Analysis of renal perfusion from [^{15}O]H$_2$O PET studies: time delay correction

Aim

To compare whether time delay estimated before or together the perfusion model fit will produce comparable RBF estimates.

Materials and methods

PET studies: us0568, us0569, us0570, us0571 (subject #1); us0550, us0551, us0552, us0553 (subject #3); and us0490, us0494, us0495, us0496 (subject #3). All studies of one subject are scanned during one session. Only the first scan can be considered as baseline study.

Input curve: Arterial blood TACs measured using on-line blood sampler (pump). TACs are calibrated, corrected for physical decay and for the dispersion in collection system.

Renal data: ROIs were drawn on renal cortex in single image planes and average TACs for left and right kidney were calculated.

Countrate data: The countrate curve with one-second intervals was collected during image acquisition.

Software: Delay fit together with the perfusion model was done using fit_h2o 1.1.1, fitting also Va at the same time. Time delay fits between blood curve and either renal regional TACs or countrate curve were done using fitdelay 1.9.0. Fittings were done using batch file app_a.bat.

Results and discussion

Results are shown in table A1. Time delay fitting together with model fit or before it seem to provide similar results when fitting is done against the renal TACs. In contrast, when countrate curve is used, the fitted time delay is much higher; that would move the blood TAC too much to left (earlier times), and that may lead to overestimation of perfusion, depending on how the blood volume is accounted for. If we assume that actual time delay is the same between all studies of one subject, then the standard deviation would represent the reliability of the method; all methods produce comparable s.d. values, suggesting that in this case the countrate data does not provide better time delay correction.

Conclusion

Time delay can be fitted before perfusion model fit. Regional renal TACs must be used in the delay fit; usage of countrate curve, or probably also image derived "head curve", would lead to severe bias in time delay.

Table A1. The resulting time delays (s) from the three methods in the four PET studies for three subjects.

Study	Perfusion model with time delay	Separate estimation against renal TACs	Separate estimation against countrate
Subject #1	-2.5	-1.8	-5
	2.5	0.4	-5
	-0.5	-1.3	-8
	-3.5	-1.7	-5
mean ± s.d.	-1.0 ± 2.0	-1.1 ± 0.8	-5.8 ± 1.1
Subject #2	-8	-8.2	-16
	-5.5	-5.1	-12
	-9.5	-10.9	-15
	-6.5	-7.6	-20
mean ± s.d.	-7.4 ± 1.4	-8.0 ± 1.6	-15.8 ± 2.3
Subject #3	-5	-5.3	-17
	-10	-9.8	-22
	31	29.2	21
	-4	-4.9	-19
mean ± s.d.	3.0 ± 14.0	2.3 ± 13.5	-9.3 ± 15.1