Quantifying coronary microvascular disease: assessing absolute microvascular resistance reserve (MRR) by continuous coronary thermodilution

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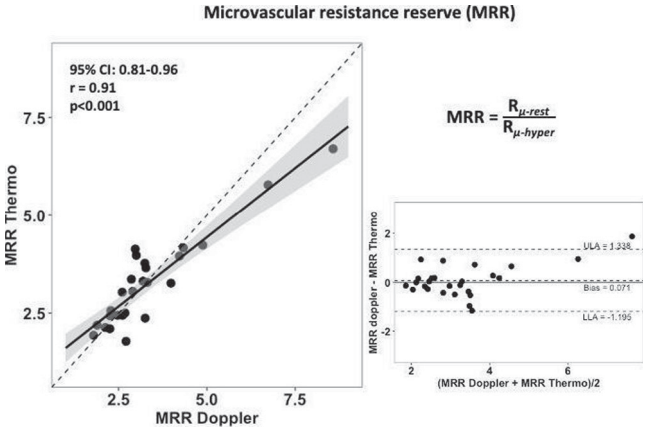
Background and aim: Hyperemic absolute coronary blood flow (in mL/min) can be safely and reproducibly measured with intracoronary continuous thermodilution of saline at room temperature at an infusion rate of 20 mL/min. This study aims at assessing whether continuous thermodilution can also measure resting flow and microvascular resistance.

Methods and results: In 87 coronary arteries (58 patients) with angiographic non-significant stenoses absolute flow was assessed by continuous thermodilution of saline at infusion rates of 10 mL/min and 20 mL/min using a pressure/temperature sensored guide wire, a dedicated infusion catheter and a dedicated software. In addition, in 26 arteries, average peak velocity (APV) was measured simultaneously using an intracoronary Doppler-wire.

There was no significant difference between Pd/Pa at baseline and during saline infusion at 10 mL/min, (0.95±0.053 vs 0.94±0.054, respectively (p=0.53) and there was no significant difference in APV at baseline and during the infusion of saline at 10 mL/min (22.2±8.40 vs 23.2±8.39 cm/s, respectively, p=0.63), thus indicating presence of resting coronary blood flow during the infusion of 10 mL/min of saline.

In contrast, at an infusion rate of 20 mL/min, a significant decrease in Pd/Pa was observed compared to baseline: (0.85±0.089 vs 0.95±0.053, respectively, p<0.001) and a significant increase in APV was observed (22.2±8.4 cm/s to 57.8±25.5 cm/s, respectively, p<0.001). The coronary flow reserve (CFR) calculated by thermodilution and by Doppler flow velocity were similar (2.73±0.85 vs 2.72±1.07, respectively) and their individual values correlated closely (r=0.87, 95% CI 0.72–0.94, p<0,001). Microvascular resistance (Rμ), defined as the distal coronary pressure divided by the absolute flow was calculated both at rest (Rμ-rest) and during hyperemia (Rμ-hyper). Microvascular Resistance Reserve (MRR), is calculated as the ratio of Rμ-rest and Rμ-hyper and showed a good correlation with the analogous Doppler-derived parameter (using the APV instead of absolute flow). Mean doppler and thermodilution derived MRR were similar (3.32±1.50 vs 3.23±1.16) and values correlated closely (r=0.91, 95% CI 0.81 - 0.96, p<0.001; Bland-Altman analysis: mean bias = 0.071, limit of agreement –1.195 to 1.338).

Conclusion: Absolute coronary blood flow (in mL/min) can be measured by continuous thermodilution both at rest and during hyperemia. This allows accurate, reproducible, and operator-independent direct volumetric calculation of CFR and MRR. The latter is a quantitative metric which is specific for microvascular function and independent from myocardial mass.



Doppler and Thermodilution derived MRR