Principal components analysis of whole trial onset aligned DCE-MRI gadolinium uptake curves produces metrics that correlate with conventional PK parameter estimates

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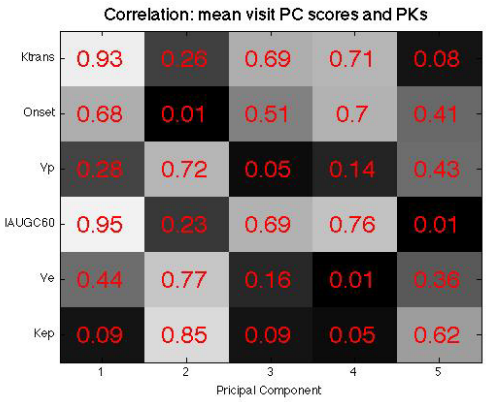

Figure 1 - correlation between mean visit PK estimates and PC scores for Gd curves

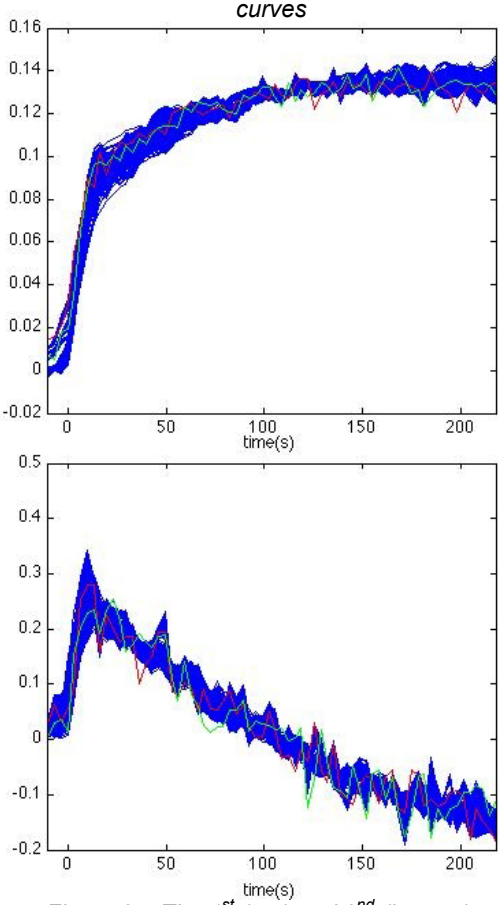

Figure 2 – The 1st (top) and 2nd (bottom) principal components for each subset of 462 combinations of 6 patients (blue) and visit 1 (red) and visit 2 (green)

Introduction: In this work, it is shown that analysis of onset aligned dynamic contrast enhanced magnetic resonance (DCE-MRI) gadolinium (Gd) uptake curves using principal components analysis (PCA) can identify metrics that correlate with pharmacokinetic (PK) parameters derived from model fitting and is robust to changes in patient cohort. In contrast to pharmacokinetic (PK) modelling, principal components analysis (PCA) methods are able to evaluate all the curves from a cohort of patients as a single data volume. PCA methods avoid the need for an AIF and do not require computationally expensive model fitting. It also allows all curves from a whole trial to be assessed as a single entity.

Methods: Under appropriate ethics, 11 patients with varying histology, including head, neck and pelvic lesions; were imaged twice at baseline resulting in 22 DCE-MRI acquisitions made up of images acquired at 3.3s intervals. Gadolinium uptake curves for each pixel within volumes of interest (VOIs) were obtained using established protocols[1] (126,478 curves). Analysis of the uptake curves was performed using local code developed in MATLAB® (Natick, MA). Extended Kety[2] models were fitted to the Gd Curves using a population AIF[3]. For each VOI, the user selected the temporal sample nearest to onset by inspecting the mean intensity values. The curves in the volume were aligned to that point. PCA was conducted and each curve in the dataset assigned a score for each of the principal components (PCs). Correlations between mean PC scores and PK parameters across each VOI were calculated (*Figure 1*). To assess the robustness of the analysis, the PCA was repeated on: each combination of 6 patients (462 combinations), all data from baseline 1, all data baseline 2. The first 2 principal components for each subset were compared (*Figure 2*).

Results: *Figure 1* shows the correlations between mean PC score and mean PK parameter per VOI. *Figure 2* show the first 2 PCs were similar for all subsets of data.

Discussion: PCA of DCE-MRI obtained from large patient cohorts can be used to obtain metrics that are analogous to PK parameters obtained through model fitting. The PC curve shapes (*Figure 2*) are consistent with and correlate with PK parameters. *Figure 2* shows the robustness of the method to changes in cohort (blue) and that any baseline bias (red and green) is similar in magnitude to random cohort selection. A benefit of analysing the data in this way is that the PCs retain there meaning across datasets. Previous methods of PCA applied to DCE-MRI Gd curves[4] have not aligned the data to onset. It would appear that aligning the data to onset, might identify metrics that are correlated to additional PK parameters.

[1]Orton MR et al 2009 Phys. Med. Biol. 54 2197 [2]Kety SS, Pharmacol. Rev 3 1-41 [3]Parker GJM, Magn Reson Med 56(5) 993-100 [4]Gwilliam et al 2011 Proc. ESMRMB

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