WAVE SPEED IN THE HUMAN CORONARY ARTERY DOES NOT DECREASE WITH VASODILATION: EXTENDING THE LIMITS OF VALIDITY OF THE SINGLE-POINT TECHNIQUE FOR WAVE INTENSITY ANALYSIS

Moderated Poster Contributions
Poster Sessions, Expo North
Sunday, March 10, 2013, 9:45 a.m.-10:30 a.m.

Session Title: Physiological Assessment
Abstract Category: 38. TCT@ACC-i2: Intravascular Imaging and Physiology
Presentation Number: 2107M-219

Authors: Cristina Rolandi, Kalpa de Silva, Matt Lumley, Tim Lockie, Brian Clapp, Maria Siebes, Divaka Perera, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands, St Thomas Hospital, King’s College London, London, United Kingdom

Background: The rapidly expanding technique of wave intensity analysis (WIA) requires that coronary wave speed is known. This study is the first to directly measure coronary wave speed in humans and compare it to the single-point technique (SPc), which is derived from local pressure and velocity signals, but has not been validated in coronary vessels.

Methods: In 11 patients undergoing cardiac catheterization, intracoronary pressure was measured in angiographically normal epicardial coronary arteries using a high-fidelity catheter equipped with two pressure sensors located Δs = 5 cm apart. The actual wave speed was calculated as \( c = \Delta s / \Delta t \), where \( \Delta t \) is the time delay between the two pressure signals. Simultaneously, intracoronary pressure (P) and flow velocity (U) were measured with a dual-sensor guide wire to derive \( \text{SPc} = 1 / \rho \cdot \sqrt{\sum dP^2 / \sum dU^2} \), where \( \rho \) is the blood density. All signals were recorded at baseline, at maximal hyperemia induced by intracoronary adenosine, and after large vessel relaxation by nitroglycerin (NTG) injection at rest and hyperemia. Changes in the energy of the early diastolic backward expansion wave (BEW) were assessed at maximal hyperemia using SPc and c.

Results: At baseline, \( c = 16.6 \pm 6.6 \text{ m/s} \) equaled \( \text{SPc} = 18.7 \pm 5.8 \text{ m/s} \) (p>0.05). During hyperemia, SPc dropped by 39% to 11.4 \pm 3.7 \text{ m/s} (p<0.001), while c increased by 9% to 18.3 \pm 8.2 \text{ m/s} (p<0.05). NTG administration did not affect c or SPc. Small vessel dilation after NTG did not change c, but again lowered SPc to 12.5 \pm 5.3 \text{ m/s} (p<0.05). This change in SPc was strongly related to the baseline value (r=0.89) and proportionally affected the BEW, which overall decreased by 10%. Notably, SPc at baseline did not differ from c during hyperemia (p>0.05).

Conclusion: In agreement with animal data, coronary wave speed in humans remains essentially constant after microvascular dilatation. While the SPc reliably appraises wave speed in normal vessels under resting conditions, it markedly underestimates true wave speed during hyperemia, leading to a progressive underestimation of the BEW. However, our results suggest that SPc assessed at baseline can be used for WIA during hyperemia, which greatly extends its validity to study coronary physiology.