Journal of Radiotherapy in Practice

Journal of Radiotherapy in Practice (2011)
10, 137–140
© Cambridge University Press 2010
doi:10.1017/S1460396910000269

Case Report

Personalising margins for bladder radiotherapy

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Abstract

This patient case study represents the introduction of adaptive radiotherapy (ART) at the Andrew Love Cancer Centre (ALCC) with non-uniform margins for invasive bladder cancer treatment. Invasive bladder cancer has historically had poor local control with radiotherapy treatment; however, with the introduction of cone-beam computer tomography (CBCT) and adaptive treatment, there is potential for improvements in disease control and reduced toxicities.

Keywords

Adaptive radiotherapy; Cone Beam Computer Tomography (CBCT); Invasive bladder cancer

INTRODUCTION

Invasive bladder cancer treated with external-beam radiotherapy generally has poor local control rates. These patients often have inoperable tumours or are medically unfit to undergo a cystectomy and are therefore referred for radiotherapy. There are no benefits for cystectomy compared with radiotherapy, and prognostic factors for survival are related only to tumour grade.[1–3] Radiotherapy techniques previously used for bladder cases had large treatment fields adding to the poor outcome. However, the introduction of image-guided radiotherapy (IGRT) and adaptive radiotherapy (ART) demonstrate potential for improving the treatment of these patients.

The most common technique used in radiotherapy for invasive bladder cancer remains encompassing the whole bladder with a 20 to 30 mm uniform margin for the planning target volume (PTV) dosed from 60 to 66 Gray.[4] A recent paper by Turner proposed that margins of 17 mm for the superior and anterior portions of the bladder were more appropriate, given modern set-up accuracy, and Foroudi et al. used 15 mm margin.[5–6] Traditional treatment techniques limit the use of dose escalation due to toxicities. Pos et al. proposed that only the delineated bladder clinical target volume (CTV) was irradiated, and the 'healthy' tissue of the bladder remained out of the high-dose area.[7] However, due to the mobility of the bladder and its structure, it has the tendency to change shape, size and position throughout the treatment course. This results in the bladder tumour also, varying in position through the treatment course, limiting tumour localisation. Therefore, with traditional treatment and verification techniques the proposal by Pos et al. is not feasible.[7]

At the Andrew Love Cancer Centre (ALCC) online IGRT was introduced in 2007, followed by a zero millimetre-action translational displacement threshold in 2008, as best practice. A zero-

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https://doi.org/10.1017/S1460396910000269 Published online by Cambridge University Press

action threshold has resulted in improved accuracy of treatment by approximately 4.2 mm in the superior-inferior direction, 3.2 mm anterior-posterior and 3.7 mm left to right (Foulstone 2009; personal communication, 22 September). The first treatment of a patient using cone-beam computer tomography (CBCT) verification was carried out in 2009. ART utilises IGRT not only for treatment verification but also for implementing changes to a plan when a patient's tumour changes in size, shape or position, thus providing optimal treatment throughout the entire treatment course. Analysis of off-line CBCT scans has revealed the potential for non-uniform margin reductions. The ALCC implemented their first truly ART treatment in September 2009 for an invasive bladder cancer case.

CASE HISTORY

A 60-year-old Caucasian male presented at the ALCC in July 2009 after three cystoscopic examinations over the previous 2 years. He had experienced a prolonged ordeal with intermittent hematuria since August 2008. In June 2009, a third cystoscopy revealed a large, solid tumour measuring approximately 50 mm in diameter on the right side of the bladder and inside the bladder neck. Histology revealed it was a T_2 N_0 M_0 high-grade urethelial carcinoma with muscularis propria invasion. No lymphovascular invasion was evident. A computer tomography (CT) scan of his abdomen showed no evidence of liver or lymph-node involvement. A positron emission tomography (PET) scan showed no evidence of metastatic disease in mediastinum.

He had no family history of bladder cancer. However, he had significant comorbidity in the form of ischaemic heart disease, valvular heart disease and poor left ventricular function, and, as a result, was not a suitable candidate for cystectomy; therefore, radical radiotherapy was considered the best course of treatment.

MANAGEMENT WITH RADIOTHERAPY

The treatment prescribed was a course of radiotherapy to a total of 63 Gray (Gy) in 35 fractions over 7 weeks. A 4-field conformal beam arrangement of 18 megavoltage (MV) energy with multileaf collimators (MLC) was used. Patients with bladder cancer are planned and treated with an empty bladder, with the aim of achieving consistency throughout the treatment course.

The adaptive treatment process utilised was similar to that of Pos et al.[7] The CTV was the bladder volume. Daily kilo-voltage (kV) imaging was used before treatment for set-up verification. Cone-beam CT scans were taken on the first five fractions immediately after treatment. Patient appointments were increased in time from 10 to 20 minutes on the days when CBCT scans were performed. From the five CBCT scans, a new adaptive treatment volume was constructed. The CBCT scans, in treatment position, were automatically fused with the planning CT scan. The fused scans represented the final position of the patient after set-up and treatment and, therefore, included the total set-up error. The radiation oncologist (RO) contoured the CTV on all five fused scans. A new region of interest was created encompassing all CTVs on the five CBCT; this was called the bladder total volume. The bladder total volume accounted for translational and rotational displacement in the bladder CTV. For the first adaptive bladder case, the bladder total volume was covered with a conservative margin between the ALCC standard bladder and standard pelvis margins. Contouring the bladder on the CBCT scans took the RO considerably longer than expected (over an hour for each CBCT), delaying the analysis of scans and resulting in a delayed change of phase. A four-phase treatment was the result of the adaptive process to optimise this patient's radiotherapy treatment. There was a superior margin reduction of 35 mm from the initial phase of treatment through to the final phase; this is illustrated in Figure 1. Refer to the Table for the treatment plan with details of each phase detailing the margins and the CBCT frequency.

DISCUSSION

This initial adaptive bladder treatment was a success, enabling large margin reductions to

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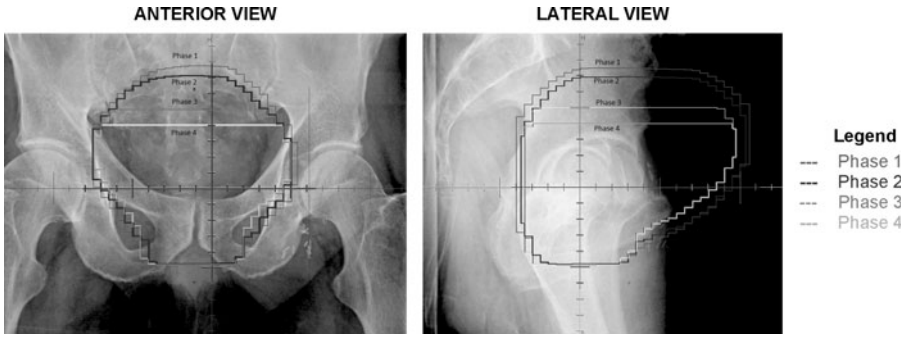

Figure 1. Digitally reconstructed radiographs.

Table 1. *Treatment plan*

PHASE 1															
Fraction	1	2	3	4	5	6	7	8	9	10	11	12	13		
Margins on the CTV (mm)	Sup 20			Inf 22		Ant 20			Post 17		Lat 14				
Post-treatment CBCT	*	*	*	*	*							*			
PHASE 2															
Fraction	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Margin reductions (mm)	Sup 5			Inf –			Ant 3			Post 2			Lat 4		
Post-treatment CBCT			*					*					*		
	PHASE 3							PHASE 4							
Fraction	29							30	31	32	33	34	35		
Margin reductions (mm)	Sup 20	Inf –	Ant –	Post –	Lat –			Sup 10	Inf –	Ant –		Post –	Lat –		
Post-treatment CBCT								*	*	*	*	*	*		

be made. On treatment, additional time was required for CBCTs. The ART was time consuming for the RO, who was responsible for contouring the bladder volume on the CBCT and CT scans, taking approximately 16 hours over the course of treatment. In the future, radiation therapists at the ALCC will be trained in contouring for adaptive plans so as to share the increased workload and reduce the overall time needed for the planning and treatment. Prior to radiation therapists undertaking bladder contouring, reliability and validity studies comparing radiation oncologists and therapists will be completed.

Another ART strategy being implemented at other radiotherapy departments is a three-plan method for each patient with small, medium and large bladder volume planned and choosing an appropriate plan for each daily treatment. This strategy is less patient-specific in terms of margin reductions than the ALCC ART; however, it is more conformal on a daily treatment basis. The ALCC has evaluated the ART strategies available and it endeavours to employ an ART protocol as standard practice in the near future.

CONCLUSION

ART has the potential to dramatically improve the treatment of invasive bladder cancer, by customising each treatment for each and every patient. This case report highlights margin reductions possible in these cases with the potential for reduced side effects and highlights areas for ART development at the ALCC.

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ACKNOWLEDGEMENTS

The authors gratefully acknowledge Dr. Rod Lynch, Director of Radiation Oncology, for the time and effort he put into this first adaptive bladder case.

References

1. Kotwal S, Choudhury A, Johnston C, Paul AB, Whelan P, Kiltie AE. Similar treatment outcomes for radical cystectomy and radical radiotherapy in invasive bladder cancer treated at a United Kingdom specialist treatment center. Int J Radiat Oncol Biol Phys 2008; 70:456–463.
2. Hayter CR, Paszat LF, Groome PA, Schulze K, Mackillop WJ. The management and outcome of bladder carcinoma in Ontario, 1982–1994. Cancer 2000; 89:142–151.
3. Scrimger RA, Murtha AD, Parliament MB, Venner PM, Hanson J, Houle G, Chetner M. Muscle-invasive transitional cell carcinoma of the urinary bladder: a population-based study of patterns of care and prognostic factors. Int J Radiat Oncol Biol Phys 2001; 51:23–30.
4. Sengeløv L, von der Maase H. Radiotherapy in bladder cancer. Radiother Oncol 1999; 52:1–14.
5. Turner S. Defining the Optimal CTV for Bladder Cancer. Faculty of Radiation Oncology Genito-Urinary Special Interest Groups (FROGG) Workshop, 2009.
6. Foroudi F, Wong J, Kron T et al. Development and evaluation of a training program for therapeutic radiographers as a basis for online adaptive radiation therapy for bladder carcinoma. *Radiography* 2010; 16:14–20.
7. Pos FJ, Hulshof M, Lebesque J, Lotz H, van Tienhoven G, Moonen L, Remeijer P. Adaptive radiotherapy for invasive bladder cancer: a feasibility study. Int J Radiat Oncol Biol Phys 2006; 64:862–868.

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