Image Derived Input Functions

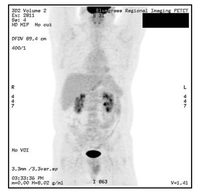
OVERALL AIM

To be able to quantify physiological processes in the body with Positron Emission Tomography (PET) without blood sampling by extracting a pure blood signal from the scan images.

FINE

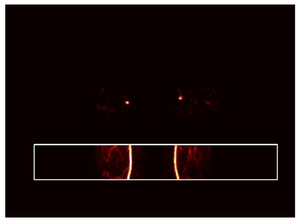
AIM

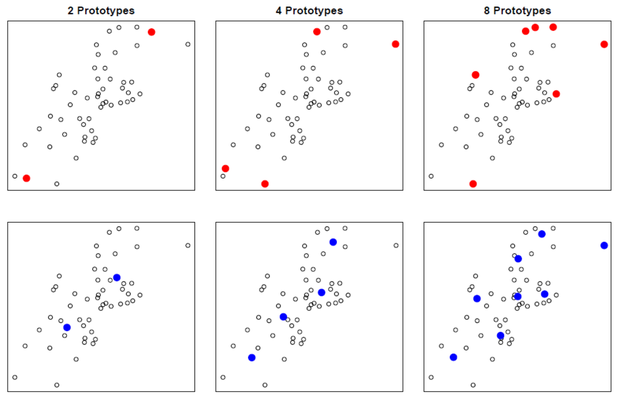
The Four-IN-onE project looks at metabolic and cultural health in moderately overweight young males. 24 PET scans with FDG with arterial bloodsampling were performed to determine the metabolic uptake rate of glucose in various tissues and to see if a method without arterial blood sampling could be developed.



METHOD

The arteries are quite clear in the early part of the scan where most of the activity is still in the blood. For automatic segmentation several algorithms have been proposed. Independant Componant Analysis (ICA), Non-negative Matrix Factorisation, K-means and Archetypal Analysis among others.

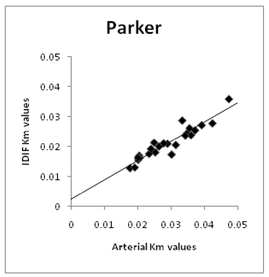




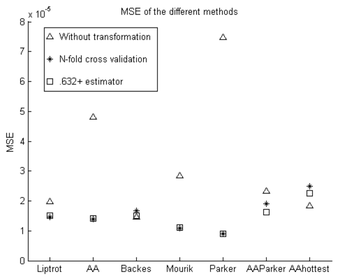
Due to the limited resolution of PET systems - around 5 mm FWHM in clinical scanners - a voxel will often contain signal from several different types of tissue. This should make Archetypal Analysis more sutable than K-means

RESULTS

The metbolic rate of glucose in the thigh muscle were calculated with both the image derived input function and the one obtained with arterial blood sampling. The image derived underestimated the metabolic rate for all methods. Method Parker shown here



Since there is a simple relation between the values determined with the two methods, the problem was turned into a calibration problem and using the slope and intersection from a linear regression to transform the data. N-fold crossvalidation and the .632-estimator was used to find the best method after transformation.

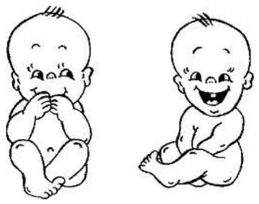


CONCLUSION

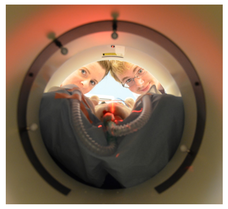
All tested methods for obtaining an image derived input-function yielded underestimated values for the metabolic rate. By applying a linear regression and transforming the data, an unbiased method with low variance was found.

Neonatal

AIM

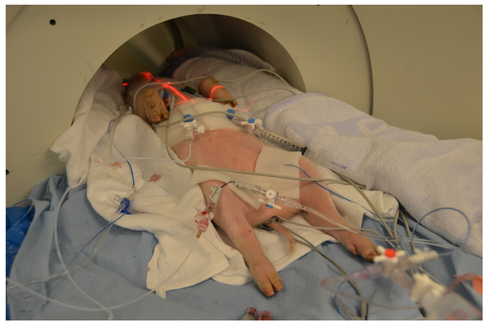


Currently no method exists for evaluation of prenatal and perinatal hypoxic brain damage. To rectify that a PhD-project were initiated aiming at using the HRRT, high resolution PET scanner, at Rigshospitalet to measure cerebral perfusion in newborns.
To validate the method I and MD Julie Bjerglund Andersen scanned 8 piglets in the HRRT and in a MRI-scanner to compare with perfusion measurements using an Arterial Spin Labelling (ASL) sequence. Microspheres were used as the gold standard.



METHOD

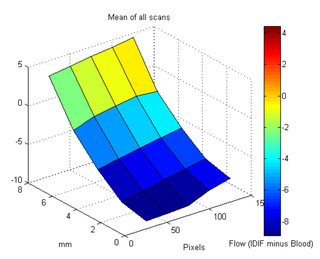
PET: Instead of taking arterial blood samples - which is not a reasonable option in neonates - the blood in the heart was used. Both piglets and neonates are small enough that they can be placed with both the heart and the brain in the scanner at the same time.

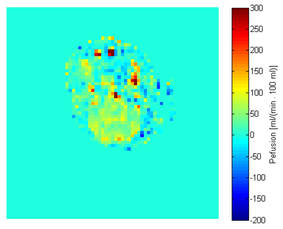


MRI: T1 and T2 weigthed scans were acquired for coregistration with PET for anatomical information. The ASL-sequence Q2TIPS were used to measure perfusion.

RESULTS

The heart can be used to generate an image derived input function. When comparing the image derived input function to the blood sampled by looking at whole brain perfusion we get 0.3927±5.103 [ml/(min 100ml) ±STD]. I.e. approximately unbiased and with reasonable variance.





The ASL results looks promising with values within a physiologically reasonable range, but the final quantification with microspheres has yet to be done.

CONCLUSION

The right ventricle can be used to generate an input function in piglets yielding approximately unbiased perfusion values with reasonable variance. ASL looks promising with physiologically reasonable perfusion values.

FUTURE STUDIES

Simultaneous Estimation a possible candidate for a method that would work in general

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