Direct Step & Shoot: a New Module for Prostate Cancer IMRT

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Aims & Objectives

The aim of this treatment planning study is to compare the techniques of 3D conformal radiotherapy (3DCRT) and IMRT to determine the feasible advantages for prostate cancer patients using a new direct step & shoot (DSS) IMRT module.

For the optimisation of the IMRT, Nucletron offers as a part of the optimising process their IM-optimisation software or their new module DSS. The earlier IM-optimisation software searches first for the ideal fluence for each beam, and this is then followed by the segmentation. The new DSS module integrates the segmentation into the optimisation process. After that both continue with the final dose calculation.

	PTV Minimum		PTV Maximum		OAR 20% Vol.		Help contours Max.	
Scheme	Dose [Gy]	Weight	Dose [Gy]	Weight	Dose [Gy]	Weight	Dose [Gy]	Weight
1	59	3000	64	3000	40	100	55	300
2	59	3000	64	3000	40	3000	55	300

Table1: Dose-volume objective schemes

Materials & Methods

Between March 2006 and November 2006, four patients with a mean age of 71 years were enrolled for primary EBRT for localised prostate cancer. Three of these patients received antiandrogen therapy either before or during radiotherapy. All four patients had 3D CT treatment planning with a slice thickness of 5 mm and with immobilisation in a vacuum mattress (BlueBAG BodyFIX, Medical Intelligence).

As an initial step, it was planned (using Oncentra MasterPlan) to deliver 60 Gy to the planning target volume (PTV), calculated using data for a Siemens Primus linear accelerator (15 MV photons, with multileaf collimator leaf width of 1cm at the isocentre). The preselected gantry angles were 25º, 90º, 120º, 240º, 270º and 335º. The rectal volume and urinary bladder were delineated as organs at risk (OARs). Additional structures were also contoured in order to help (we term them 'Help Contours') avoid hot spots in normal tissues surrounding the PTV to a distance of 1cm. The dose-volume objectives were defined by two schemes (Table 1). After optimisation the plans were re-normalised to the average of PTV, giving 30 fractions with a fractional dose of 2 Gy. The 3DCRT plan used identical gantry angles with the beams weighted by experience.

Results

Both IMRT optimisation schemes reduced the doses received by the OARs when compared to the 3DCRT plan. Using the Nucletron IM-optimisation software the first weighting scheme of the objectives resulted in satisfactory dose-volume histograms (DVHs) for the OARs, and an obviously 'softened' DVH for the PTV (when compared to the 3DCRT plan). The DSS optimisation produced a steeper DVH for the PTV, but worse results for the OARs when compared to the IM-optimisation.

Scheme 2 improved the DVHs for the OARs using the DSS process, to about the same level as the IM-optimisation with scheme 1, the PTV DVH staying nearly unchanged. The IM-optimisation produced the worst DVH for the PTV of the five different plans we considered. In Figure 1 the DVHs are shown of a characteristic 3DCRT plan, the IM plan (Scheme 1) and the DSS plan (Scheme 2). Table 2 presents the mean values, averaged over the four patients, for the PTV and for the two OARs.

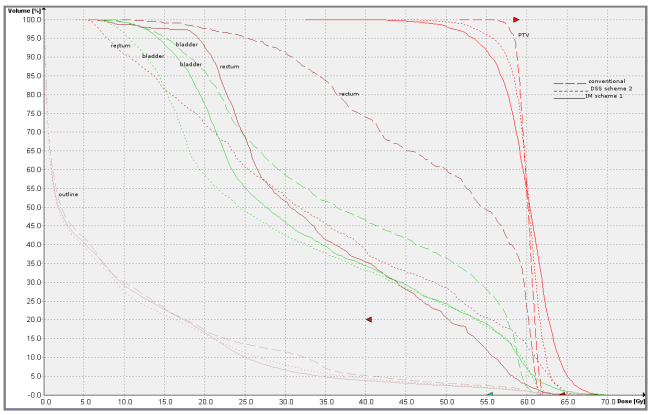

Figure 1: DVHs for one characteristic case in three different plans

	mean in PTV [Gy]	mean in bladder [Gy]	mean in rectum [Gy]
3D conmformal	60,3	33,8	41,1
IM scheme 1	60,2	29,6	30,7
DSS scheme 1	60,1	30,3	33,4
IM scheme 2	60,3	28,2	28,5
DSS scheme 2	60,2	28,0	29,8

Table2: Mean dose values in different regions, averaged over five plans

Conclusions

In every case the DSS optimisation resulted in a steeper DVH for the PTV than found using the IM process. The DVHs for the OARs are worse with scheme 1 but improve to about the same level with scheme 2. The patients benefit from IMRT by reduced doses to the OARs, keeping a very steep DVH for the PTV with the DSS optimisation.

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