VMAT Optimization for the Treatment of Prostate Cancer: Single versus Dual Arc

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Background and Purpose

Volumetric modulated arc therapy (VMAT) has recently been introduced clinically. Nucletron BV (Veenendal, Netherlands) offers this treatment modality in Oncentra® MasterPlan 3.3. A lot of parameters are available to improve the quality of the dose distribution in the optimization process. One of them is the number of rotations. Differences for single and dual arc technique are investigated.

Methods

In this planning study five patients with localised prostate cancer are enrolled to compare different VMAT plans. The planning target volume (PTV), the clinical target volume (CTV) and the organs at risk (OAR) rectum volume, urinary bladder and femoral heads are delineated. Two additional "help structures" (HS) are added for the optimization process: First: a margin of 5mm is added to the PTV and the resulting volume (PTV+Margin) is subtracted from the outline (HS1). Second: The (PTV+Margin) is subtracted from the rectum volume. The resulting volume represents approximately the dorsal rectum volume (HS2). The dose-volume objectives are identical for all plans: PTV minimum dose 59.4 Gy, CTV minimum dose 71.0 Gy, maximum dose 74.2 Gy, all weighted 3000, urinary bladder 50.0 Gy to 50% of the volume, weight 1000, rectum 70.0 Gy to 20% of the volume, weight 1000, and both femoral heads 50.0 Gy to 50% of the volume, weight 300. HS1 is set to a maximum dose of 56 Gy and to 45 Gy to 5% of the volume, both weighted 3000. HS2 is set to a maximum dose of 50 Gy, weight 1000. Collimator and table angles are kept fixed during the treatment. The planning is accomplished using the machine data of a SynergyS linear accelerator (Elekta Ltd., Crawley, UK). VMAT calculations are based on an arc technique rotating from 182° to 178° (single arc) and back (dual arc). Mean doses for the organs at risk and target dose homogeneity H are evaluated. The homogeneity is hereby defined as (D5-D95)/Daverage. Furthermore the number of monitor units is compared.

Results

The results of the dose distribution are rather similar: the average homogeneity in CTV for the single arc plans is 0.060, in dual arc 0.057, the required minimum dose in the PTV is fulfilled for single arc (59.8 Gy) and nearly reached for dual arc (59.3 Gy). The maximum dose-volume objectives for the dorsal rectum (HS2) are fulfilled very well (48.9 and 48.5 Gy), the dose volume objectives for rectum volume and bladder are undercut by far (median rectum 36.4 and 36.9 Gy, median bladder 42.3 and 42.6 Gy), also for the femoral heads (31.8 and 28.3 Gy).

The number of monitor units is clearly higher for the dual arc plans than for the single arc (694 and 509 MU).

Conclusion

The results of the dose distributions are very similar. There might be a small advantage in homogeneity for dual arc. On the other hand the minimum dose to the PTV is higher and within the objectives for single arc. The number of monitor units and therefore the treatment time, which is the crucial factor regarding intrafractional

organ movements is advantageous for the single arc technique. Further investigations with more patients will be made for the sake of better statistics.