

Model equations for myocardial perfusion studies with [¹⁵O]H₂O PET: right ventricular region

When [¹⁵O]H₂O is administered intravenously, it first appears in the right ventricular (RV) cavity, then continues to lungs, then appears in the left ventricular (LV) cavity, and thereafter it goes through the aorta to vessels supporting the myocardium and the rest of the body. Normally the MBF model is applied only to the LV myocardial regions, using LV cavity curve to determine the arterial blood input, and therefore the earlier appearance time of radioactivity in the RV cavity (about 10-15 s) needs not to be considered. However, to estimate the parameters of the MBF model in the right ventricular (RV) myocardium, this time shift must be taken into account, because it leads to an early spill-over effect from the RV cavity to the muscle region, and thus to an apparent increase in myocardial ROI values before the arterial blood input even reaches the muscle.

The blood curve in LV cavity is more dispersed, but since this affects only the estimation of the spill-over factor from RV cavity to the muscle, the difference in shapes is here assumed to be negligible, and the only difference between them is the time shift.

The arterial blood input, $a(t)$, is first estimated from the LV cavity and large myocardial regions as usual. Equation (1) for perfusable myocardial tissue, $C_i(t)$, applies also for the RV muscle regions. The term V_a for LV muscle regions contains both the volume fraction of arterial vascular space and the spill-over from the cavity, but for the RV muscle regions the spill-over part must be separated out of it because of the time shift (Δt), resulting into a new parameter SO . Accordingly, the equation (2) has to be rewritten for RV muscle regions:

$$ROI(T) = \alpha C_i(T) + V_a a(T) + SO a(T + \Delta t) \quad (A.1)$$

Again, from this the tissue activity is solved (A.2) and then integrated (A.3):

$$C_i(T) = (ROI(T) - V_a a(T) - SO a(T + \Delta t)) / \alpha \quad (A.2)$$

$$\int_0^T C_i(t) dt = \left(\int_0^T ROI(t) dt - V_a \int_0^T a(t) dt - SO \int_0^{T+\Delta t} a(t) dt \right) / \alpha \quad (A.3)$$

These are substituted into Eq. (1) and rearranged to give the regional myocardium radioactivity as a function of arterial blood radioactivity:

$$ROI(T) = V_a a(T) + SO a(T + \Delta t) + f \left(\alpha + \frac{V_a}{p} \right) \int_0^T a(t) dt + f \frac{SO}{p} \int_0^{T+\Delta t} a(t) dt - \frac{f}{p} \int_0^T ROI(t) dt \quad (A.4)$$