than IVUS (all p<0.001), which were nevertheless significantly correlated with the IVUS assessment (r=0.38, p=0.03; r=0.48, p=0.002; r=0.39, p=0.03).

Conclusions: 3D reconstruction analysis is more accurate against IVUS than 2D analysis, especially for lesion diameter and length. Results for lesion severity are lower with 3D reconstruction than with IVUS.



	2D	3D	IVUS
Minimal Lesion Diameter (mm)	1.16 ± 0.42	1.76 ± 0.46	1.76 ± 0.13
Diameter Stenosis (%)	53.6 ± 13.2	48.5 ± 14.4	60.3 ± 10.8
Lesion Length (mm)	17.0 ± 9.3	21.1 ± 14.8	26.4 ± 14.6
Minimal Lesion Area (mm^2)	-	2.85 ± 1.31	2.83 ± 0.43
Cross Sectional Stenosis (%)	-	66.6 ± 15.1	76.3 ± 8.4
Plaque Volume (%)	-	43.9 ± 7.9	59.0 ± 8.2