PTV to Skin Proximity for Head and Neck IMRT Treatment Planning

Figure 1a-c illustrates TPS overestimation, accurate prediction, and underestimation as a function of PTV to skin proximity for calculation voxel sizes of 3, 2, and 1mm³, respectively. It seems intuitive that smaller voxel sizes would result in more favorable comparisons of surface dose since the larger voxels encompass greater volumes through the dose gradient near the surface and the average value subsequently determined, results in over-estimation as compared to measured surface values. However, as can be seen in figure 2a, dose is calculated outside the phantom for approximately 2 voxels. Furthermore, the slope of the dose gradient outside the phantom is steepest for the smallest calculation voxel size. The smaller the voxel size the greater the chance that significant portions of a voxel in the surface region may lie outside the phantom surface and the dose averaged over the voxel volume being dominated by dose outside the phantom. This is further complicated by the fact that the TLDs measuring 3mm on a side, may stretch across more than one voxel (figure 2b) but the resultant values are compared with point doses.

Plan conformality (figure 3a) and “hot spot” (figure 3b), improve as the PTV is moved away from the skin surface. For the clinically relevant grid sizes (1, 2 and 3mm³) it appears that a CI of unity is reached at a PTV-to-skin distance between 4 and 4.5mm and hot spot falls below 110%. While all plans were normalized such that a minimum of 95% of the PTV receives the prescription dose, it can be seen from the DVH in figure 3c that target underdosage depicted by the pronounced shoulder, is progressively greater as the PTV approaches the skin. From the inset images it can be seen that the axial distance from the surface to the prescription isodose line is approximately 7.4, 5.9, 5.1, 3.9 and 3.8mm for PTV-to-skin distances of 5, 3, 2, 1 and 0mm, respectively. All plans represented in the figures 3a-c were generated using a 2mm³ calculation grid. The above results appear to hold for VMAT. In the interest of plan quality and accuracy the authors would recommend the routine use of a 4-5mm PTV-to-skin distance for IMRT and VMAT treatment planning. Using a 2mm³ dose calculation grid results in a CI of approximately 1.01 and a “hot spot” of approximately 110% for this TPS. Additionally, the shoulder of the target DVH is minimized resulting in a higher minimum dose. For patients requiring a PTV-to-skin distance less than this value, a 5 mm thick bolus should be constructed prior to CT acquisition.