Helical tomotherapy versus 3D conformal radiotherapy in dosimetric planning for patients with localized prostate cancer

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Introduction:

Radiotherapy is one of the therapeutics selected for localized prostate cancer, in cases where the tumour is confined to the prostate, penetrates the prostatic capsule or has reached the seminal vesicles (T1 to T3 stages)[1]. The radiation therapy can be administered through various modalities, being historically used the 3D conformal radiotherapy (3DCRT)[2-4]. Other modality of radiation administration is the intensity modulated radiotherapy (IMRT), that allows an increase of the total dose through modulation of the treatment beams, enabling a reduction in toxicity[2-6]. One way to administer IMRT is through helical tomotherapy (TH)[7-8].

With this study we intent to analyze the advantages of helical tomotherapy when compared with 3DCRT, by evaluating the doses in the organs at risk (OAR) and planning target volumes (PTV).

Methodology:

8 patients with prostate cancer were treated in the radiotherapy department of Cliniques Universitaires Saint-Luc – Brussels. Patients age is between 60 and 83 years old, with an average of 72 (sd=8,5). In table 1 we can see the sample characterization.

Table 1 – Sample characterization.

Patient	Volume (cc)		TNM
	PTV 1	PTV 2	
1	216,45	123,28	T3a N0 M0
2	182,40	124,67	T1c N0 M0
3	190,89	141,71	T2 N0 M0
4	150,99	84,78	T2a N0 M0
5	182,10	111,76	T2 N0 M0
6	168,31	77,00	T3 N0 M0
7	216,33	106,19	T2a N0 M0
8	193,45	139,15	T1c N0 M0

Planning Process

All patients underwent a computerized tomography (CT) with a contrast and rectal probe. They were placed in supine position with the hands on the chest, a leg and feet support and a pillow under the head. The patients drank 500ml of water with 10cc of Gastrografin® one hour and half before the CT. Then the images were acquired and sent to the Focal® system. Here the rectum, head of femur, bladder, CTV 1 and 2 were delimited in all slices and after the images were sent to the treatment planning system (TPS). In the CTV 1 we include the prostate and seminal vesicles and the CTV 2 consist only in the prostate. The PTV 1 and 2 were created in the TPS with a margin of 7mm relative to the corresponding CTV. For all patients it was prescribed 74 to 78Gy with 2Gy per fraction.

3DCRT

The 3DCRT plans were created trough XiO® TPS, version 4.40.00. There were performed 5 to 7 fields with 18MV and for optimization was used wedges, different field weights, gantry rotations, multi-leaf collimators and field-in-field technique.

Tomotherapy

The TH plans were created trough Hi-Art Helical Tomotherapy®. For all plans it was used a jaw width of 2.5cm, a pitch of 0,287 and a modulation factor <2.

Statistical Analysis

The data was analysed by the Statistical Package for Social Sciences (SPSS), 20. It was used the Wilcoxon test to compare all parameters of the two techniques ($\rho \leq 0,05$).

Results:

In table 2 we observed the dose average in the PTV and OAR.

Table 2 – Average values of the dose in PTV and OAR.

	3DCRT	TH	ρ
Rectum			
Maximum Dose (%)	99.95 (1.57)	104.05 (0.78)	.012*
Average Dose (%)	54.58 (11.74)	41.97 (15.92)	.012*
Minimum Dose	4.07(5.25)	5.50 (4.21)	.123
V50%	51.26 (21.87)	42.89 (12.17)	.093
V25%	78.17 (6.89)	63.66 (17.55)	.069
Right Head Femur			
Maximum Dose (%)	65.02 (4.98)	44.01 (4.91)	.012*
Average Dose (%)	47.62 (8.88)	23.73 (5.07)	.012*
Minimum Dose	3.51 (1.91)	9.82 (5.07)	.012*
V50%	54.66 (7.52)	23.08 (4.97)	.012*
Left Head Femur			
Maximum Dose (%)	64.98 (6.90)	43.42 (4.79)	.012*
Average Dose (%)	46.46 (9.32)	23.27 (5.25)	.012*
Minimum Dose	3.26 (1.73)	9.71 (4.70)	.012*
V50%	55.40 (7.03)	23.14 (4.92)	.012*
Bladder			
Maximum Dose (%)	99.70 (2.10)	103.56 (2.21)	.017*
Average Dose (%)	36.13 (16.39)	33.43 (14.12)	.575
Minimum Dose	5.04 (11.94)	4.18 (5.73)	.161
V50%	25.28 (24.58)	28.34 (16.76)	.401
V25%	56.64 (21.46)	59.45 (15.67)	.779
PTV1			
Maximum Dose (%)	103.13 (3.62)	105.70 (.90)	.069
Average Dose (%)	99.97 (2.86)	100.00 (.23)	.889
Minimum Dose	92.76 (1.78)	85.65 (3.69)	.012*
V95%	97.33 (2.56)	96.69 (.57)	.263
PTV2			
Maximum Dose (%)	100.86 (1.81)	105.65 (.66)	.012*
Average Dose (%)	98.78 (1.99)	100.01 (.17)	.093
Minimum Dose	92.78 (1.70)	86.21 (3.83)	.025*
V95%	97.01 (1.66)	96.83 (.52)	.779

Final Considerations:

With this study we observed a significant dose reduction in the heads of femur, when TH is applied. Also we can find in the data a slight improvement in the homogeneity of the dose with TH, when compared to the 3DCRT. In future studies it could be possible to assess the dose in PTV and OAR with TH and volumetric modulated arc therapy.

Bibliography:

1. Hansen E, Roach M, editors. Handbook of evidence-based radiation oncology. 2nd edition. Springer, 2010, p.431-71.
2. Beyzadeoglu.M, Ozyigit.G, Ebruli.C, editors. Basic Radiation Oncology. London: Spriger; 2010. p. 148.
3. Brady L, Heimann H, Molls M, editors. Technical basis in radiation therapy. 4th edition. Springer; 2006. p.687-724.
4. Palma D, Vollans E, James K, Nakano S, Moiseenko V, Shaffer R et al. Volumetric modulated arc therapy for delivery of prostate radiotherapy: Comparison with intensity-modulated radiotherapy and three-dimensional conformal radiotherapy. Int. J. Radiation Oncology Biol. Phys [serial online]. 2008 [cited 2013 May 9];72(4):996-1001. Available from: http://www.sciencedirect.com/science/article/pii/S0360301608003428 English.
5. Zelefsky M, Levin E, Hunt M, Yamada Y, Shippy A, Jackson A et al. Incidence of late rectal and urinary toxicities adter three-dimensional conformal radiotherapy and intensity-modulated radiotherapy for localized prostate cancer. Int. J. Radiation Oncology Biol. Phys [serial online]. 2008 [cited 2013 May 9];70(4):1124-29. Available from: http://www.sciencedirect.com/science/article/pii/S0360301607046573 English.
6. Cho J, Lee H, Dong K, Chung W, Lee J, Park H. Quantitative Analysis of Tomotherapy, Linear-accelerator-based 3D Conformal Radiation Therapy, Intensity-modulated Radiation Therapy, and 4D Conformal Radiation Therapy. Journal of the Korean Physical Society [serial online]. 2012 [cited 2013 Jun 25];60:1167-76. Available from: http://www.springerlink.com/content/g57m4313052272h5/ English.
7. Cattaneo G, Dell'Oca I, Broggi S, Fiorino C, Perna A, Pasetti M et al. Treatment planning comparison between conformal radiotherapy and helical tomotherapy in case of locally advanced-stage NSCLC. Radiotherapy and Oncology. 88:310-18, 2008.
8. Ji Y, Dong K, Kim C, Choi S, Chung W, Lee J. Comparison of dose-volume histograms for Tomo therapy, linear accelerator-based 3D conformal radiation therapy, and intensity-modulated radiation therapy. Annals of Nuclear Energy [serial online]. 2011 [cited 2012 May 24];38:2569-74. Available from: http://www.sciencedirect.com/science/article/pii/S0306454911002854 English.