



A comparison of doses to OARs in inverse planned IMRT and 3D conformal prostate treatments.

B. Mzenda¹, P. Peters¹, J. Pettingell², H. Kerr², K. Walsh², A. Eve², N. McAndrew³, M. Robb³, S. Razaq⁴, A. Penny⁴

¹CancerPartnersUK, Chalybeate Close, Southampton, UK

²CancerPartnersUK, Elstree, London, UK

³CancerPartnersUK, South Downs, Portsmouth, UK

⁴CancerPartnersUK, Little Aston, Birmingham, UK

Corresponding author: bongile.mzenda@cancerpartnersuk.org

Purpose

Following the recent Royal College of Radiologists (RCR) recommendations^{1,2} all prostate cancer patients at CancerPartnersUK centres are treated with inverse planned IMRT. This study compares the

organ at risk (OAR) doses as well as the PTV dose distributions and irradiated volumes in IMRT and 3D conformal radiotherapy (3DCRT) treatment of prostate carcinoma.

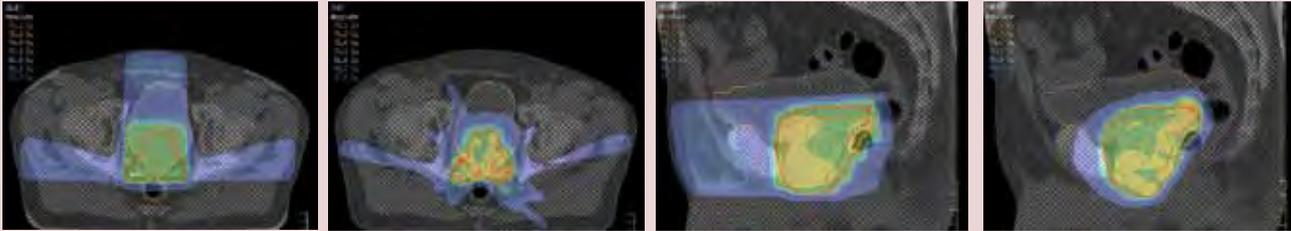


Figure 1. An axial and sagittal isodose example of IMRT vs. 3DCRT prostate treatment plan. PTV=red; Bladder=orange; Rectum=brown

Method

Twenty patients treated for prostate cancer to a prescribed dose of 74Gy were planned using 7-field step & shoot IMRT and 3-field 3DCRT techniques. The bladder, rectum and prostate CTV were outlined. The CTV was expanded to a PTV using a margin of 0.7cm in all directions. As per local protocol IMRT planning objectives were set to try to achieve: $\geq 99\%$ dose coverage to the PTV, 100% modal dose, an ICRU maximum (2cc) $\leq 105\%$ and to satisfy OAR dose constraints. Figure 1 demonstrates a typical dose distribution. The dose constraints used in the treatment planning for the bladder were V50<50%, V60<25% and V74<5% whilst for the rectum the constraints were V50<60%, V60<45%, V65<30% and V70<15%. The resultant OAR doses and dose volume histograms (DVHs) were used for plan comparison. PTV coverage was evaluated in terms of the V95%, conformity index (CI) and the homogeneity index (HI).

	V95% (%)		Conformity index		Homogeneity Index	
	IMRT	3DCRT	IMRT	3DCRT	IMRT	3DCRT
Mean	98.8	98.8	0.86	0.64	1.11	1.14
SD	0.52	1.57	0.04	0.11	0.29	0.29
P-value	P1=0.4	P2=0.9	P1<0.001	P2<0.001	P1=0.4	P2=0.8

Table 1: PTV volume dose statistics

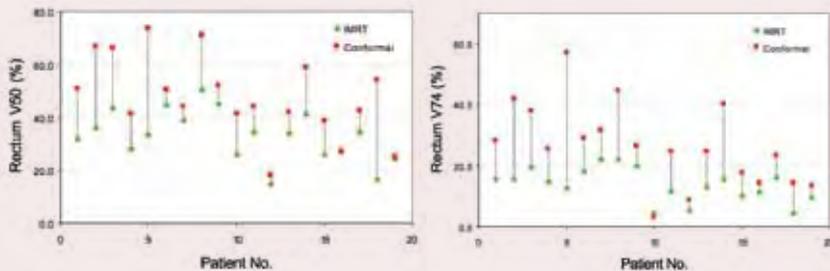


Figure 2. Rectum V50 and V74 statistics, lines show reduction in irradiated rectum volumes at this dose level

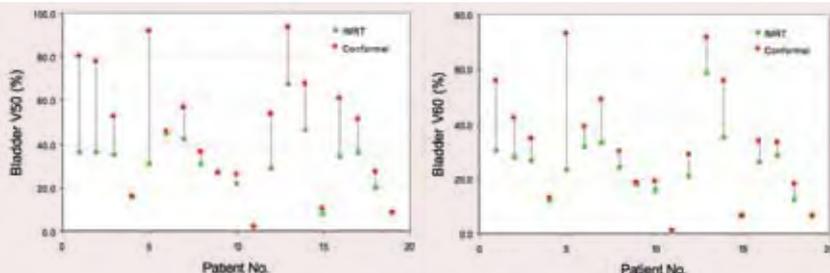


Figure 3. Bladder V50 and V60 statistics, lines show reduction in irradiated bladder volumes at this dose level

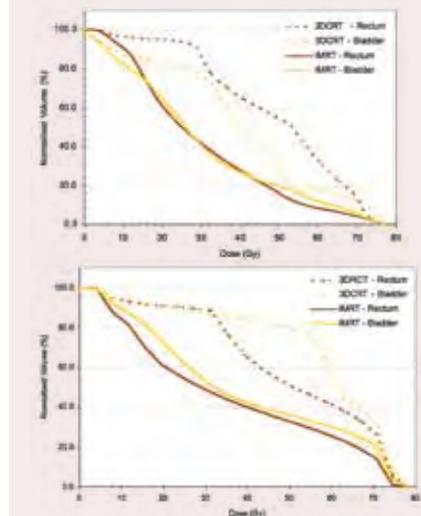


Figure 4. Example rectum and bladder DVHs for two patients

Results

Table 1 examines the V95% dose coverage, conformity index and heterogeneity index between the two methods. The statistical significance of the differences observed has been assessed using a paired-t test. There is no significant difference between the two planning techniques in terms of V95% coverage and dose heterogeneity, but the IMRT technique demonstrates significantly improved Conformity. The values obtained have been compared to similar studies^{3,4}, with good agreement found in all cases.

Figures 2 and 3 summarise the DVH information for all patients presenting the volume of bladder and rectum receiving two dose levels. The IMRT plans have reduced the volume of tissue receiving high doses for the majority of patients with a reduction of more than 40% observed in some cases. Figure 4 gives examples of DVHs for two patients, highlighting the lower rectal and bladder doses in the IMRT plans.

References

- Williams MW, Cooper T, Mackay R, Staffurth J, Routis D, Burnet N, The Implementation of Intensity-modulated Radiotherapy in the UK, *Clinical Oncology*, 22, 2010, 623-628.
- Staffurth J (on behalf of the Radiotherapy Development Board), A Review of the Clinical Evidence for Intensity-modulated Radiotherapy, *Clinical Oncology*, 22, 2010, 643-657.
- Luxton G, Hancock SL and Boyer AL, Dosimetry and radiobiological model comparison of IMRT and 3D conformal radiotherapy in treatment of carcinoma of the prostate, *Int. J. Radiat. Oncol Biol Phys*, 59, 2004, 267-284
- Vlachaki MT, Teslow TN, Amosson C, Uy NW and Ahmad S, IMRT versus conventional 3DCRT on prostate and normal tissue dosimetry using an endorectal balloon for prostate immobilization, *Medical Dosimetry*, 30, 2005, 69-75

Conclusions & further work

For all patients the IMRT plan improved bladder and rectum sparing and PTV dose conformity whilst maintaining PTV dose coverage and homogeneity.

Continued follow-up of these patients will provide organ toxicity and long-term survival data. As all patients in this planning study were treated using inverse planned IMRT it is fair to assume the improvements observed in the treatment plans should lead to better treatment outcomes, particularly as all treatments were delivered with 3D IGRT and daily online correction.

The improvements achieved in the planned dose distributions also suggest the potential for dose escalation when using inverse planned IMRT for future patients.