

Comparing Apples to Apples: Fusion of Preplan Ultrasound Structures and Postimplant CT Images for Prostate Brachytherapy Dosimetry

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PURPOSE: Accuracy of target volumes and dose volume histograms derived from postimplant CT scans has been questioned in the literature. We describe a technique that addresses these issues by fusing target structures from the preplan ultrasound volume study onto the postimplant CT scan.

MATERIALS AND METHODS: Study set consisted of ten consecutive patients with stage I-II adenocarcinoma of the prostate treated with I125 implant (8 primary and 2 boost) without androgen ablation. Each patient underwent a preplan ultrasound volume study with cross sectional images taken at 5mm intervals; the target (prostate), planning margin and urethra were defined by the physician. Postimplant CT scans (5mm slice increment, 3-5mm thickness, no contrast, no catheter) were obtained 4 weeks after implant to allow for resolution of edema. The US structures and CT images were loaded onto a commercially available treatment planning system (Strata by Rosses Medical).

Target volumes were established by two methods for each patient: 1) fusion software superimposing target structures from the ultrasound volume study onto the postimplant CT scan – referred to as fusion target (note – the fusion target volume exactly matched the preplan US target volume) and 2) experienced physician drawing target freehand onto CT scans – referred to as freehand target. US structure/CT fusion, established by software on the planning system, used co-registration of a mid posterior point of the prostate base and apex as defined by the physician on both the US volume and postimplant CT images. If necessary, individual structures could then be dragged or translated to ensure proper alignment. Fusion target was compared to freehand target in terms of target volume, D90, V100, V150.

RESULTS: Ratio of fusion target volume to freehand target volume ranged from 0.76 to 1.58 with a mean of 1.162 and median of 1.14. Ratio of D90 values obtained from fusion target volume/freehand target volume ranged from 0.84 to 1.02, mean 0.977, median 0.99. V100 ratios ranged from 0.93 to 1.05, mean 1.002, median 1.0. V150 ratios ranged from 1.01 to 1.4, mean of 1.10, median of 1.06.

CONCLUSION: Fusion of preplan US volume study structures onto the postimplant CT scan is a relatively simple method that addresses the issues of subjectivity and inaccuracy inherent in freehand CT target definition. In this small study, there was as much as a 58% difference in target volume, a 16% difference in the D90 and a 40% difference in the V150 between the fusion target and the freehand target. US target/CT fusion may represent a way to standardize postimplant target volumes and enable better comparison of DVH's from one institution to another. Utilizing this method, one compares apples to apples – the postimplant target volume is always the same as the planned target volume. This is a reasonable assumption based on the timing of postimplant CT scans in this study (4 weeks post implant) and the temporal resolution of edema reported in the literature. More importantly, the fusion target is consistent and reproducible for each patient. This method does not add extra cost or inconvenience to the patient (such as obtaining an MRI) and is applicable to any institution that utilizes US volume study and obtains postimplant CT scans. Furthermore, this type of fusion allows for dose analysis of any volume outlined on the preplan US – ie. one can determine the DVH to not only the target but also to the planning target (prostate + margin) or TURP defect. This method also allows for determination of dose to the urethra without the need to place a catheter in the patient at the time of the post volume CT scan.