

HRRT and Advance scanner comparison using a steady-state scan approach

Svarer C, Marnier L, Madsen K, Keller SH¹, Haahr M, Sibomana M¹, and Knudsen GM

Neurobiology Research Unit, and ¹PET center, Rigshospitalet, Copenhagen University Hospital, Denmark

Objectives

With the Siemens HRRT scanner, it is possible to acquire PET images with a higher resolution (< 2mm) than with the clinical GE Advance scanner. For many purposes, it is essential that the acquired HRRT images is quantitatively correct. A bolus-infusion approach is optimal for examination of this as both scans can be performed under steady-state conditions.

We further examined if the voxel based method for correction for partial volume effects (PVE) (Mueller-Gartner, 1990) yielded Advance images more similar to the HRRT images.

Methods

In four healthy volunteers, 5HT-2A receptor distribution images of the brain were obtained using a bolus-infusion scheme of ¹⁸F-altanserin, that generate tracer steady-state levels in brain and plasma (Pinborg, 2003). Two hours before scan start a bolus corresponding to 1.75 hours of constant infusion was given. The constant infusion of tracer was continued during scanning sessions. Three subjects were first scanned 40 min with the Advance scanner and then 30 min with the HRRT scanner. The order was reverted for the last subject.

The HRRT images were reconstructed using the new iterative PSF reconstruction (Sureau, 2008) with attenuation map improvements whereas the Advance images were reconstructed using a traditional FBP algorithm. A Gaussian filter with a FWHM of 6 mm was used to match HRRT images to Advance image resolution. The images acquired at the two scanners and the resolution matched HRRT image are illustrated in figure 1.

Volumes of interests (VOI's) were delineated using the method described in Svarer, 2005. These VOI's were used for extraction of mean regional values.

In figure 2 the mean regional values for the neocortical, subcortical and cerebellum regions are shown. Each of the scans have been split into five frames, 5x8 minute for the Advance scan and 5x6 minute for the resolution matched HRRT scan. Further, the neo- and subcortical (C_{roi}) concentrations minus cerebellum (C_{ref}) concentration are shown. The binding potential BP_p is proportional to this as it can be calculated as:

$$BP_p = \frac{C_{roi} - C_{ref}}{C_p}$$

where plasma concentration C_p is kept constant during both scan sessions.

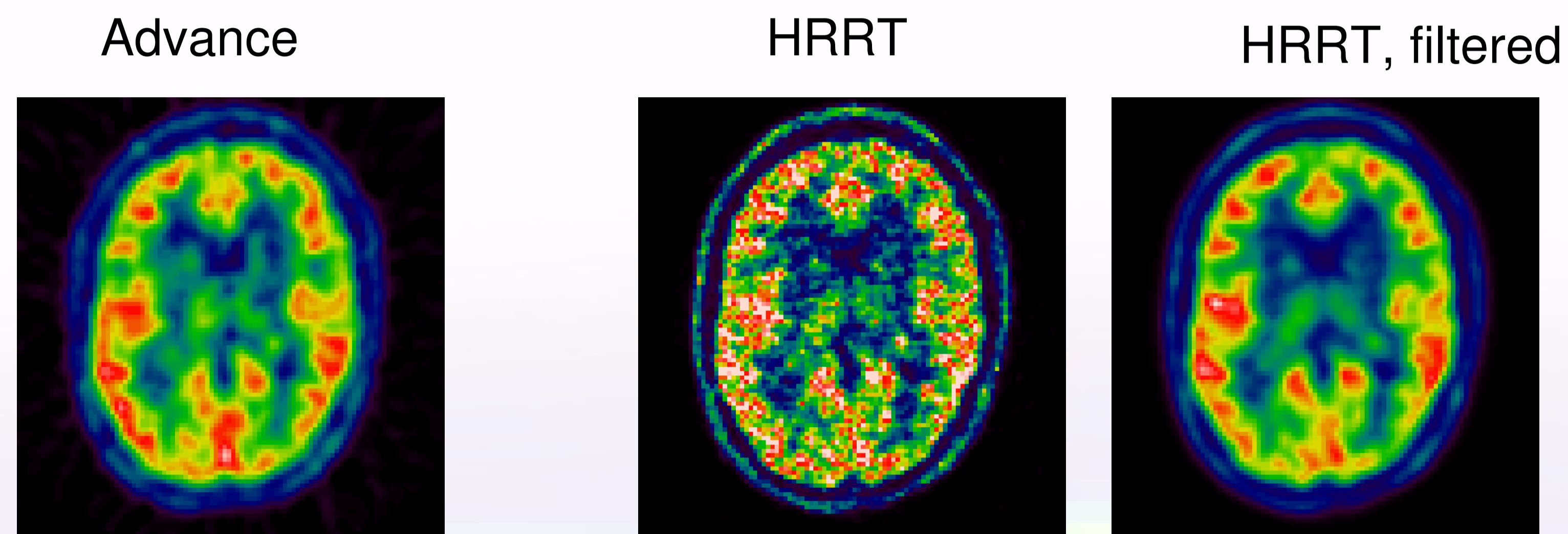


Figure 1: PET scan performed using the Altanserin tracer, showing the distribution of the 5HT-2A serotonin receptors in the brain. At the left an image from the GE Advance scanner, in the middle the same image slice from the Siemens HRRT scanner, and at the right the HRRT image filtered with a Gaussian filter (PSF- 6x6x6 mm).

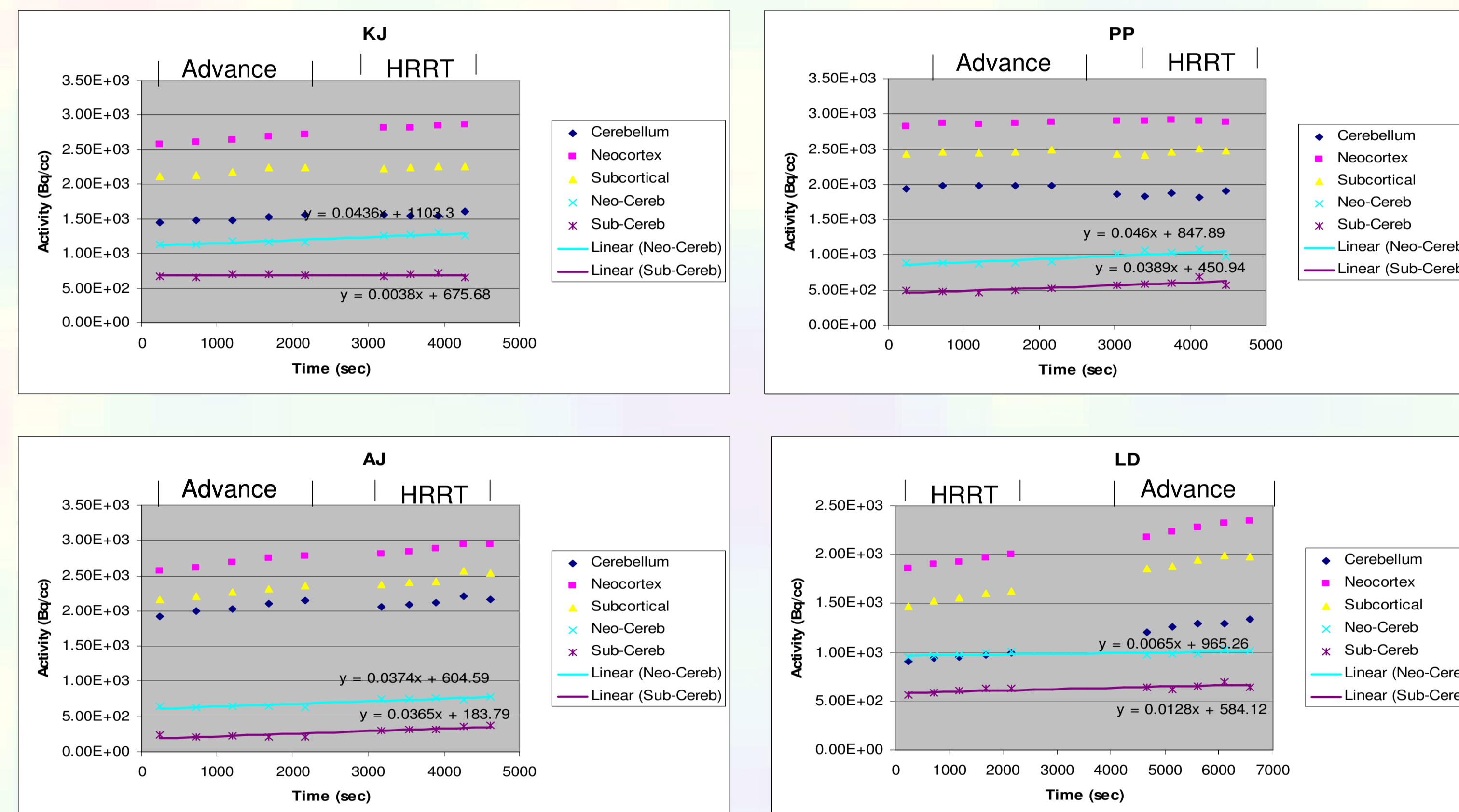


Figure 2: Time activity curves from three brain regions (neo-, subcortical and cerebellum=non-specific binding) and the specifically bound activity ($C_{roi}-C_{ref}$) in the neo- and subcortical regions. The resolution in the HRRT image has been matched to the resolution in the Advance image.

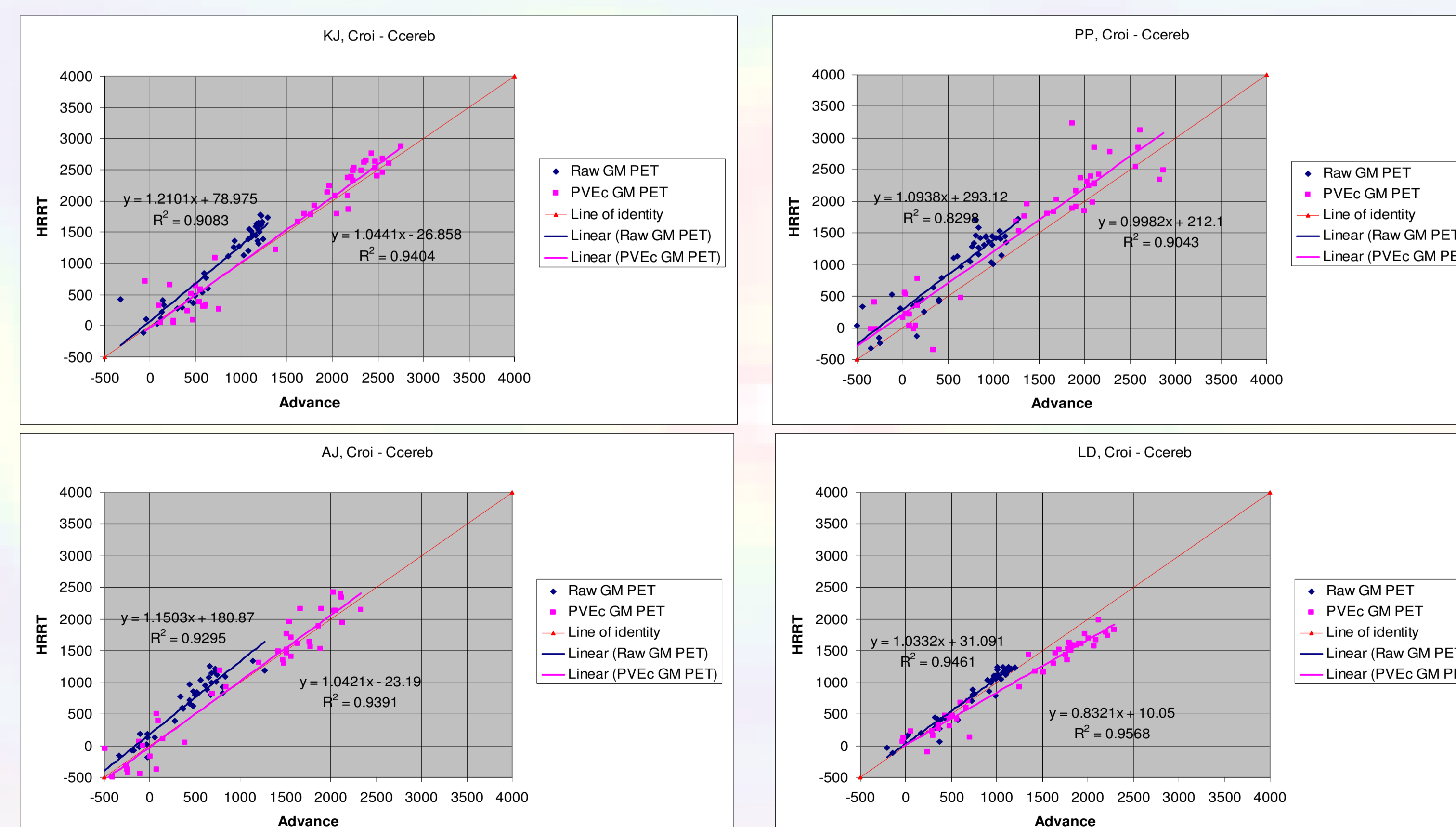


Figure 3: Scatter plot showing specific bound ($C_{roi}-C_{ref}$) regional values (45 regions, Svarer 2005) extracted from PVE corrected images. The Advance scanner images have been corrected using the Mueller-Gartner method with a PSF 6x6x6 mm and HRRT images with a PSF of 3x3x3 mm.

In figure 3 scatter plots of the Advance (X axis) and HRRT (Y axis) regional values (only gray matter voxels included) are shown and the slope of a fitted line for the four subjects is identified. Further, the acquired scans were corrected for partial volume effects using the (Mueller-Gartner, 1990) method (PSF 6 mm for Advance, PSF 3 mm for HRRT) and scatter plots were generated.

Results

Figure 2 shows that the slope of the line proportional to BP_p for the neocortical region is 0.033 ± 0.018 and for the subcortical region it is 0.023 ± 0.017 . In both cases the slope is significantly different from zero which means that last scan has higher binding potential than the first scan. This suggests a systematic difference between Advance and HRRT scans, except that this was also the case when the scans were acquired in the opposite order. We will further examine the reason for this difference.

The slope of the line fitted for the scatter plot (figure 3) for the Advance and HRRT images is 1.12 ± 0.08 . As expected the mean regional values extracted from the HRRT scans are higher than the ones extracted from Advance scans due to better contrast between high and low binding tissue in the brain. When correcting the scans for PVE using Muller-Gartner's method the slope of the line is 0.98 ± 0.10 which is very close to and not statistical different from the expected value of 1.

Conclusions

Using this very stable bolus-infusion approach, it is possible to very precisely compare human brain images acquired with the HRRT and Advance scanner.

Filtering the HRRT scan to Advance scan resolution yields same specific binding with the Advance and HRRT scanners, both in the neo- and subcortical regions. The same is the case when comparing 45 PVE corrected values from various brain regions.

It is concluded that comparable results can be achieved when the HRRT scanner is used for measuring binding in the brain. Further, it is demonstrated that the HRRT images have a higher contrast between high and low binding areas in the brain than images acquired at a traditional clinical PET scanner, such as the Advance scanner.

References

- H. W. Muller Gartner, et al., J Cereb Blood Flow Metab 12 (4):571-83, 1992.
- L. H. Pinborg, et al., J Cereb Blood Flow Metab 23 (8):985-96, 2003.
- F. C. Sureau, et al., J.Nucl.Med. 49 (6):1000-1008, 2008.
- Svarer C, et al., NeuroImage 24(4):969-79 (2005)

Acknowledgements

The Lundbeck Foundation and the EU 7th framework program Euripides are acknowledged for financial support. The John and Birthe Meyer Foundation is thanked for donation of the Cyclotron and PET scanners.