24/25 OTTOBRE 2014
Università degli studi di Milano
STEREOTACTIC BODY RADIATION THERAPY

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*).

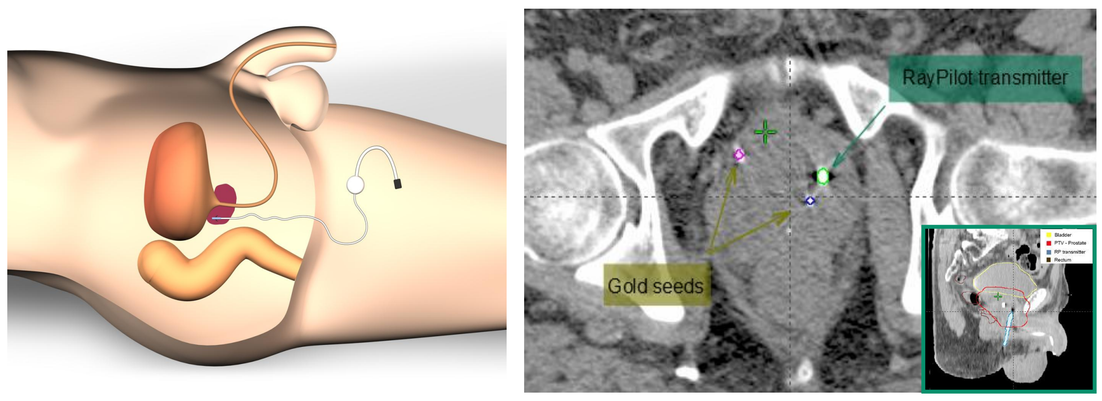

Figure 1. Images of the trasmitter implant. The trasmitted is connected to the external receiving system by a wire which passes through the patient perineum. The trasmitter is implanted in the prostate gland and it is used as fiducial marker together with the two implanted gold seeds.

The tracking system (Raypilot System, Micropos 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.

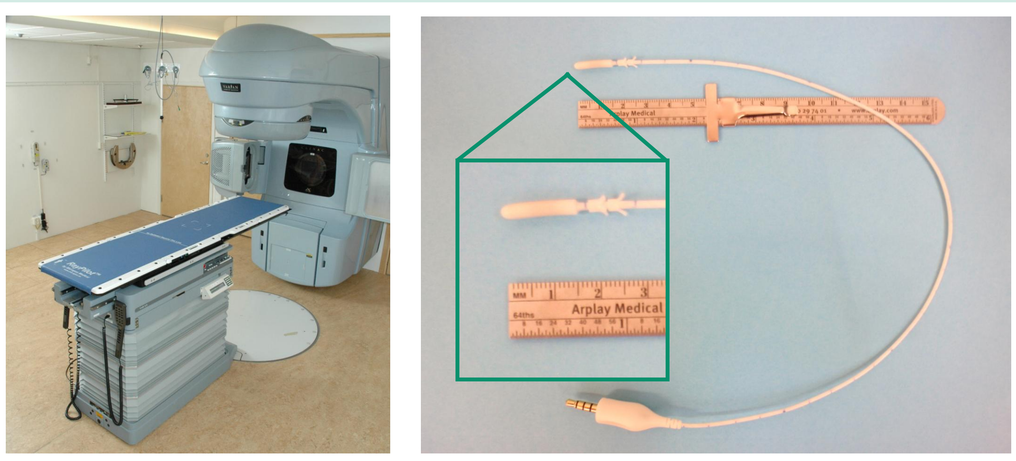

Figure 2. Layout of the system. The receiver consists in a flat bed placed on the usual linac treatment bed. The receiveing antennas are located in an area in correspondence with the patient pelvis. The transmitter is a 17-mm long by 3-mm wide.

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

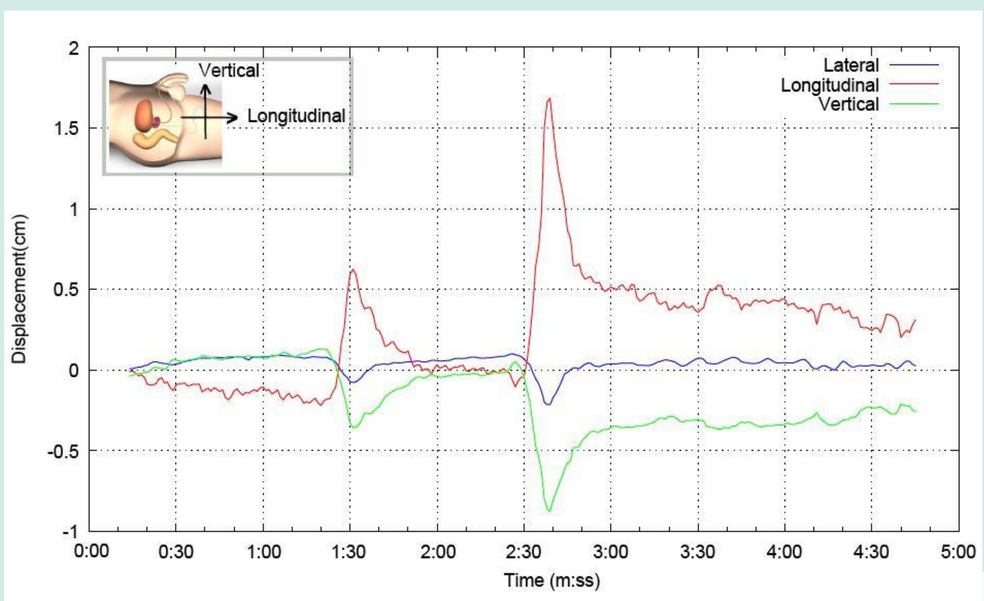

Figure 3. Recorded intrafraction displacement. A transient excursion of about 20 seconds duration is shown.

The plan robustness analysis function in CERR (Computational Environment for Radiotherapy Research, Washington University) was used to simulate the DVH uncertainty with measured systematic and random shifts. PTV coverage and dose ranges were evaluated for a set of Organs At Risk *(Figure 4*).

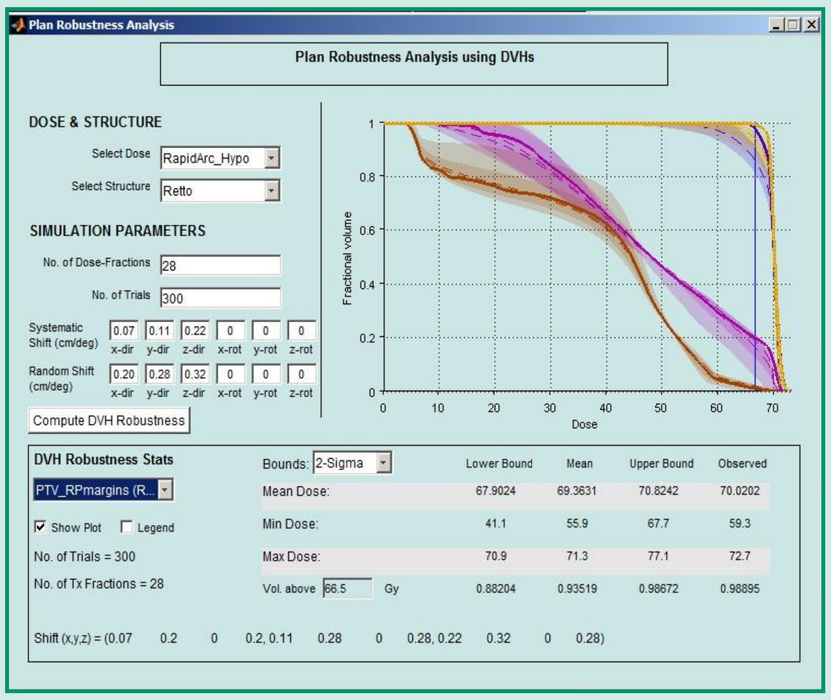

Figure 4. Example of plan robustness analysis with CERR .

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 were identified in 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_{60Gy} for bladder respectively.

Measured interfraction motion (cm)

	AP	CC	LR
Mean	-0,027	-0,075	0,026
Σ_{inter}	0,098	0,222	0,072
σ_{Inter}	0,221	0,296	0,183

Measured intrafraction motion (cm)

	AP	CC	LR
Mean	0,005	0,011	0,008
Σ_{intra}	0,044	0,027	0,026
σ_{Intra}	0,188	0,123	0,084

Margins (cm)

	AP	CC	LR
Excluding intrafraction motion	0,401	0,763	0,309
Including intrafraction motion	0,472	0,784	0,333
Difference	0,071	0,021	0,024

Table 1. Evaluated prostate margins for a group of 9 patients. AP= anterior - posterior; CC = cranial - caudal; LR = left- right. Σ = sistematic error, σ = 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

[1] van Herk et al*, The probability of correct target dosage: Dose population histograms for deriving treatment margins in radiotherapy.* Int J Radiat Oncol Biol Phys 2000:47:1121-1135

[2] Litzenberg D et al*, Influence of intrafraction motion on margins for prostate radiotherapy*, Int J Radiat Oncol Biol Phys 2006:65, 2:548-553

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