

RECTAL SPARING BY BALLOON CATHETER IMMOBILIZATION DURING INTENSITY MODULATED RADIATION THERAPY FOR PROSTATE CANCER

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Purpose : Escalating radiotherapy dose results in a substantial improvement in prostate cancer outcome. Obtaining an optimal plan and acceptable dose distribution would be limited by normal critical structures. Our study is to evaluate the effect of rectal balloon immobilization in reducing rectal dose during daily treatment of prostate cancer with intensity modulated radiation therapy (IMRT).

Materials and Methods : From June 2005 to August 2005, 11 patients with prostate cancer underwent computed tomography (CT) simulations with and without rectal balloon (filled with 60 ml air) before and at the end of IMRT course. TMS Helax treatment planning system was used to generate step-and-shoot five coplanar-field IMRT plans. Plans were separately designed with and without a rectal balloon. The prescription dose to clinical target volume (CTV) was 78 Gy in 39 fractions of 2 Gy each. CTV was determined according to the patients' risk category. The dose to 95% of planning target volume (PTV) was 78 Gy. Cumulative dose-volume histograms (DVHs) were analyzed for the CTV, PTV, rectum, and bladder. Inter-fractional prostate displacement was measured on two separate CT images with the distance between pubic bone rim / sacrum and anterior / posterior borders of prostate, respectively, at the cranial level of pubic symphysis. To assess the dosimetric difference and inter-fractional variation of balloon setup, the paired Student t-test was used.

Results : Patients included in this study had the TNM stage distribution of T1cN0M0 in 4 patients, T2bN0M0 in 4 patients, T3bN0M0 in 2 patients, and T4N0M0 in 1 patient. CTV was prostate alone in 8 patients and prostate plus bilateral seminal vesicles in 3 patients. Minimum dose to CTV with and without a rectal balloon were both 79 Gy in average. Average segment number in plans with and without a rectal balloon were 43 and 42 ($P = 0.7$), respectively. Plans with a rectal balloon showed a significant reduction in rectal volume fraction at ≥ 65 Gy (13% vs 17%, $P = 0.007$), and at ≥ 70 Gy (9% vs 13%, $P = 0.005$). Plans with a rectal balloon did not show difference in bladder volume fraction at ≥ 65 Gy (18% vs 16%, $P = 0.07$). Inter-fractional prostate positions before and at the end of IMRT were similar in the distance from pubic bone to anterior border (0.90 cm vs 0.96 cm, $P = 0.6$), and posterior border of prostate to sacrum (3.69 cm vs 3.73 cm, $P = 0.8$). All patients tolerated their whole IMRT course with daily placement of rectal balloon. There was no grade III acute toxicity.

Received: 2006, 5, 11. Accepted: 2006, 8, 29.

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Conclusion : Rectal balloon immobilization during daily fractionated IMRT for prostate cancer is a feasible and reproducible procedure. It would be beneficial to reduce high dose to the rectum. The effect of prostate immobilization is acceptable with minimal inter-fractional setup variation.

[Therapeut Radiol Oncol 2007; 14(1): 1-10]

Key words: Rectal balloon, Prostate cancer, Intensity modulated radiation therapy, Inter-fractional displacement

INTRODUCTION

Since the use of prostate-specific antigen (PSA) has been introduced as a surrogate end point after radiotherapy (RT) for the treatment of prostate cancer, it has become apparent that the standard doses of 65–70 Gy result in far fewer cures than once believed. In nearly every retrospective and prospective PSA era trial that evaluated radiotherapy dose escalation response, an outcome improvement has been substantial for intermediate- and high-risk patients [4, 9, 13-15, 18, 26].

Optimizing the planning of intensity-modulated radiotherapy (IMRT) is to deliver maximum radiation dose to the tumor while keeping the dose to the surrounding normal tissues below tolerance [25]. Rectal toxicity is the major limiting factor in dose escalation, and it is related to the total dose prescribed and the volume of rectal wall receiving a high dose [7, 19, 22]. One of the challenges in RT of prostate is to deliver higher doses without increasing rectal toxicity.

Immobilization devices can achieve significant reduction in positional inaccuracies of target [17]. There have been some reports describing the use and influence on dose planning during IMRT for prostate. In this study, we investigate the effect of rectal balloon immobilization during daily IMRT for prostate cancer. All patients were treated in a single institution by the same treatment team.

MATERIALS AND METHODS

Patient setup and placement of endorectal balloon

From June 2005 to August 2005, 11 patients undergoing IMRT for localized prostate cancer at a single institution were included in this study. All patients were treated in prone position with an individually designed immobilization device, BuleBAG™ vacuum cushion (Figure 1a). The rectal balloon catheter consisted of an EZ-EM® nonlatex inflatable retention cuff enema tip connected to a scalp vein set (with needle removed), Nipro. The proximal end of set was sealed with female luer lock. The balloon apparatus was inserted into the rectum up to the side port and was inflated with 60 ml of air, which was retained in place and locked by the scalp vein set (with needle removed) (Figure 1b). The inflated balloon catheter was pulled back until resistance from the internal anal sphincter was reached. One balloon catheter was used per patient for the entire treatment course with a disposable condom in each fraction. The patients were instructed to have a full bladder for the simulation computed tomography (CT) scan and for each RT fraction.

Organ delineation and treatment planning

All patients underwent two immediately consecutive simulation CT scans, with and without balloon placement (in prone position with external laser localization). The third