Sari et al. EJNMMI Physics 2014, 1(Suppl 1):A54
http://www.ejnmmiphys.com/content/1/S1/A54

EJNMMI Research
a SpringerOpen Journal

MEETING ABSTRACT Open Access

Modelling the impact of injection time on the bolus shapes in PET-MRI AIF Conversion

Hasan Sari[1*], Kjell Erlandsson[1], Anna Barnes[1], David Atkinson[2], Simon Arridge[3], Sebastien Ourselin[3], Brian Hutton[1]

From PSMR14: 3rd Conference in PET/MR and SPECT/MR
Kos Island, Greece. 19-21 May 2014

[1]Institute of Nuclear Medicine, University College London / University College London Hospitals, London NW1 2BU, UK

With the introduction of combined PET/MRI systems, AIF conversion can be made under certain circumstances (see [1]). We propose a model that allows modification of the injection parameters in the AIF fit to account for differences caused by different injection durations [2].

Brain ^{18}F-Choline PET and DSC-MRI data were obtained using Siemens mMR. The MR contrast agent was injected with a rate of 4ml/sec and the PET tracer was injected manually. Perfusion Mismatch Analyzer [3] was used to extract the MRI-AIF. Carotid arteries were segmented on a post contrast MPRAGE image. PET frames were registered onto this MPRAGE image using rigid registration and partial volume correction was done using the iterative Yang method [4]. The AIFs were fitted using a convolution of a 'double Butterworth' function, representing the injection, with a tri-exponential function representing the elimination [Eq. 1]. The bolus shape can be adjusted by

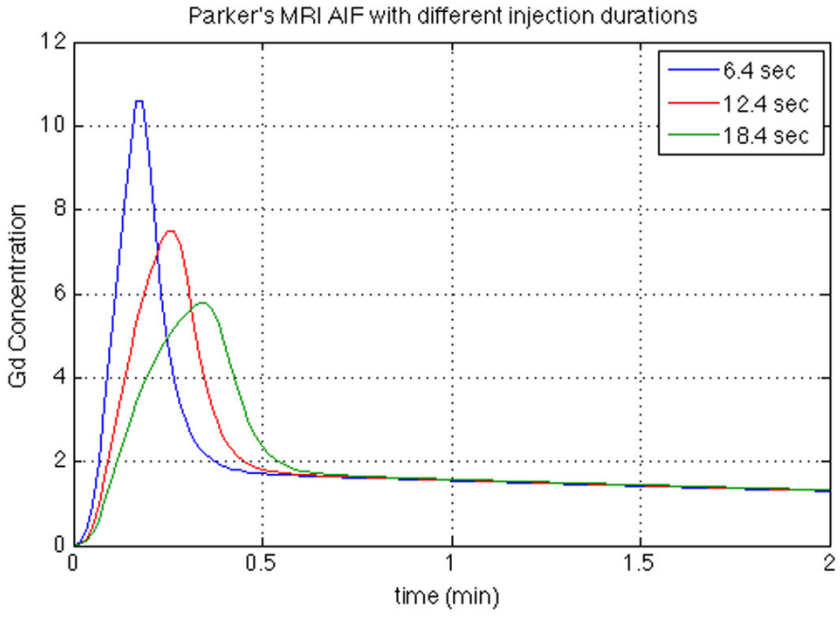

Figure 1 Simulated MRI-AIFs using Parker's population-based input function refitted with the developed function. AIF shapes with different injection durations, $\Delta\tau$ is shown.

changing $\Delta\tau$ (τ_2 - τ_1). This was tested with a population based MRI AIF [5], as well as with clinical data.

$$C_p(t) = \frac{1}{a} D(t) \otimes (\beta_1 e^{-m_1 t} + \beta_2 e^{-m_2 t} + \beta_3 e^{-m_3 t}) \text{ and } D(t) = \left(1 - \frac{1}{1 + (\frac{t}{\tau_1})P_1}\right)\left(\frac{1}{1 + (\frac{t}{\tau_2})P_2}\right) \quad (1)$$

where

$$a = \int_0^\infty D(t)dt$$

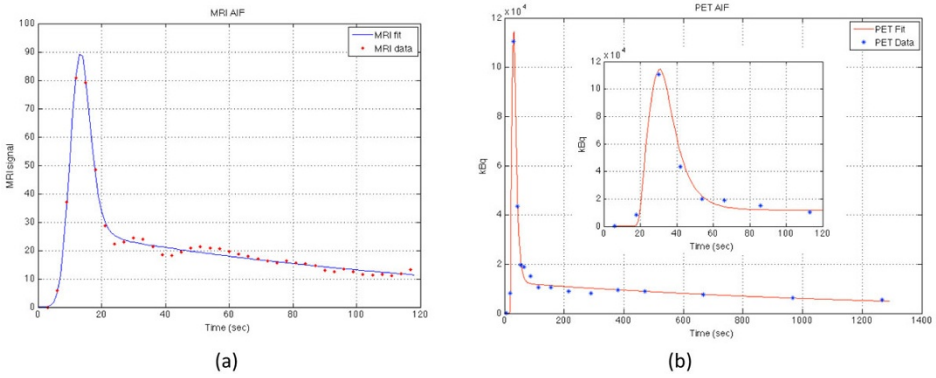

Figure 2 The double Butterworth convolution function used to fit (a) DSC-MRI data and (b) 18F-Choline PET data together with a plot where the timescale of PET-AIF was limited to MRI-AIF's to show different bolus widths.

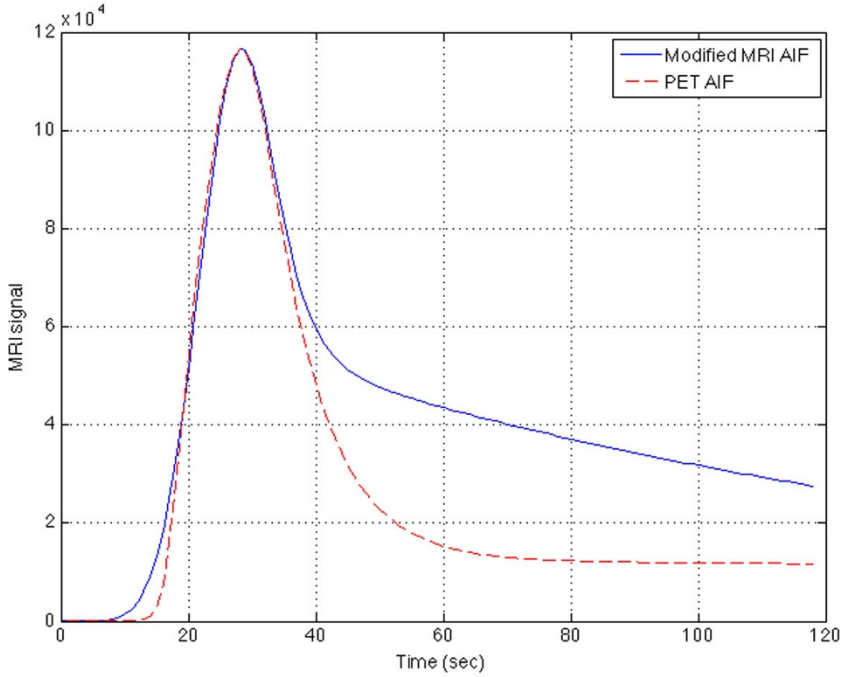

Figure 3 The MRI-AIF with modified τ1 and τ2 values plotted together with the PET-AIF. The MRI-AIF peak is scaled to PET-AIF's peak.

For the population based input function, Figure 1 shows that when $\Delta\tau$ was increased, lower and wider peaks were seen, and with decreased $\Delta\tau$, higher but narrower peaks were observed. Figure 2 shows that the function fits both clinical PET and MRI AIFs well. Values of τ_1 and τ_2 were changed to modify the MRI-AIF and Figure 3 shows the modified MRI-AIF together with the original fitted PET-AIF, normalized to their peaks. Two AIFs have similar peak shapes but start to differ at the elimination phase as Gd-DOTA and ^{18}F-Choline have different tissue uptake rates.

This enables conversion of the early part of the AIFs from one modality to another even if different injection protocols are used.

Acknowledgements
This work was supported by an IMPACT studentship funded jointly by Siemens and the UCL Faculty of Engineering Sciences. K.E. is funded by a grant from EPSRC (EP/K005278/1). UCL/UCLH research is supported by the NIHR Biomedical Research Centres funding scheme. We thank Celia O'Meara for her help with the PET and MRI datasets and Alex Bousse for his valuable comments.

Authors' details
[1]Institute of Nuclear Medicine, University College London / University College London Hospitals, London NW1 2BU, UK. [2]Center for Medical Imaging, University College London, London NW1 2PG, UK. [3]Center for Medical Image Computing, University College London, London WC1E 6BT, UK.

Published: 29 July 2014

References

1. Poulin E, Lebel R, Croteau E, Blanchette M, Tremblay L, Lecomte R, Bentourkia M, Lepage M: **Conversion of arterial input functions for dual pharmacokinetic modeling using Gd-DTPA/MRI and 18F-FDG/PET.** *Magn. Reson. Med.* 2013, **69**:781-92.
2. Holt A, Pasca E, Heijmink SW, Teertstra J, Muller SH, van der Heide UA: **The impact of overall injection time on the arterial input function and pharmaco-kinetic analysis using the Tofts model in DCE-MRI for prostate cancer patients.** *Proc. Intl. Soc. Mag. Reson. Med.* 2012, **20**:238.
3. **Perfusion Mismatch Analyzer, version 3.4.0.6 [January 20, 2014].** *ASIST-Japan Web site* 2006 [http://asist.umin.jp/data-e.shtml], updated June 2011.
4. Erlandsson K, Buvat I, Pretorius PH, Thomas B, Hutton BF: **A review of partial volume correction techniques for emission tomography and their applications in neurology, cardiology and oncology.** *Phys. Med. Biol.* 2012, **57**(21): R119-59.
5. Parker GJM, Roberts C, Macdonald A, Buonaccorsi GA, Cheung S, Buckley DL, Jackson A, Watson Y, Davies K, G C, Jayson GC: **Experimentally-derived functional form for a population-averaged high-temporal-resolution arterial input function for dynamic contrast-enhanced MRI.** *Magn. Reson. Med.* 2006, **56**:993-1000.

doi:10.1186/2197-7364-1-S1-A54
Cite this article as: Sari *et al.*: Modelling the impact of injection time on the bolus shapes in PET-MRI AIF Conversion. *EJNMMI Physics* 2014 **1**(Suppl 1):A54.