Intraprostatic calcifications as IGRT fiducial markers: analysis of 646 CBCT images in 35 patients

Purpose or Objective: To review CBCT images of 35 pts receiving radical irradiation for localized prostate cancer, according to an IGRT protocol based on the use of intraprostatic calcifications as natural fiducial markers for the evaluation of inter-fraction organ motion.

Material and Methods: Between 2013 and 2014, 646 KV CBCT images of 35 pts radically irradiated with moderately hypofractionated VMAT (2.5 Gy/fraction × 70 Gy in 28 fractions) for localized prostate cancer were acquired according to an IGRT protocol aimed at evaluating the role of intraprostatic calcifications as natural fiducial markers. All the evaluated pts presented at least 3 calcifications >2 mm located inside or at the borders of the CTV and contoured on high resolution CT-simulation scans and on each CBCT (mean: 18 CBCT/patient). In order to assess the internal stability of the calcifications the distances between them were measured for each patient on both CT-simulation scans and each CBCT, then mean ± SD of differences between distances was calculated. Distances between calcifications and the center of mass of CTV were also calculated in 21 patients by drawing CTV on 360 CBCT images, contoured by a same physician. The center of CTV mass spatial coordinates (X, Y, Z) was determined for each CTV and finally the distances between calcifications the distances between them were measured. Stability of calcifications in respect of CTV was assessed by calculating mean values ± SD of measured distances.

Results: The mean value of differences in distances between calcifications was -0.04 mm ± 1.54 SD, with 95% of values contained inside 3 mm (μ ± 2SD). The mean value of differences in distances between calcifications and center of mass of CTV (Fig. 1) was -0.03 mm ± 1.55 SD, with 95% of values contained inside 3 mm (μ ± 2SD).

Conclusion: Our results derived from the analysis of a large data set of CBCT images confirm that intraprostatic calcifications, when >2 mm and present at least Nc=3, properly selected and contoured, can be used as very reliable natural fiducials, with potential reduction of iatrogenic risks and costs associated with the implantation of fiducial markers for prostate cancer IGRT.