AbstractID: 12998 Title: Low dose-rate prostate bracytherapy dosimetry using quantitative SPECT imaging and three-dimensional discrete Fourier transform convolution dose calculation algorithm

Purpose: Single photon emission tomography (SPECT) was used to measure the distribution of radioactivity and obtain quantitative air-kerma strength (AKS) of the seeds implanted in low-dose rate prostate brachytherapy. A fast 3D discrete Fourier-transform convolution algorithm that uses quantitative SPECT numbers was developed to calculate internal dose in prostatic gland and surrounding critical structures.

Methods and Materials: Four prostate brachytherapy patients were imaged with SPECT after seed implantation. SPECT numbers from reconstructed axial slices were used to measure quantitatively AKS of the implanted seeds. A new dose calculation algorithm based on a fast Fourier-transform convolution was developed. It convolves the AKS distribution measured by quantitative SPECT numbers with a dose distribution kernel of an ^{125}I point source using the AAPM Task Group 43 formalism. Dose distribution calculated with this technique was benchmarked with dose calculated using the VariSeed treatment planning system on CT and ultrasound.

Results: The dose difference calculated on SPECT and CT can be up to 80% locally over small areas, and the distance-to-agreement between isodose lines 150%, 100%, and 50% are within 5 mm. The isodose line 150% breaks similarly around urethra on SPECT and CT studies. Several factors might contribute to the discrepancies between this convolution algorithm and Variseed. These include variation in prostate volume due to edema after seed implantation, variation in AKS between the individual seeds, seed alignment and AKS distribution, seed-to-seed photon attenuation, heterogeneities such as calcification in the prostatic gland.

Conclusions: Prostate brachytherapy lacks techniques of direct measurement and verification of the AKS and associated dose from the implanted seeds. This technique employs SPECT number to measure directly AKS from implanted seeds which may provide useful quality assurance tools for prostate brachytherapy. Errors in dose calculation by seed-based treatment planning systems may be corrected by considering dose calculation with SPECT numbers.