

# Improving focal bladder treatment with IMRT

Dominique van Rooijen MSc\*, Jeroen van de Kamer PhD, Maarten Hulshof PhD, Pieter Gangel, Arjan Bel PhD



Dept. Radiation Oncology, Academic Medical Center, University of Amsterdam, The Netherlands

\* d.c.vanrooijen@amc.uva.nl

## Purpose

To investigate the possible benefit of an IMRT plan for bladder cancer treatment, taking differences in lymph node and tumor displacement into account.

## Methods

### Patients

- Treated in the period 2003 - 2007.
- 20 patients, 10 patients with a prescribed dose of 55 Gy and 10 with 60 Gy.
- A 'field-in-field' (FiF) technique was used for the original treatment plan[1].
- All patients had implanted markers at the border of the tumor as reference points for GTV delineation[2].

### Volumes and delineation

- For the original plan bladder, GTV and PTV were delineated. The GTV and PTV are determined by an adaptive margin strategy. The GTV to PTV margin was 1.0 cm [3].
- For IMRT planning some additional structures were delineated: small intestines, rectum, pelvic lymph nodes and a PTV for the 40 Gy area (PTV<sub>40</sub>). PTV<sub>40</sub> consists of four parts: the PTV<sub>tumor</sub>, a margin of 5 mm around the left and right pelvic lymph nodes and an anisotropic margin of 8 to 20 mm around the bladder.

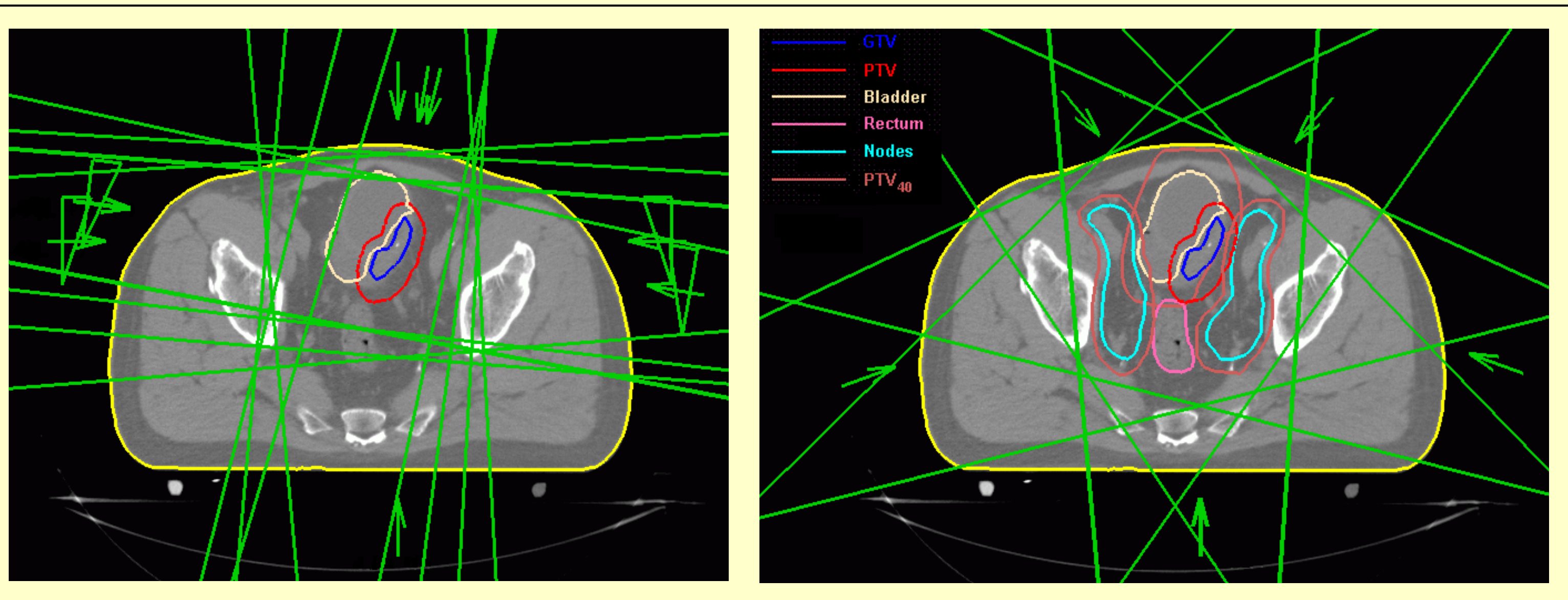


Figure 1: Left the FiF technique with four fields to construct the elective field and four additional beams to deliver the boost. Right IMRT.

### Treatment planning

- Treatment plans are generated by PLATO®.
- All patients received 40 Gy to the elective field (PTV<sub>40</sub>) and an additional boost of 15 Gy or 20 Gy to the PTV<sub>tumor</sub>, depending on the risk of bowel complications.
- Markers enable on-line position verification for the tumor position with conebeam-CT. Unlike the tumor, the lymph nodes hardly move with respect to the bones. To cope with these differences two IMRT plans are required: one for the elective field and one for the boost.
- At least 99% of the PTV<sub>tumor</sub> should receive 95% of the prescribed dose. In the IMRT plans also 99% of the PTV<sub>40</sub> should receive 95% of the prescribed 40 Gy.
- For IMRT 5 beams were used with gantry angles: 40°, 110°, 180°, 250° and 320°.

### Analysis

A number of DVH-points of the healthy bladder, intestines, rectum and PTV<sub>40</sub> of the conventional and IMRT plan are compared. For the organs at risk these DVH-points are related to the TD<sub>5/5</sub> of 1/3, 2/3 and the whole volume, based on a 2.75 Gy fraction dose [4]. For PTV<sub>40</sub> the volume that receives 95% of the prescribed dose (V<sub>38</sub>) is evaluated.

The IMRT boost field and elective field are added for the analysis.

## Results

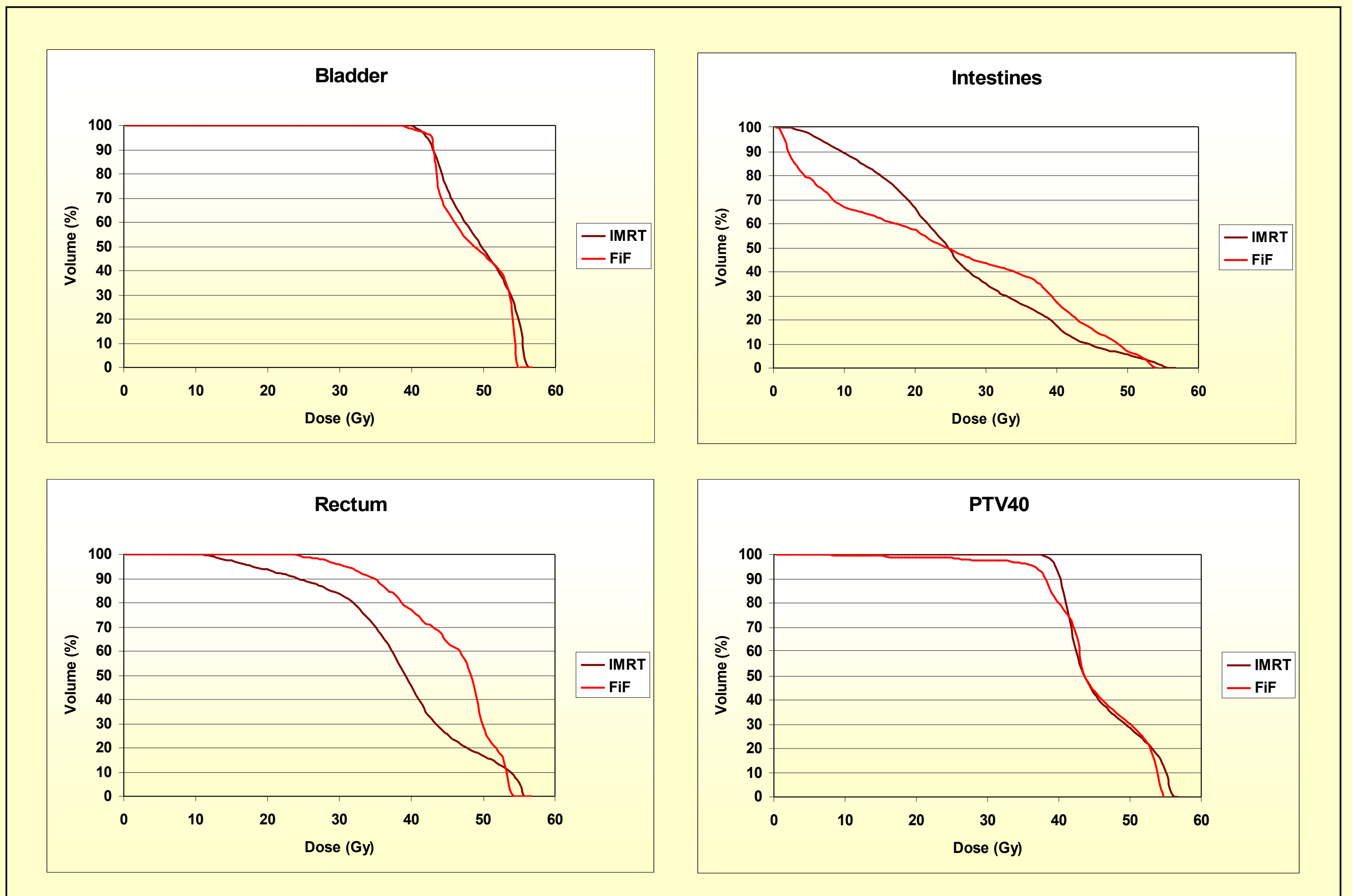


Figure 2: Example of dose-volume histograms of a patient treated with 55 Gy.

	FiF (% ± SD)	IMRT (% ± SD)	p-value
Bladder V <sub>49Gy</sub>	55.8 (±20.5)	57.5 (±21.0)	0.079
Bladder V <sub>50Gy</sub>	53.6 (±20.4)	54.4 (±20.7)	0.262
Bladder V <sub>52Gy</sub>	49.0 (±20.2)	48.0 (±19.7)	0.201
Intestines V <sub>40.5Gy</sub>	22.1 (±17.0)	17.4 (±12.6)	0.055
Intestines V <sub>42Gy</sub>	15.7 (±14.6)	12.3 (±11.2)	0.029
Intestines V <sub>44Gy</sub>	11.9 (±11.7)	8.8 (±10.0)	0.003
Rectum V <sub>48Gy</sub>	29.4 (±18.9)	16.7 (±13.4)	<0.001
Rectum V <sub>49.5Gy</sub>	26.2 (±17.5)	14.6 (±12.3)	<0.001
Rectum V <sub>52Gy</sub>	19.6 (±14.1)	11.2 (±10.2)	<0.001
PTV <sub>40</sub> V <sub>38Gy</sub>	83.6 (±11.0)	99.5 (±0.3)	<0.001

Table 1: Results of the comparison between IMRT and conventional plans are presented as the average volume that receives the evaluation dose or more ± standard deviation. Because Bonferroni correction is applied, the significance level is set to p = 0.005.

The results show that with IMRT a smaller volume of the organs at risk receives a high dose. However, the standard deviation is large because of the large interpatient variation in OAR involvement in the PTV<sub>tumor</sub> and PTV<sub>40</sub>.

Rectum and intestines receive a lower dose with IMRT, while the PTV<sub>40</sub> is covered better. The PTV<sub>40</sub> is underdosed in all FiF plans. Delineation of the lymph nodes causes a better coverage.

The PTV<sub>tumor</sub> was sufficiently covered in all IMRT and FiF plans.

## Conclusion

With IMRT, a smaller volume of the intestines and rectum receives a high dose, while the lymph nodes are covered better. The PTV<sub>tumor</sub> is equally well covered. Future dose escalation can be considered.

1. F.J. Pos et al, Concomitant boost radiotherapy for muscle invasive bladder cancer, Radiother. Oncol. 68 (2003) 75-80
2. M.C.C.M. Hulshof et al, Intravesical markers for delineation of target volume during external focal irradiation of bladder carcinomas, Radiother. Oncol. 84 (2007) 49-51
3. F.J. Pos et al, Adaptive radiotherapy for invasive bladder cancer: a feasibility study, Int. J. Radiat. Oncol. Biol. Phys. 64 (2006) 862-868
4. T.S. Kehwar, Analytical approach to estimate normal tissue complication probability using best fit of normal tissue tolerance doses into the NTCP equation of the linear quadratic model, JCRT 1 (2005) 168-179