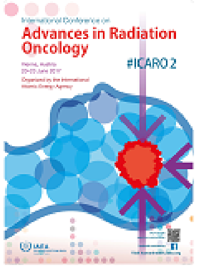

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Treatment plan stability to geometric uncertainties. PTV and CTV related dose-volume statistics comparison for 3D CRT, IMRT and VMAT irradiation of the «average» prostate patient in N.N. Alexandrov National Cancer Centre of Belarus.

Thursday, June 22, 2017 3:45 PM (5 minutes)

Aim or Objective: To quantify the impact of geometrical uncertainties in patient position during prostate cancer irradiation on the PTV and CTV related dose-volume statistics and to analyze the results obtained for the 3D CRT, IMRT and VMAT techniques.

Methodology: For our study, we analyzed 220 treatment plans of the prostate cancer patients that were treated in the N.N. Alexandrov National Cancer Centre of Belarus last year. We have identified anatomical parameters influencing the dose distribution and identified representative («average») patient with these parameters, the most appropriate medium to their values in the sample: BODY height- 237,8 mm; BODY width - 364,5 mm; CTV - 338,2 cm3; prostate volume - 123,6 cm3; rectum volume - 75,7 cm3. The experienced medical physicist created and calculated clinically acceptable 3D CRT, IMRT and VMAT treatment plans for this «average» patient using the Eclipse TPS version 13.7 and photon dose calculation algorithm AAA. The following parameters were used in the planning process: total dose - 78Gy, fraction dose 2Gy, PTV=CTV+0,5cm margin; 3D CRT - 4 fields 18MV, simple box technique; IMRT - 9 fields 6MV (0, 40, 80, 120, 160, 200, 240, 280 and 320 deg. gantry rotation); VMAT - 2 arcs 6MV (360 deg. rotation CW and CCW). These plans have been artificially introduced geometrical uncertainties 5 and 10 mm on each axis x - lateral, y - vertical, z - longitudinal). For every of the treatment plans with the presented geometrical uncertainties PTV and CTV related dose-volume statistics were analyzed.

Results: For treatment plan stability to geometric uncertainties determination following dose-volume parameters were analyzed: for PTV: PTVmin, % - minimal percentage absorbed dose; D2%, Gy – near-max absorbed dose; D98%, Gy – near-max absorbed dose; D50%, Gy – meadian absorbed dose, HI – homogeneity index; для CTV - CTVmin, % - CTV minimal percentage absorbed dose; CTVD98%, Gy – CTV near-max absorbed dose. Table 1 shows the results for 3D CRT, IMRT and VMAT treatment plans both reference and with introduced geometric uncertainties.

Table 1. PTV and CTV related dose-volume statistics.

Conclusion: Geometric uncertainties on the longitudinal axis z had the most significant impact on the PTV and CTV related dose-volume characteristics, than for other axes for every considered radiotherapy techniques. Significant changes in the heterogeneity index of the treatment plan were observed if any geometric uncertainties are introduced. This situation seems typical for all considered radiotherapy techniques. In the cases where geometric uncertainties about 10 mm can not be taken into account during patient irradiation, IMRT and VMAT techniques is not appropriate due to significant deviations in the delivered absorbed dose. In general, the stability of 3D CRT treatment plans to geometric uncertainties in patient positioning is higher than that of IMRT and VMAT (approximately the same for these techniques) for prostate cancer treatments. It is mandatory to perform patient position control during IMRT and VMAT prostate cancer treatments. An additional research are required to evaluate the effect of geometric uncertainties on the bladder and rectum related dose-volume statistics.

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