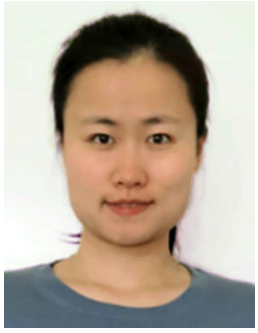

Cross-validation log-likelihood regularization strength optimization in penalized likelihood reconstructions for total-body and conventional PET

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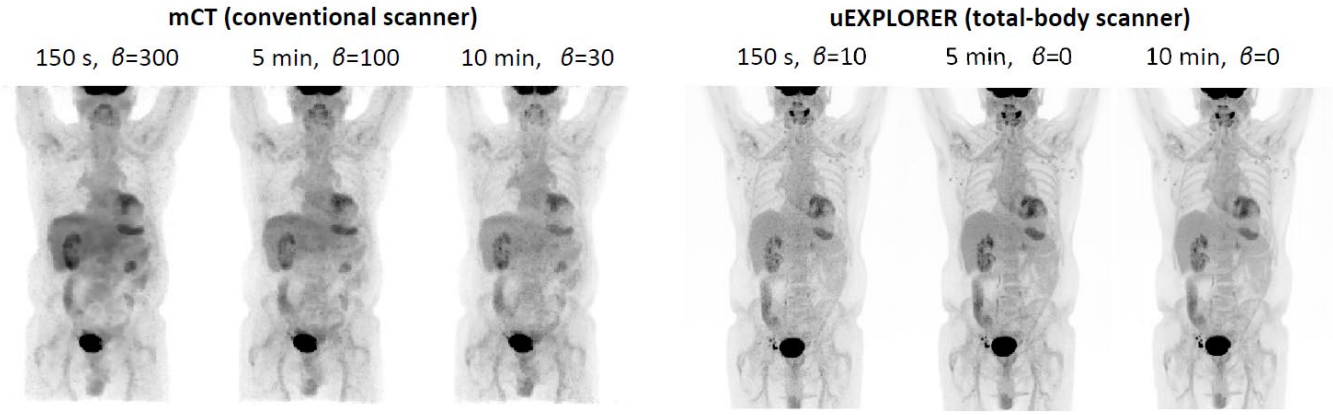
Introduction: The penalized likelihood (PL) reconstruction is a widely used PET image reconstruction algorithm particularly effective for low count-density data. However, its regularization strength is typically chosen empirically. To select the optimal regularization strength, a cross-validation log-likelihood (CVLL) method was proposed by maximizing a CVLL function. Methods: The CVLL function is the likelihood function of the images reconstructed using one subset of a list-mode dataset, based on another subset of the same dataset. This study compares the CVLL method in conventional and total-body PET imaging with contrast-to-noise (CNR) measures. A human subject with lung cancer was injected with ~213 MBq [^{18}F]FDG and scanned for 22 min starting at 60 min with a total-body PET/CT scanner and at 90 min with a conventional PET/CT scanner. An in-house list-mode ordered subset expectation maximization algorithm with a CVLL method module integrated was used for image reconstruction. The same attenuation, random, and deadtime correction methods were used for the two scanners, except for the scatter correction method.

Discussion: The optimal regularization strengths that maximize the CNRs were not perfectly consistent with those determined by the CVLL method. There is potential for both the CVLL and CNR methods to work jointly to select the optimal regularization strength that well balances image resolution and noise.

Conclusion: The CVLL method will facilitate our exploration of the limits of injected activity and scan time, and can be used to guide image reconstruction under different circumstances. We will further validate the CVLL method in total-body and conventional PET imaging of different cancer patients.



Maximum intensity projections of the in-house reconstructed human (lung cancer patient) images of different scan durations (150 s, 5 min and 10 min), using the optimal regularization strengths β for the mCT and uEXPLORER, respectively.