Electron Absorbed Fractions and S Values in a Mouse Voxel Phantom

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For preclinical assessments of radiopharmaceuticals, electron absorbed fractions (AFs), the fraction of energy emitted by a radiation source that is absorbed within the target organ, were evaluated in a mouse voxel phantom. In this study, Digimouse voxel phantom was converted to an input file for EGS4 code, in conjunction with an EGS4 user code, UCSAF. The sources were assumed to be mono-energetic and distributed uniformly in the major organs with isotropic emission. The AFs were evaluated in the Digimouse for the major organs. Figure 1(a) shows electron AFs for organ self-absorption (source = target) in heart and stomach, and Figure 1(b) shows electron AFs for organ cross-fire (source ≠ target) in skin, lungs and liver of the Digimouse while source was in heart.

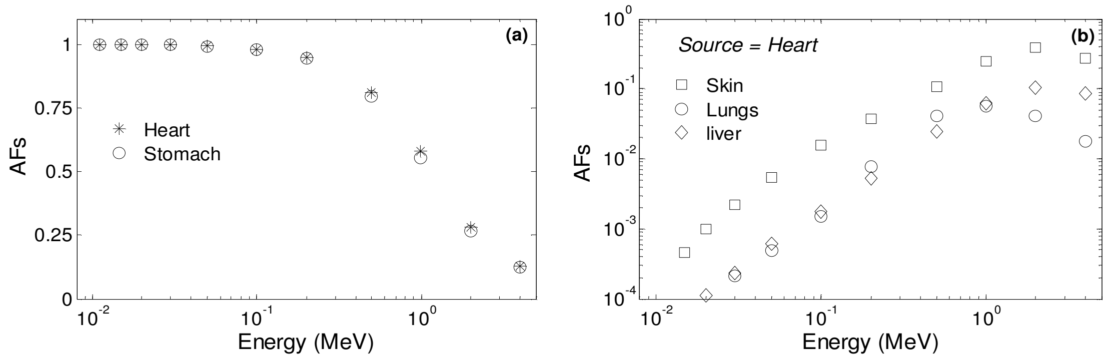

Figure 1 Electron AFs in some organs of the Digimouse phantom, for organ (a) self-absorption and (b) cross-fire.

From the figures, it can be seen that AFs in heart and stomach (source organs) depends on the electron energy (or electron range) and it is certainly not always appropriate in the mouse to assume a 100% localized electron energy absorption (the standard MIRD assumption model for human) unless for low energy electrons where the electron range is very smaller than the organ dimensions. Comparison of AFs in heart and stomach, the organs with the same masses, also confirmed the mass dependency of AFs for self-absorption. AFs for organ cross-fire depend on electron energy and source/targets geometry including source/targets shape, size and distance.

S values, dose per unit cumulated activity (Gy/Bq.s), were calculated in the major organs of the Digimouse phantom using the results of the photon and electron AFs for ^{131}I, ^{153}Sm, ^{188}Re, ^{90}Y and ^{111}In. Figure 2 (a) and (b) compare S values for self-absorption and cross-fire for the five radionuclides with Bitar *et al.* and Stabin *et al.* results which were obtained in two different mouse voxel phantoms using Monte Carlo method.

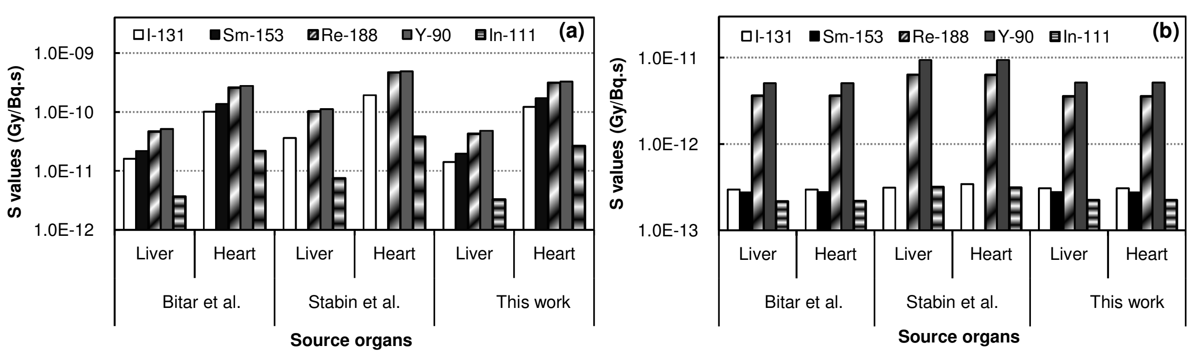

Figure 2 Comparison of S values (Gy/Bq.s) for five radionuclides in the Digimouse liver and heart with those of Bitar *et al.* and Stabin *et al.* studies. S values for organ (a) self-absorption and (b) cross-fire.

Differences between S values in this study and those in Bitar et al. study are insignificant however the differences are huge between the later studies and Stabin *et al.* results.

In this study, a set of electron AFs and S values were tabulated for the Digimouse phantom. From the results, energy and mass dependency of electron AFs were confirmed for organ self-absorption and cross-fire although AFs for organ cross-fire was dependent upon geometry of source and target organs. The results showed that organ dose evaluation should be performed in the sophisticated phantom with the Monte Carlo method since comparison of S values between this study and Bitar *et al.* studies in different mouse voxel phantoms confirmed the accuracy of the method.