1007-174 The Effect of Microvascular Dysfunction on the Relationship Between Fractional Flow Reserve and Anatomic Stenosis Severity

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Objectives: Fractional flow reserve (FFR) had been applied as a specific functional indicator of stenosis severity and it showed an excellent correlation with anatomic stenosis severity, at least in patients with preserved microvascular function. However, to what extent the degree of microvascular dysfunction could affect the relationship between FFR and anatomic stenosis severity has not been clarified.
Methods: Thirty-four lesions of 33 patients (14 AMI related arteries; 19 non MI related arteries) were studied. Coronary stenting was done in 25 lesions. IVUS % area stenosis (IVUS-%AS), FFR, and coronary flow reserve (CFR) were measured .before and after PCI. Fifty-four studied lesion sites were divided into two groups according to the degree of microvascular dysfunction(Group 1, Post-stent CFR or CFR without PCI ≥2.5, n=38; Group 2, Post-stent CFR<2.5, n=18).
Results: There was no significant difference in IVUS-%AS between two groups (44±37 vs. 51±30, p=0.449). FFR was lower and CFR was higher in Group 1 than in Group 2 (0.80±0.18 vs. 0.89±0.07, p=0.044; 3.40±0.55 vs. 1.90±0.33, p<0.001, respectively). There were significant correlation between FFR and IVUS-%AS in Group 1 (r=0.88, p<0.001), and in Group 2 (r=0.69, p=0.024). However, the concordance between FFR and IVUS-%AS was 89.5% in Group 1 (sensitivity 90.1%, specificity 88.9%, κ=0.757, p<0.000) and 72.2% in Group 2 (sensitivity 16.7%, specificity 100%, κ=0.211, p=0.333), on the cut-off values of 0.75 and 75%, respectively.
Conclusion: Microvascular dysfunction significantly affects the relationship between FFR and anatomic stenosis severity. FFR significantly underestimates the anatomic stenosis severity in cases of microvascular dysfunction. This data suggested that microvascular vasodilatory reserve at least greater than 2.5 is required for the excellent correlation between FFR and anatomic stenosis severity.

1007-175 Fixing Chronic Stent Underexpansion Is Associated With a Low Rate of Recurrence: An Intravascular Ultrasound Analysis

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Background: Previous studies have shown that chronic stent underexpansion is a common intravascular ultrasound (IVUS) finding in in-stent restenosis (ISR) lesions. In particular, almost 40% of ISR lesions have a minimum stent area <6.0mm^2 and half of these have a minimum stent area <5.0mm^2. We hypothesized that "fixing" this stent underexpansion would be associated with a low rate of recurrence.
Methods and Results: Seventy-three patients with ISR met the following criteria: pre- and post-intervention IVUS imaging with a pre-intervention IVUS minimum stent area <6.0mm^2, no brachytherapy, and one year follow-up. 32% of patients were diabetic; and 45/73 (62%) of lesions were classified as diffuse or proliferative ISR. IVUS results are shown in the table. The absolute increase in stent area averaged 2.2±2.3mm^2. Post-intervention stent expansion (stent area/reference lumen area) increased to 1.13±0.27 (p=0.0014). Importantly, at one year, the recurrence rate was only 13.7% (10/73) and was not different in diffuse/proliferative vs focal ISR (p=0.5).
Conclusion: Additional stent expansion is possible even in chronically underexpanded stents. When recognized (by IVUS) and corrected, chronic stent underexpansion results in a low recurrence rate (13.7% at one year) even in diffuse or proliferative ISR. This supports routine IVUS evaluation when patients present with ISR.

	Pre-intervention	Post-intervention	p
Reference lumen area (mm^2)	5.8±2.1	6.4±1.9	0.3
Minimum stent area (mm^2)	5.0±0.7	7.3±2.2	<0.0001
Minimum lumen area (mm^2)	1.9±0.5	5.4±2.1	<0.0001
Intimal hyperplasia (mm^2)	3.2±0.6	1.9±1.3	<0.0001

1007-176 Mechanisms of Abrupt Vessel Closure After Coronary Angioplasty: Results of a Systematic Intravascular Ultrasound Study

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Background: The factors leading to abrupt closure after percutaneous coronary angioplasty (PCI) have not been well established. We used intravascular ultrasound (IVUS) to determine the pre- and post-PCI characteristics involved in abrupt closure.
Methods: We analyzed 10,723 consecutive pts without acute myocardial infarction who were treated with PCI and underwent IVUS imaging during the intervention. 46 (0.4%) had angiographically documented abrupt closure <1 week post-PCI (median time to abrupt closure=24hrs). 30 arteries were treated with stent at the time of procedure.
Results: In stented arteries, lumen reference and minimal stent areas were 9.6 ± 3.2 mm^2 and 6.4 ± 2.6 mm^2, respectively. In non-stented arteries, reference lumen area was 10.8 ± 3.3 mm^2 and final minimal lumen area was 6.8 ± 2.7 mm^2. Overall, post-IVUS identified at least one cause for abrupt closure in 82% of patients; the cause was multiple in 33%. Causes included dissection 13% (all distal), thrombus 13%, tissue protrusion within the stent struts with compromised lumen 8%, and plaque tear post-PCI 3%. 94% of patients with one of these abnormal morphologic findings also had reduced lumen dimensions post-PCI (final lumen <80% reference lumen area). Stent expansion according to the MUSIC criteria was adequate in only 20% of the arteries. Pre-PCI IVUS showed a thrombus in only 5% (not documented any longer in post-PCI IVUS after stenting).
Conclusions: Abrupt closure is infrequently related to the pre-intervention lesion characteristics. Inadequate post-procedure lumen dimensions -- alone or in combination with other procedurally-related abnormal lesion morphologies (dissection, thrombus, tissue prolapse) -- contribute to this phenomenon.

1007-177 Volumetric Analysis of LAD-Diagonal and LCX-Obtuse Marginal Coronary Bifurcations: An Intravascular Ultrasound Study

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Background: Vessel bifurcations are prone to early atherosclerotic plaque accumulation. In order to better understand plaque distribution at bifurcation lesions we systematically analyzed LAD-Diag and LCX-OM bifurcations using intravascular ultrasound.
Methods: We analyzed plaque distribution in 49 LAD-Diag and 20 LCX-OM bifurcations with <50% angiographic stenosis. Planimetry of the lumen and EEM was performed at 1 mm intervals in the segments 5 mm proximal and distal to the bifurcation. EEM, lumen and plaque volume and % plaque burden (plaque volume/EEM volume) were calculated. In each of the 12 images, plaque thickness was measured at 4 different points relative to the origin of the branch: plaque thickness at 0°, 90°, 180° and 270°, clockwise from the side branch.
Results: % plaque burden was similar in proximal and distal segments. However, plaque volume, lumen volume and EEM volume were significantly larger proximal to bifurcation (table). Maximal plaque thickness was observed opposite to the branch equally in proximal and distal segments. However, plaque thickness at 90°, 270° and 360° was smaller distally.

	Vessel Volume(mm^3)	Lumen Volume(mm^3)	Plaque Volume(mm^3)	% plaque burden	Plaque Thickness at 0° (mm)	Plaque Thickness at 90° (mm)	Plaque Thickness at 180° (mm)	Plaque Thickness at 270° (mm)
Proximal	100.2±30	54.8±17	45.4±19	0.45±0.19	0.44±0.33	0.57±0.42	0.69±0.40	0.58±0.35
Distal	77.3±29	43.2±17	34.2±18	0.42±0.26	0.30±0.21	0.50±0.43	0.71±0.40	0.50±0.34
p	0.0001	<0.0001	0.0005	NS	<0.0001	0.025	NS	0.0015

Conclusion: 1) Although % plaque burden was similar, proximal segments have larger plaque volume than distal segments. 2) Plaque volume is asymmetrically located opposite to the flow divider, especially in distal segment. These angiographically unrecognized plaque distributions should be considered during PCI of more advanced bifurcation lesions.

1007-197 Impact of Diabetes on Coronary Remodeling in Patients With Acute Coronary Syndromes: An Intravascular Ultrasound Study

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Background: Intravascular ultrasound (IVUS) studies have shown that positive remodeling predominates in lesions responsible for acute coronary syndromes (ACS), whereas negative remodeling is more prevalent in diabetic pts and in stable angina pts. **Objectives:** To use IVUS to investigate the association between remodeling of the culprit lesion, ACS, and diabetes. **Methods:** We performed pre-intervention IVUS on 927 pts and divided the pts into 4 groups according to clinical presentation and presence of diabetes: Stable angina and diabetes (n=88), stable angina/no diabetes (n=187), unstable angina and diabetes (n=183) and unstable angina/no diabetes (n=469). Vessels were classified as positive or negative remodeling if the lesion vessel CSA was larger or smaller, respectively, than the average of the proximal and distal reference vessel areas.
Results: Overall, positive remodeling was more prevalent in patients with ACS compared to stable pts (43% vs. 21%. p<0.001), see table.

	Stable DM	**Stable/ No DM**	**Unstable DM**	**Unstable No DM**	**p-value ANOVA**
Reference vessel CSA (mm^2)	12.9±4.0	13.5±4.4	14.3±5.6	14.1±4.9	0.23
Lesion vessel CSA (mm^2)	12.2±4.6	11.2±4.3	12.1±5.0	12.2±4.8	0.24
Lesion lumen CSA (mm^2)	2.4±0.9	2.3±1.0	2.3±0.9	2.5±1.2	0.04
+ Remodeling	19.6%	22.3%	32%	48%	<0.001
- Remodeling	80.4%	77.7%	68%	52%	<0.001

Conclusions: Diabetes modulates the relationship between remodeling and ACS. Diabetes decreases the frequency of positive remodeling in ACS pts while it increases the frequency of negative remodeling in stable angina. These data suggest a unique patho-

biologic response in the diabetic pt with ACS, which may impact the detection and treatment of vulnerable plaque in this cohort.

1007-198 Effect of -Irradiation With ^{188}Re-Filled Long-Balloon on Reference Segments

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Background: To avoid edge restenosis and geographic miss, brachytherapy with long source is now frequently used. However, the effect of β-irradiation with a balloon catheter on reference segment has not been defined well. **Method** : SPARE trial was a prospective, randomized, case-controlled study to evaluate the efficacy of ^{188}Re-filled balloon system in patients(pts) with significant de novo or in-stent restenosis lesions. Among 210 pts enrolled, 30 pts with de novo lesion who received brachytherapy after successful stenting with a balloon at least 10 mm longer than the length of a stent used were analyzed. Pts who received debulking were excluded. Serial IVUS comparison between post-radiation and 6 mo follow-up were available in 20 pts. Reference segment was divided into full-dose (FR) and low-dose radiation segments(LR). LR was defined as a 5 mm-long-segment proximal or distal to the edge of a balloon. IVUS images were acquired at every 1 or 2 mm intervals from the edge of a stent to the end of LR. Mean values of each segment were used in the analysis. Changes in lumen area (LA), EEL area (VA) and plaque + media area (PMA) were evaluated. **Result**: 39 FR and 36 LR were analyzed. Duration between 2 IVUS studies was 188±30 days. There was no geographic miss or residual dissection. The IVUS findings were shown at table. **Conclusion**: β-irradiation had no effect on LA, VA and PMA at LR. However, both PMA and VA were increased at FR. In conclusion, brachytherapy with long balloon is safe in terms of its effect on reference segments

	LR			FR		
	Initial	Follow-up	P value	Initial	Follow-up	P value
LA(mm^2)	7.2 ±2.5	6.4± 2.0	0.2	7.6± 3.0	7.5± 3.6	0.9
VA(mm^2)	14.1± 3.6	13.2± 4.9	0.2	14.1± 4.5	14.8± 4.7	0.08
PMA(mm^2)	7.0 ±2.3	6.8 ±3.7	0.8	6.6± 2.4	7.3± 2.5	0.01

1007-199 Predictors of Neointimal Regression Six Months After Intravascular Brachytherapy for In-Stent Restenosis

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Background: Intravascular brachytherapy (IVB) for in-stent restenosis (ISR) has been successfully tested to prevent recurrent restenosis. The aim of this study was to investigate possible predictors of neointimal regression 6 months after IVB using gamma source (^{192}Ir) for ISR.
Methods: Ninety-seven ISR lesions treated with either IVB or placebo with complete serial (post and 6-month follow-up) intravascular ultrasound (IVUS) imaging were selected and enrolled from the WRIST study. Mean stent, lumen and neointimal cross sectional areas (CSA) were obtained by dividing each volume with stent length. Neointimal regression was defined as Δneointimal CSA of less than 0.
Results: During 6-month follow-up, neointimal regression occurred in 28 lesions (26 IVB, 2 placebo). Mean lumen CSA increased significantly (7.3±2.0 to 7.8±2.1 mm^2, p<0.01) in lesions with neointimal regression as a result of decreased mean neointimal CSA (3.5±2.0 to 2.9±1.7 mm^2, p<0.01). Univariate predictors for neointimal regression were use of IVB (p<0.0001), SVG lesion (p=0.08), longer follow-up period (p=0.0006), and larger postintervention mean neointimal CSA (p=0.049). By multivariate logistic regression analysis, use of IVB (p=0.0001) and larger postintervention mean neointimal CSA (p=0.01) were independent predictors for neointimal regression.
Conclusions: Following IVB using gamma source, neointimal regression and late lumen gain may occur. Neointimal regression 6 month after IVB may be related to a larger residual neointima after intervention.

1007-200 Intracoronary Calcium and Coronary Artery Disease Risk Factors: An Intravascular Ultrasound Study

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Introduction: Lesion calcification has an important effect on percutaneous coronary intervention (PCI) decision making, as higher calcium content may necessitate the use of mechanical rotablation or cutting balloon as opposed to plain angioplasty. Previous reports offer conflicting views relating calcification to various coronary risk factors. **Objective:** This study was performed to determine the content and pattern of calcification in coronary atherosclerotic plaques, and also to define the relationship of target lesion calcification to various cardiovascular disease (CVD) risk factors in patients with symptomatic coronary disease. **Methods:** We analyzed the intravascular ultrasound (IVUS) imaging data in 919 studies of 897 patients prior to conducting any PCI. The mean age of the population was 62 ± 12 years, of which 57% were male. The vessels imaged (n=919) were left main (131), left anterior descending (475), left circumflex (93), obtuse marginal (7), diagonal (15), right (169), and other or unknown coronary (29) arteries. Twenty-five percent of the study population had prevalent diabetes mellitus, 69% had hypertension, 48% had hypercholesterolemia, 37% were current smokers, and 2.6% were on hemodialysis. Pearson correlation coefficients and linear regression models were used to determine the relationship between target lesion calcification and clinical correlates. **Results:** Among 919 vessels studied, 64% had target lesion calcification; 262 had one-quadrant, 183 had two-quadrant, 78 had three-quadrant and 59 had four-quadrant calcification. Presence of calcification was correlated with the age of the patient (p<0.0001), but had no relationship to smoking status, hypercholesterolemia, hypertension, diabetes mellitus, or end-stage renal disease (all p > 0.60), with serum creatinine (p=0.30). **Conclusions:** We conclude that the prevalence of target lesion calcification in patients with symptomatic coronary artery disease is high (64%) and related to age. Contrary to previous reports, calcification was unrelated to current smoking or renal failure. Coronary lesion calcification is related to mechanisms generally unexplained by traditional (CVD) risk factors.

1007-201 Does a Thrombotic Lesion Detected by Coronary Angiography Always Contain a Thrombus? An Intravascular Ultrasound Study

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"Thrombotic lesions" in native coronary arteries are detected angiographcially by the presence of a filling defect surrounded by contrast material and by the absence of calcium within the filling defect. Thrombi can lead to complications during percutaneous coronary intervention (PCI). **Methods:** From January 1994 to December 1998, 264 (1.6%) out of 16757 native coronary artery lesions were classified as thrombotic using coronary angiography. Of these, 51 were studied using IVUS. Fourteen lesions (29.2%) were acute/recent (within 1 week) infarct lesions; and 9 lesions received thrombolysis before IVUS. We defined a calcified lesion as more than 2 quadrants (180°) of calcium within the lesion. We identified a thrombus as a mobile, pedunculated, hypoechoic mass; a brightly speckled mass; or by channels or flow within the plaque. **Results:** Three lesions were excluded from this study because the IVUS catheter did not cross the lesion. The 48 lesions were classified into 4 categories by IVUS: thrombus without calcium (n=20), thrombus+calcium (n=6), calcium without thrombus or soft plaque (n=11), and soft plaque without thrombus or calcium (n=11). There was no significant difference in patient age, gender, LVEF, or history of either MI or thrombolysis within 1 week. Post-intervention, peak CPK (IU/L) was significantly higher in thrombus+calcium-containing lesions (597.0±376.6) than in the other three lesion subsets (157.5±132.5, 203.2±230.6, 76.6±84.6, respectively, p=0.0032). **Conclusion:** Angiographic "thrombotic lesions" do not always contain thrombus; some are, in fact, merely calcific plaques, and others contain both calcium and thrombus. The high CPK levels post-PCI of "thrombocalcific" lesions indicate that these have a very high embolic potential. IVUS may be useful in identifying this high-risk group.

1007-202 Eccentric Atherosclerotic Plaques With Positive Remodeling Have a Pericardial Distribution: A Permissive Role of Epicardial Fat--A Three-Dimensional Intravascular Ultrasound Study of Left Anterior Descending Artery Lesions

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Aims: The transversal distribution of coronary atherosclerotic plaques (AP) (myocardial vs pericardial) affects vessel remodelling. The aim of this study was to define the impact of transversal lesion distribution on vessel remodelling in proximal and distal coronary segments using a 3D intravascular ultrasound (IVUS) reconstruction. Methods: The study group included 70 lesions located in the left anterior descending artery within 5 mm of the septal take-off, and imaged using 3D-IVUS. The take-off of the septal branch was used to divide the plaque into a myocardial and pericardial surface. The IVUS index of vessel remodelling was calculated as: [narrowest external elastic membrane (EEM) site cross-sectional area (CSA) – reference EEM CSA) / reference EEM CSA x 100]. The lesions with an intermediate vessel remodelling index (between -5% and +5%) were excluded from analysis. Results: Of the 38 APs with a pericardial distribution, 34 (89%) showed positive remodelling (P<0.001). The distal lesions had a positive vessel remodelling index regardless of transversal plaque distribution. At multivariate analysis, pericardial distribution and the distal location of AP were the only independent variables predictive of positive remodelling.Conclusions: The transversal distribution of atherosclerotic plaque affects vessel remodelling in left anterior descending coronary lesions, probably because of an extravascular splinting effect. Distal lesions usually show positive remodelling regardless of transversal plaque distribution.