

Image-Guided Radiotherapy Treatment Using Daily versus Weekly Cone Beam CT for Intensity Modulated Radiotherapy of Prostate

Introduction

IMRT has become a main line of definitive treatment of Prostate cancer in localized cases as it allows delivery of higher doses to target volumes while sparing normal tissues which was shown to offer better biochemical failure-free survival [1-2].

Proper Positioning and daily setup are an essential step in the proper treatment of IMRT patients to ensure that the main goal of IMRT is achieved, which is higher doses to target volumes while sparing surrounding normal tissues for best local control and least side effects. Adequate PTV is essential to cover both inter and intra fractional variations in patients position [3].

CBCT is a new applicable and successful technique for better patients setup and positioning verification [4-10].

Aim of the work

To compare the daily cone beam CT (DCBCT) with weekly CBCT (WCBCT) as a verification method for delivery of the treatment by intensity modulated radiotherapy (IMRT), for patients with prostate cancer.

Patients and Methods

We retrospectively reviewed the readings of CBCT images of 24 patients with prostate cancer treated with IMRT from January 2012 to February 2015. All images obtained from the 24 patients were divided into three pools: unclassified, daily and weekly CBCT images. For each image, data collected included the size in millimeters of the shifts measured in the 6 directions of the 3 axes: medial-lateral (ML), superior-inferior (SI) and anterior-posterior (AP). In all 6 directions' measurements, the presence of a significant shift was assumed for an absolute value $>0.4\text{cm}$. The proportion of significant shifts was compared between DCBCT and WCBCT images. In addition; means (SD) of absolute shifts were compared between DCBCT and WCBCT.

Furthermore, we assessed the fitness of our planning target volume (PTV) that uses a 1 cm margin all around the prostate, except 0.6 cm in the posterior direction. We compared the proportion of readings within the PTV in DCBCT versus WCBCT images.

Statistical analysis was performed using SPSS, version 16.0 for Windows (SPSS Inc., Chicago, IL, USA). Comparisons of means were carried out on continuous variables using independent t-test; while comparisons of proportions were carried out on categorical variables using Pearson's Chi-square test or Fisher's exact test, as appropriate. The null hypothesis was rejected for a p-value <0.05 .

Proceeding

Volume 4 Issue 5 - 2016

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Received: April 07, 2016 | **Published:** May 04, 2016

Results

Total number of images = 502: 306 (60.9%) daily; 61 (12.1%) weekly; 135 (26.9%) unclassified. Comparisons between DCBCT versus WCBCT images showed that Weekly images exhibited significantly smaller (0.23 ± 0.19) mean \pm SD absolute shift in the median-lateral axis, as compared with daily images (0.31 ± 0.30), ($p=0.043$). However, no difference in the mean \pm SD absolute shift was observed in the superior-inferior ($p=0.167$) or the anterior-posterior ($p=0.531$) axes (Table 1).

Weekly images are more likely to be non-shifted (21.3%) than daily ones (13.1%); but the results are not statistically significant ($p=0.84$). Moreover, there are more (44.3% versus 38.8%) right-shifted images and less (34.4% versus 48.4%) left-shifted images in weekly versus daily group, respectively (Table 2).

Shift significance

Daily images are more likely to exhibit significant ($\geq 0.40\text{cm}$) shifts in both median-lateral (31.7% versus 23.0%, $p=0.174$) and anterior-posterior (25.8% versus 19.7%, $p=0.310$) axes, respectively; however, results are not statistically significant (Table 2).

Margin respect assessment

Surprisingly, although not statistically significant, 100% of weekly images versus 96.7% of daily images were

with margin, in both median-lateral ($p=0.380$) and superior-inferior axes ($p=0.380$) (Table 2).

Table 1: Comparisons between DCBCT versus WCBCT images showed that Weekly images exhibited significantly.

Parameter	Unclassified [§] (n=135)		Daily (n=306)		Weekly (n=61)		p-value
	Mean	SD	Mean	SD	Mean	SD	
Raw Shift Values							
Med-Lat	0.02	0.44	-0.06	0.43	0.02	0.3	0.174
Sup-Inf	-0.16	0.41	-0.14	0.44	-0.02	0.38	.048*
Ant-Post	0.02	0.37	0.04	0.34	0.03	0.31	0.766
Absolute Shift Values							
Med-Lat	0.32	0.3	0.31	0.3	0.23	0.19	.043*
Sup-Inf	0.33	0.3	0.35	0.31	0.29	0.24	0.167
Ant-Post	0.25	0.27	0.25	0.24	0.22	0.21	0.531

*Statistically significant (independent t-test, p-value<0.05); §not included in the comparative analysis.

Table 2: Shift significance values both anterior-posterior and § p-value calculated using Fisher's exact test.

Parameter	Value	Daily (n=306)		Weekly (n=61)		p-value
		Freq	%	Freq.	%	
Shift Direction						
Med-Lat	No shift	40	13.1	13	21.3	0.084
	Right shift	118	38.6	27	44.3	
	Left shift	148	48.4	21	34.4	
Sup-Inf	No shift	33	10.8	10	16.4	0.057
	Inferior shift	92	30.1	25	41	
	Superior shift	181	59.2	26	42.6	
Ant-Post	No shift	65	21.2	14	23	0.954
	Posterior shift	140	45.8	27	44.3	
	Anterior Shift	101	33.3	20	32.8	
Shift Significance (≥0.40cm)						
Med-Lat		97	31.7	14	23	0.174
Sup-Inf		104	34	19	31.1	0.668
Ant-Post		79	25.8	12	19.7	0.31
Beyond Margin (shift >1.00cm in all directions; and > 0.60cm in posterior direction)						
Med-Lat		10	3.3	0	0	.380 §
Sup-Inf		10	3.3	0	0	.380 §
Ant-Post		13	4.2	2	3.3	1.000 §

Conclusion

Daily CBCT did not show superior accuracy as compared to weekly CBCT, in patients with prostate cancer treated with IMRT. Consequently, weekly CBCT appears to be a safe alternative, especially recommended in departments with over-request. As per the direction, the use of a 6-to-10 mm margin in the PTV was found to be adequate to cover shifts in all directions in both Daily and Weekly analysis.

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