Influence of the resolution mode on mean and maximum SUV of a preclinical PET image

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1. Introduction

In PET (positron emission tomography), SUV (standardized uptake value) is a robust quantifier used to analyze PET images, including preclinical PET images. In preclinical PET, SUV can be defined as a ratio of tissue radioactivity concentration (kBq/mL) and administered dose divided by animal body weight (kBq/g). The literature shows that several factors – biological or technical – can affect SUV determination. Among technical factors it's possible to cite the reconstruction protocols of PET images.

The objective of this work was to evaluate the influence on mean and maximum SUVs of two resolution modes – standard and high – in a reconstruction protocol with MLEM-3D algorithm and 20 iterations.

2. Methodology

From a ^{18}F-FDG-PET image bank – technical collection of the Molecular Imaging Laboratory (LIM)/CDTN – an image of a mouse with a tumor implanted in left flank was selected. The acquisition file was reconstructed with two different protocols, one using standard resolution (SR) and other using high resolution (HR). Table I shows the protocols used in this study.

Table I: PET Image reconstruction protocols.

Algorithm	Resolution Mode	Number of Iterations
MLEM-3D	Standard	20
	High	

To determine SUV_{mean} and SUV_{max}, Eq. 1 was used:

$$SUV_{mean/max} = \frac{Mean\ or\ max.\ activity\ concentration\ in\ volume\ of\ interest\ \left(\frac{kBq}{mL}\right)}{\left(\frac{Injected\ activity\ (kBq)}{Body\ weight\ (g)}\right)} \quad (1)$$

After reconstruction, the post-processing of images was performed using AMIDE software and the volumes of interest (VOIs) were defined. These VOIs are shown in Table II.

Table II: Volumes of interest.

Organ/Tissue	Geometric Form	Volume (mm^3)
Bone	Cylinder	4.74
Brain	Ellipsoid	14.13
Cardiac Muscle	Ellipsoid	0.52
Harder Gland	Ellipsoid	1.76
Heart	Ellipsoid	65.41
Muscle (Right Flank)	Ellipsoid	4.19
Tumor (Left Flank)	Ellipsoid	4.20
Urinary Bladder	Ellipsoid	14.10

Last step consisted in results comparative analysis and determination of the protocol influence in SUV_{mean} and SUV_{max}.

3. Results and Discussion

Fig. 1 shows the images obtained using different reconstructions protocols. Qualitatively, it is possible to see light improvement in tissue/structures definition in HR image when compared to SR image.

Figure 1: MLEM-3D, 20 iterations, reconstructed mouse images. Tumor in left flank.

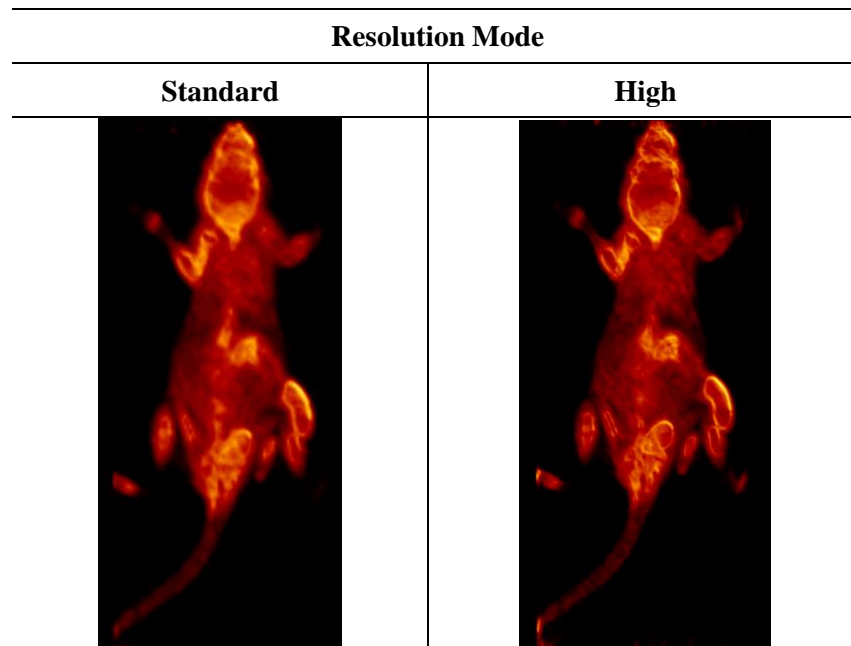| Resolution Mode	
Standard	**High**

Fig. 2 and Fig. 3 show, respectively, mean SUV and maximum SUV obtained for the analyzed tissue for both protocols.
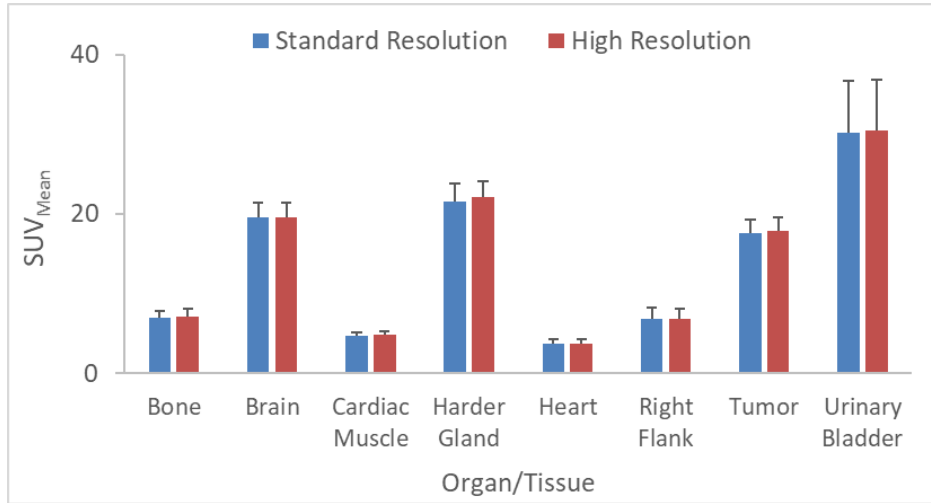
Figure 2: Mean SUVs for standard and high-resolution image reconstruction protocols.
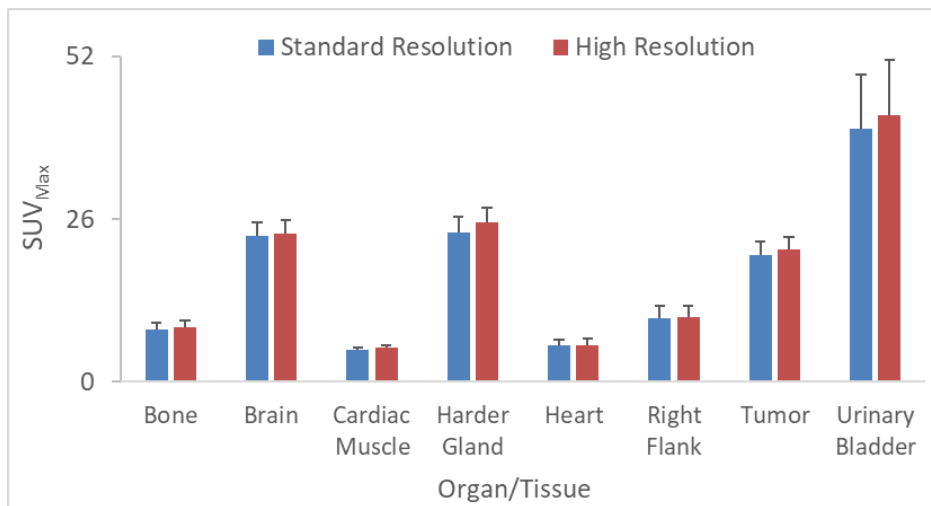

Figure 3: Maximum SUVs for standard and high-resolution image reconstruction protocols.

The results for target (tumor)/non-target (right flank) tissue comparison are presented in Table III. The use of high resolution mode did not improve significantly recuperation in both cases (SUV_{mean} and SUV_{max}).

Table III: Target (tumor)/non-target (right flank) comparison.

SUV	$R = SUV_{tumor}/SUV_{right\ flank}$		
	Standard Resolution	**High Resolution**	**Difference* (%)**
Mean	2.58	2.61	1.35
Maximum	2.00	2.05	2.39

* Calculated by: $\dfrac{HighResol\_R - StandardResol\_R}{Standard\ Resolution\ Ratio} \times 100$

The relation between SUV_{max} and SUV_{mean} for the analyzed organs/tissues are presented in Table IV.

Table IV: Ratio SUV$_{max}$/SUV$_{mean}$ using different image reconstrution protocols.

Organ/Tissue	R =SUV$_{max}$/SUV$_{mean}$		
	Standard Resolution	High Resolution	Difference (%)*
Bone	1.20	1.23	2.03
Brain	1.19	1.21	1.21
Cardiac Muscle	1.09	1.11	1.78
Harder Gland	1.11	1.15	3.90
Heart	1.55	1.60	3.18
Right Flank	1.49	1.52	1.68
Tumor (Left Flank)	1.16	1.19	2.72
Urinary Bladder	1.34	1.39	4.44

* Calculated by: $\dfrac{HighResol\_R - StandardResol\_R}{Standard\ Resolution\ Ratio} \times 100$

4. Conclusions

In general, at the semiquantitative analysis, image reconstruction protocols using high resolution mode did not improve significantly the recuperation of radiopharmaceutical uptake into analyzed tissues.

Acknowledgements

References

[1] C. J. Jaskowiak, J. A. Bianco, S. B. Perlman, J. P. Fine, "Influence of Reconstruction Iterations on 18F-FDG PET/CT Standardized Uptake Values", *Journal of Nuclear Medicine*, vol. 46, pp. 424–428 (2005).

[2] J. A. Thie, B. Shore, "Understanding the Standardized Uptake Value, Its Methods, and Implications for Usage", *Journal of Nuclear Medicine*, vol. 45, n. 9, pp. 1431–1434 (2004).

[3] L. T. Tan, K. L. Ong, "Semi-quantitative Measurements of Normal Organs with Variable Metabolic Activity on FDG PET imaging", *Ann Acad Med Singapore*, vol. 33, pp. 183–185 (2011).

[4] M. C. Adams, T. G. Turkington, J. M. Wilson, T. Z. Wong, "A Systematic Review of the Factors Affecting Accuracy of SUV Measurements", *American Journal of Roentgenology*, vol. 195, n. 2, pp. 310–320 (2010).

[5] R. M. G. Gontijo, A. V. Ferreira, G. C. A. Souza, B. M. Mendes, J. B. Silva, M. Mamede, "Image quality evaluation of a small animal PET scanner", *Brazilian Journal of Radiation Sciences*, vol. 08-02, pp. 01–13 (2020).