Atherosclerotic Plaque Can Be Quantified Using Multifractal and Wavelet Decomposition Techniques

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Introduction: Classification of plaque morphology into soft, fibroc calcific and calcific by intravascular ultrasound (IVUS) is done by comparing plaque intensity to surrounding adventitia. However, this technique is subject to bias and to inherent limitation of IVUS machine. Texture analysis is a form of tissue characterization based on the distribution of ultrasound amplitude signals within a region-of-interest (ROI). Two methods, the wavelet decomposition and multifractal techniques are currently being utilized to quantify image texture.

Methodology: IVUS images performed from year 2000-2002 at the Cardiac Catheterization Laboratory of South Texas Veterans Health Care Systems, San Antonio, Texas were analysed. These images were entered into Desktop computer and analyzed after placing a 16 x 16 ROI box. Mean and standard deviation of pixel intensity values were generated. Quantification of ROI texture using 2 methods were performed by generating of multifractal exponents, and normalized detail coefficients using wavelet decomposition method.

Results: Seven images were analysed. The overall intensity and energy generated by different plaque morphologies were significantly higher in calcific lesions as compared to soft plaque. Furthermore, a significant association is also noted with different plaque morphologies and texture analysis using both multifractal and wavelet decomposition method. The values generated with texture analysis using multifractal exponents are higher in calcific plaques as compared to soft lesions (0.539 ± 0.03 vs 0.504 ± 0.04, P = 0.001). However, with wavelet decomposition method, the normalized detail coefficients were significantly lower in calcific lesions (0.004 ± 0.01 vs 0.008 ± 0.00, P = 0.006).

Conclusion: A significant association was noted between plaque morphology and texture analysis using both wavelet decomposition and multifractal techniques. Using these techniques, these images were entered into Desktop computer and analyzed after placing a 16 x 16 ROI box. Mean and standard deviation of pixel intensity values were generated. Quantification of ROI texture using 2 methods were performed by generating of multifractal exponents, and normalized detail coefficients using wavelet decomposition method.

Coronary Artery Wall Temperature Heterogeneity in Patients With Acute Coronary Syndrome: An Intracoronary Thermography Study

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Background: Increase of vessel wall temperature in patients with acute coronary syndrome (ACS) has been previously reported. The aim of this study was to assess the safety and accuracy of intracoronary vessel wall temperature measurements in patients with ACS using new catheter based, flow limiting thermography system.

Methods: We performed intracoronary thermography in 23 patients (pts) (mean age 54±10 years) with ACS (13 pts with acute myocardial infarction within 12 hours of chest pain onset, 10 pts with unstable angina within 48 hours of the last chest pain) with TIMI 3 flow in the culprit artery before the procedure. We used 3.5-F thermography catheter containing a self-expanding basket with 5 arms and a thermocouple on each arm measuring vessel wall temperature, as well as a central thermocouple measuring blood temperature, allowing detection of differences of 0.05°C. Thermography was performed before PCI of the culprit lesion. In all studied vessels we assessed blood temperature (Tb, °C) and the maximum temperature difference between blood and any thermal couple (ΔTmax, °C) during pullback (0.5mm/sec).

Results: There were no device-related adverse effects or system failures. Mean Tbl was 36±7.0°C and mean ΔTmax was 0.093±0.032°C. Temperature difference was higher in the culprit segment in comparison to non culprit segment of the vessel (ΔTmax = 0.12±0.03 vs 0.07±0.006, p<0.001). In one case, a focal 0.18°C temperature peak was recorded at the culprit lesion. In 6 pts thermography catheter stopped the flow during thermal mapping when catheter was in a severely stenotic lesion. Tbl increased on average 0.2±0.07 with no flow at culprit segment, but it was paralleled by the increase in the vessel wall temperature, so ΔTmax remained unchanged.

Conclusions: Intracoronary thermography in patients with ACS was safe and able to detect heterogeneous arterial wall temperature within the culprit vessel. Temperature heterogeneity was higher in the culprit that in non culprit segment of the vessel.

Coronary Lesion Temperature Measurement During Transient Blood Flow Occlusion Using a Novel Thermal Sensing System

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Background: Temperature measurement of coronary arteries may provide lesion assessment beyond conventional angiography and ultrasound imaging. It holds the potential to be a predictor of future clinical events. However, studies have shown that blood flow through an artery interferes with the ability to measure lesion temperature.

Methods: We performed the first in man application of a novel thermal sensing catheter (Accumed Systems Inc, Ann Harbor, MI) that temporarily occludes flow through the artery to make temperature measurement in patients before undergoing elective percutaneous coronary intervention. On the distal portion of the catheter is an expandable braid (Accumed Systems Inc, Ann Harbor, MI) that temporarily occludes flow through the artery to make temperature measurement in patients before undergoing elective percutaneous coronary intervention.

Results: Plasma LDL level was significantly reduced from 133 ± 87 to 27 ± 9 mg/dl (p < 0.0001) during the 6-month follow-up. IB was substantially increased from –38.8 ± 4.5 to +51.2 ± 9.8 mg at the ROIs (r = 0.001). Increase of IB change of LDL level change >40% was significantly greater than at the ROIs (n = 60) in patients with %LDL change <40% (3.79 ± 4.8 vs. 0.7 ± 3.6; db; p<0.0001), however, increase of IB was not different between patients with LDL < 100 mg/dl and LDL >= 100 mg/dl at the follow-up.

Conclusions: These results suggest that statin may alter acoustic properties of coronary plaques and the effect of statin on plaque composition may not be related to the value of LDL cholesterol at the end point but the amount of its reduction.