

performed *ex vivo* IVPA-US imaging of a fresh human coronary artery, and compared to NIRS and histology.

**RESULTS** Along the artery lengths, dyslipidemic swine showed significantly greater average cross-sectional lipid area than lean swine (0.089 mm<sup>2</sup> vs 0.059 mm<sup>2</sup>; *p*<0.0001). Similar results were shown in *ex vivo* NIRS measurements, in which dyslipidemic swine had a greater average total lipid core burden index (LCBI) than lean swine (50.3 vs 12.0; *p*=0.48). The small average lipid areas and LCBI agreed with histopathology, which showed mild neointimal thickening in both groups.

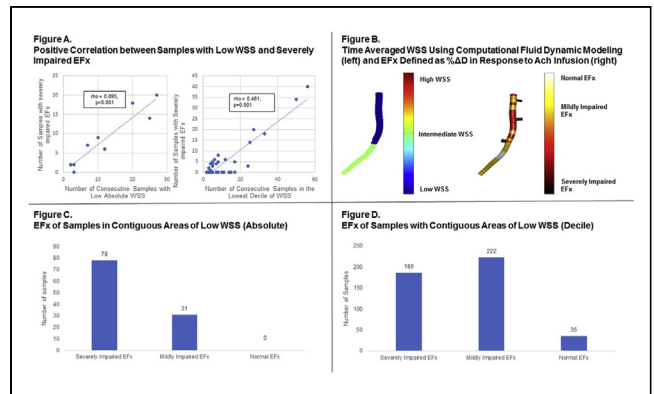
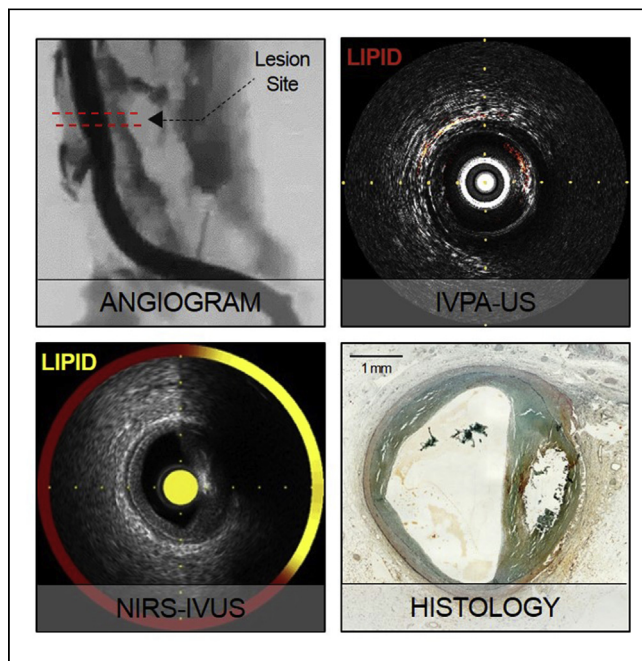
On *ex vivo* imaging of the human coronary artery and histology, we identified advanced fibroatheromas with calcification (**Figure**). The lesion had a total lipid area, as measured in a 4 mm segment, of 25.95 mm<sup>2</sup> and lipid core volume of 0.247 mm<sup>3</sup>. The NIRS chemogram-derived lipid area was comparable at 26.38 mm<sup>2</sup> with a maximum LCBI of 326 in the 4 mm segment.

**CONCLUSION** As confirmed by NIRS and histology, IVPA-US has sensitivity and depth resolution to detect lipid content in early disease, which enables quantification and localization of lipid cores within plaques.

defined as %ΔD ≥ +10%, +10% <%ΔD> -10% and -10% ≤ %ΔD, respectively. Computational fluid dynamics was used to calculate time-averaged WSS (Fig B). Low WSS was defined using an absolute cut-off (<10 dynes/cm<sup>2</sup>) and by lowest decile (<16 dynes/cm<sup>2</sup>).

**RESULTS** In 4,510 coronary samples analyzed, median WSS was 36.7 dynes/cm<sup>2</sup>. There was a strong positive correlation between samples with severely impaired Efx and low WSS using both absolute low WSS (rho = 0.90, *p*=0.001) and lowest decile of WSS (rho = 0.63, *p* < 0.001) (Fig A). Of the 109 contiguous samples with low absolute WSS, none had normal Efx (Fig C). Similarly, there were 443 contiguous samples with lowest decile of WSS, of which only 35 (8%) samples had normal Efx (Fig D). In a multiple linear regression model, a higher number of consecutive samples with low absolute WSS (β=1.185 *p*=0.016,) or lowest decile of WSS (β=0.933 *p*<0.0001,) was associated with a higher number of samples with severely impaired Efx independent of age, sex, diabetes, hypertension and % stenosis.

**CONCLUSION** In patients with non-obstructive CAD, a longer length of low WSS is associated with more endothelial dysfunction.



## NURSE & TECH

### NURSE AND TECH ABSTRACTS

#### CRT-400.01

##### Training, Simulation and Validation of Therapeutic Hypothermia as an Adjuvant Treatment in ST Segment Elevation Myocardial Infarction

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**BACKGROUND** Therapeutic hypothermia (TH) reduces the damage by ischemic / reperfusion syndrome in cases of cardiac arrest, in which its application is already widely established and carried out in centers of excellence. However its use in patients with ST segment elevation myocardial infarction (STEMI) is still scarce. The simulation decreases the gap between what is taught in theory and its application in professional practice. The aim of the trial was the development of a simulation protocol and training of the multidisciplinary team to perform therapeutic hypothermia as an adjunctive treatment in patients with STEMI, and validation of the method by applying in real cases.

**METHODS** Use of modern mannequins with realistic simulation situations and different scenarios for the treatment of patients with STEMI undergoing therapeutic hypothermia as an adjunctive treatment, from the emergency room, through the cath lab, and to the intensive care unit (ICU). There were 36 multidisciplinary professionals doing the training among realistic simulation with modern mannequins and real scenarios in sectors of the hospital where the real patients would be treated.



### PHYSIOLOGIC LESION ASSESSMENT

#### CRT-300.08

##### Coronary Vessels with Larger Contiguous Regions of Low Wall Shear Stress Have More Endothelial Dysfunction

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**BACKGROUND** Impaired endothelial function (EFx) is associated with atherosclerosis. We hypothesized that a higher number of contiguous coronary samples with low wall shear stress (WSS) is associated with more endothelial dysfunction.

**METHODS** A total of 44 patients with non-obstructive coronary artery disease (CAD) (mean age 51.2±12.5 years, 27% male, mean stenosis 20%±12%) underwent coronary angiography with and without acetylcholine (ACh) infusion and three-dimensional geometric reconstruction. Efx was defined as % change in lumen diameter (%ΔD) in response to ACh infusion in every 0.5mm coronary vessel sample. Normal, mildly impaired, and severely impaired Efx was

**RESULTS** The focus of simulation and training was the logistics optimization and debriefing with strategies to reduce waste of time in the patient's transportation between the various departments, and avoiding excessive reheating during transport between sectors. There was absolute success in the realization of therapeutic hypothermia and validation of the method in real life, with the application of knowledge and logistics in 20 real patient without any delay in the doo-to-balloon time for primary angioplasty, which occurred in a timely manner (less than 90 minutes), and maintenance of therapeutic hypothermia in the ICU successfully.

**CONCLUSIONS** Simulation was an important tool related to the training and optimization of health professionals skills, and improving the multidisciplinary team to perform therapeutic hypothermia in STEMIs. The use of real scenarios and debriefing were critical to the successful implementation of TH in practice. After simulation and training, the protocol and the method were validated with application of TH in real life successfully and without any delays.

#### CRT-400.02

##### The Impact of Patient BMI on Radiation Dose Among Scrub Technologists During Cardiac Catheterization



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**BACKGROUND** Increasing patient body mass index (BMI) results in greater scatter radiation during fluoroscopy, yet the impact of patient BMI on scrub tech radiation dose during coronary angiography has not been studied.

**METHODS** Real-time radiation exposure data were prospectively collected during coronary angiography. Scrub tech radiation dose was calculated as  $E = 0.02 (H_{os} - H_u) + H_{os}$ , where E was effective dose and  $H_{os}$  and  $H_u$  were outer and inner dosimeter radiation doses, respectively. Patient radiation dose was estimated by dose area product (DAP). Patient BMI was categorized by the NIH classification.

**RESULTS** In 1,119 consecutive coronary angiography procedures, a significant increase in patient DAP ( $p < 0.001$ ) was observed across increasing patient BMI categories. When patient BMI was evaluated as a continuous variable, there was a weak, albeit significant, correlation between patient BMI and scrub technologist effective dose ( $r = 0.14$ ,  $p < 0.001$ ). When patient BMI was categorized according to the NIH classification, there was a significant increase in scrub technologist effective dose across increasing patient BMI categories ( $p = 0.002$ ). Compared to BMI  $< 25$ , a patient BMI of 35-39.9 was associated with 2.7-fold increase in technologist effective dose (0.6 [0.1, 1.6]  $\mu$ Sv vs 1.6 [0.4, 4.5]  $\mu$ Sv,  $p < 0.0001$ ). Compared to BMI  $< 25$ , a patient BMI  $\geq 40$  was associated with 1.8-fold increase in technologist effective dose (0.6 [0.1, 1.6]  $\mu$ Sv vs 1.0 [0.1, 2.0]  $\mu$ Sv), but this difference did not reach statistical significance ( $p = 0.120$ ) likely owing to the smaller sample size of patients with a BMI  $\geq 40$ .

**CONCLUSION** During coronary angiography procedures, scrub technologist radiation dose increased significantly with increasing patient BMI. Additional studies are needed to improve scrub technologist radiation safety practices when performing coronary angiography in obese patients.

**BACKGROUND** Monocytes are crucially involved in all stages of atherogenesis as cellular drivers of vascular inflammation hallmarking atherosclerotic disease. CD16<sup>+</sup> monocytes are pro-inflammatory cells, whose proportion is related to the occurrence of coronary artery disease (CAD), intima-media thickness and plaque stability. Interleukin-6 (IL-6) and highly sensitive C reactive protein (hs-CRP) were also closely related to atherosclerotic disease.

**OBJECTIVE** We investigated the relationship between the monocyte subsets, IL-6, and hs-CRP with the severity of CAD assessed by coronary angiography (CAG) in patients with stable angina pectoris (SAP) through their correlation with Gensini score.

**METHODS** Our study included 45 SAP patients who underwent diagnostic CAG. Thirty two patients of them who diagnosed as CAD were subdivided into 2 groups: 17 patients with multiple-vessel disease (MVD) and 15 patients with single-vessel disease (SVD). The rest thirteen SAP patients without CAD (non-CAD) were considered as a comparative group. Gensini score was used to assess the severity of CAD. Monocyte subsets were analyzed by flow cytometry and serum levels of IL-6 and hs-CRP were measured by ELISA.

**RESULTS** The relative proportion of CD14<sup>+</sup> CD16<sup>+</sup> and CD14<sup>bright</sup>CD16<sup>+</sup> was significantly higher in CAD patients, MVD and SVD as compared with non-CAD patients and in MVD more than SVD. Serum levels of IL-6 and hs-CRP were significantly increased in CAD patients, MVD and SVD when compared with non-CAD patients, but no significant difference between MVD and SVD. The proportion of CD14<sup>+</sup>CD16<sup>+</sup> and CD14<sup>bright</sup>CD16<sup>+</sup> monocytes was positively correlated with Gensini score ( $r = 0.667$ ,  $P = 0.000$ ,  $r = 0.695$ ,  $P = 0.000$ ).

**CONCLUSIONS** Elevated proportion of CD14<sup>+</sup> CD16<sup>+</sup> monocytes subsets was associated with the severity of CAD in patients with SAP.

#### CRT-500.04

##### Lower Wall Shear Stress and Clinical Risk Factors are Associated with Endothelial Dysfunction in Patients with Non-Obstructive Coronary Artery Disease



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**BACKGROUND** We hypothesized that wall shear stress (WSS) has incremental value over cardiovascular risk factors for predicting severe endothelial dysfunction (EDFx) in patients with non-obstructive coronary artery disease (CAD).

**METHOD** WSS was calculated in each 0.5 mm thick coronary segment in 44 patients with CAD by performing 3-D geometric reconstruction of baseline angiograms and computational fluid dynamics (Fig A). Low WSS was defined as  $< 1$  Pascal (Pa). Severe EDFx was defined as  $\leq -10\%$  change in lumen diameter (% $\Delta$ D) in response to acetylcholine (ACh) infusion in each segment (Fig B).

**RESULTS** Mean age was  $51.2 \pm 12.5$  years, 73% were female and mean diameter stenosis was  $20 \pm 12\%$ . In 4,510 segments analyzed, median WSS was 3.7 [IQR: 2.3 to 5.5] Pa and 1065 (24%) segments had severe EDFx. In univariable analysis, lower WSS (OR: 0.81,  $p < 0.001$ ), older age (OR: 1.023;  $p < 0.001$ ), female sex (OR: 2.39;  $p < 0.001$ ), hypertension (OR: 1.43;  $p < 0.001$ ) and smokers (OR: 1.37;  $p < 0.001$ ) were associated with severe EDFx. In a multivariable logistic regression model, lower WSS (OR: 0.85;  $p < 0.001$ ) was associated with severe EDFx independent of clinical risk factors. Addition of WSS to clinical risk factors resulted in a significant increase in global  $\chi^2$  for a model predicting severe EDFx ( $p < 0.001$ ) (Fig C). Similarly, in a multivariable linear regression model, a greater number of segments with low WSS (Beta: -0.13,  $p < 0.001$ ) were independently associated with greater vasoconstriction (% $\Delta$ D) in response to ACh.

**CONCLUSION** Among patients with non-obstructive CAD, lower WSS and greater area of low WSS were independently associated with severe endothelial dysfunction. Low WSS had an incremental value over clinical risk factors for predicting severe endothelial dysfunction.

## SCIENCE

### ATHEROSCLEROSIS

#### CRT-500.01

##### Relationship Between Monocyte Subsets, IL-6 and Hs-crp with the Severity of Coronary Artery Disease in Stable Angina Pectoris Patients



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