

Applicator Heterogeneity Effect in Gynecologic HDR Treatments: A Monte Carlo Study

Purpose: To physically model the presence of CT/MR-compatible vaginal applicators in HDR dose calculations and accurately quantify the heterogeneity effects on main DVH parameters (D90, D100, V100, and V150).

Material and Methods: HDRMC is an accelerated Monte Carlo dose calculation engine for HDR planning/evaluation. It accounts for tissue and non-tissue heterogeneities. HDRMC was benchmarked against commercial TPS (under the assumption of infinite water medium) and used to re-calculate real patient GYN HDR plans (Chibani and Ma, Med. Phys. 41(5), 2014). In the present study, the dosimetric effects of vaginal applicators with diameters ranging between 20 and 40 mm are investigated. Polyphenylsulfone (PPSU) applicators with 1.29-g/cc density are used. Dose distributions (2-mm voxel grid) are calculated for three models: (1) PPSU applicator surrounded by soft tissue (ICRP46 definition), (2) homogeneous tissue medium, and (3) homogenous water medium. Ten dwell positions are used for each plan

Results: Model 1 (PPSU applicator in tissue) leads to 3% D90 decreases in comparison with Model 3 (homogeneous water) for the 40-mm cylinder. The use of water instead of tissue accounts for about 1% difference. For the 20-mm applicator D90 and D100 differences are smaller (~2%). Accounting for applicator heterogeneity and tissue composition leads to more significant differences in comparison with TPS homogeneous water assumption for V100 (up to 8%) and V150 (up to 28%). See attached data.

Conclusions: The account for applicator heterogeneity and tissue composition for vaginal cylindrical applicators has a rather small effect on D90 and D100 but can lead to significant decrease of V100 and V150.

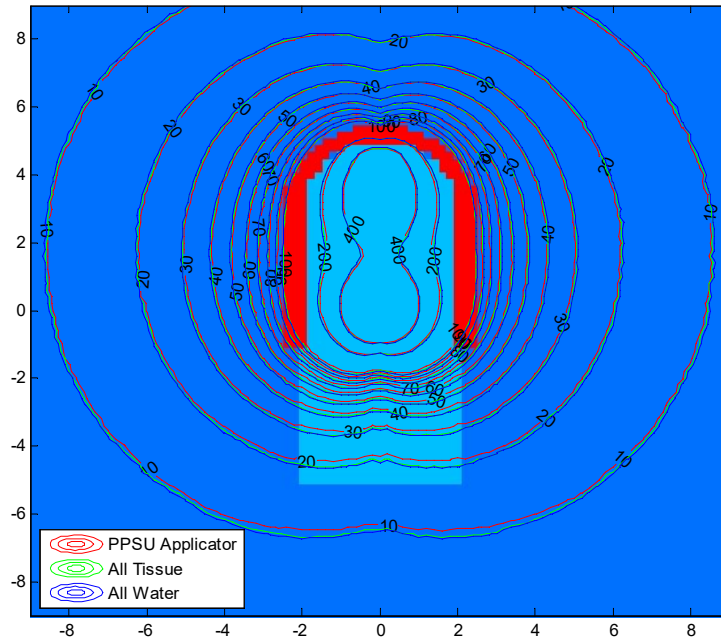
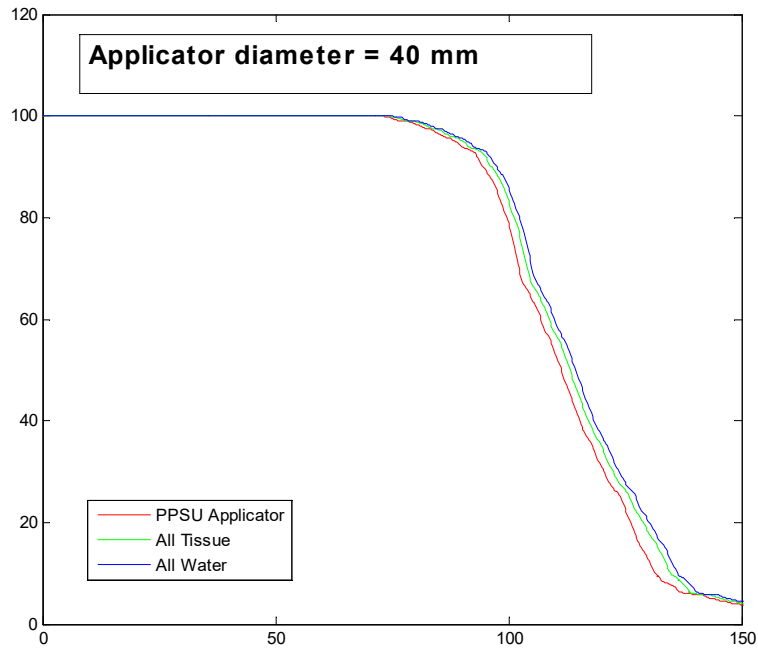


Table I: Percent differences between 3 calculation models (1: PPSU applicator in tissue, 2: Homogenous tissue, 3: Homogeneous water) for D90, D100, V100, and V150 DVH parameters for three applicator sizes.

	40-mm Applicator		30-mm Applicator		20-mm Applicator	
	Model 1 vs. 2	Model 1 vs. 3	Model 1 vs. 2	Model 1 vs. 3	Model 1 vs. 2	Model 1 vs.3
D90	-1.92	-2.97	-1.29	-2.35	-1.10	-2.11
D100	-1.67	-2.98	-1.34	-2.39	-0.42	-1.66
V100	-5.33	-8.29	-1.46	-1.86	0.93	-2.72
V150	-7.20	-17.0	-14.9	-28.8	-6.06	-10.4