

Purpose: Selective internal radiation therapy (SIRT) of liver metastases and hepatocellular carcinoma with radiolabeled microspheres has become a viable treatment modality in recent years. This technique uses the high-energy, pure beta-emitting radioisotope of yttrium-90 (Y-90) embedded in a glass or resin microsphere which is infused into the liver via the hepatic artery. However, direct imaging the post-infusion distribution of Y-90 SIRT has been a long standing problem due to the lack of any gamma emission. Recently, however, a low-yield branch of Y-90 decaying by internal pair-production was used to perform direct PET/CT coincidence imaging. With only a few publications summarizing preliminary clinical results, we have designed a quantitative phantom analysis allowing for a detailed and portable image quality and quantitation evaluation of this new imaging technique.

Methods: Owing to its wide availability, the Jaszczak PET imaging phantom is an ideal choice for Y-90 PET/CT imaging evaluation with a few minor modifications. As the Jaszczak phantom is water filled, a major difficulty is the fast settling of the microspheres, which stay in uniform suspension for less than one minute. An aqueous linear polymer ($\text{CH}_2\text{CHCONH}_2$) can be used to produce a uniform suspension of Y-90 microspheres which lasts for several days. Additionally, a 0.4mm inner-diameter capillary tube was also filled with Y-90 and placed in the Jaszczak phantom, with no modification, to provide a quantitative resolution evaluation .

Results: The modified Jaszczak phantom was scanned on a prototype Siemens molecular CT through a research agreement with Siemens medical. Results gave a good indication of the accuracy in quantitation expected as well as image quality improvement over post-infusion bremsstrahlung SPECT that we may see when we begin Y-90 post-infusion PET/CT patient imaging.

Conclusion: The proposed modifications to the Jaszczak phantom allow for accurate, portable evaluation of a PET/CT system for quantitative Y-90 imaging.