Intrafraction motion assessment in SBRT for prostate cancer: a prospective study

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Physics track: Intrafraction motion management

Introduction and objectives

Stereotactic Body Radiation Therapy (SBRT) for prostate cancer is a technically demanding treatment in terms of target localization. In this study, a temporary implanted wired electromagnetic tracking system was employed in prostate treatments with standard fractionation, to investigate the impact of motion for future SBRT prostate cancer treatments at our department.

Methods

A group of 9 patients treated with radiation therapy (dose 70.0 Gy, 2.5 Gy fraction) of the prostate gland was studied. Each patient was implanted with two gold seeds and an electromagnetic transmitter in the prostate gland, which was surgically removed at the end of therapy (Figure 1).

The tracking system (Raypilot System, Microps Medical AB), an add-on device to the linear accelerator composed by the implanted transmitter and a flat receiver placed on the patient bed, provides the 3-D real-time position of the transmitter itself, which is passively employed as a surrogate of prostate motion (Figure 2). Target is monitored during every treatment fraction without affecting radiation beam delivery.

Both interfraction and intrafraction motion displacements were recorded (Figure 3).

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Results

Transient excursions, typically within 20 seconds duration, and drifts of the prostate gland were observed during treatment. Spatial displacements > 11 mm in the cranial-caudal direction of 1 patient, > 4 mm in the cranial-caudal and anterior-posterior directions in 3 patients, < 4 mm in the remaining patients. Evaluated CTV-to-PTV margins are shown in Table 1. Concerning robustness plan analysis, more than 98% of PTV is covered by 95% of prescription dose. The mean values of the DVH uncertainty ranges (upper / lower range bound with respect to the planned dose) is (+1.5% ; -2%) and (+2.7% ; -13.1%) at V_68Gy for rectum and at V_75Gy for bladder respectively.

<table>
<thead>
<tr>
<th>Measured interfraction motion (cm)</th>
<th>Measured intrafraction motion (cm)</th>
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</thead>
<tbody>
<tr>
<td>AP</td>
<td>CC</td>
</tr>
<tr>
<td>Mean</td>
<td>-0.027</td>
</tr>
<tr>
<td>( \Sigma )</td>
<td>0.098</td>
</tr>
<tr>
<td>( \Sigma_{AP} )</td>
<td>0.221</td>
</tr>
</tbody>
</table>

Table 1. Evaluated prostate margins for a group of 9 patients. AP = anterior, CC = cranial - caudal, LR = left - right, \( \Sigma \) = systematic error, \( \Sigma_{AP} \) = random error

Conclusions

This prospective study suggests: a) intrafraction motion impact on treatment margins should be considered; b) variation in DVH analysis for bladder and rectum are not negligible. Therefore target repositioning or beam-gating techniques should be considered in the therapy execution protocol.

References


Keywords: intrafraction motion, online target tracking, hypofractionated treatments.

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