How the Choice of Beam Angles Affects the Dosimetry of OARs in IMRT of the Prostate

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Introduction

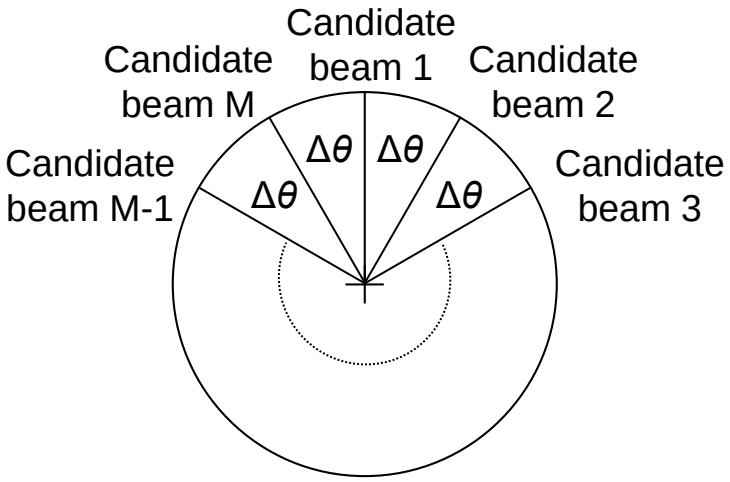
- Despite the widespread use of IMRT for 20 years, the question of how beam directions affect the dosimetry and, therefore, which beam directions are optimal remains open.
- Many beam angle optimization algorithms have been proposed, but the results cannot be independently verified.
- In this work, a large number of prostate IMRT plans are calculated and the results are analyzed to determine how the choice of beam angles affects the doses received by OARs (rectum and bladder)

Methodology

- Five prostate patients, previously treated to 86.4 Gy using a 5-beam IMRT plan were selected for this study.
- The patients were treated in the prone position
- For each patient, the clinical plan was used as the reference plan.
- For each patient, all the optimization constraints and parameters were kept fixed as in the clinical plan and only the beam angles were varied.

Methodology

- *M* candidate equispaced coplanar beams were defined in 360°
- *N* plan beams were selected from the pool of *M* candidate beams and the plan was calculated
- All combinations of *N* plan beams out of *M* candidate beams were used.



Methodology

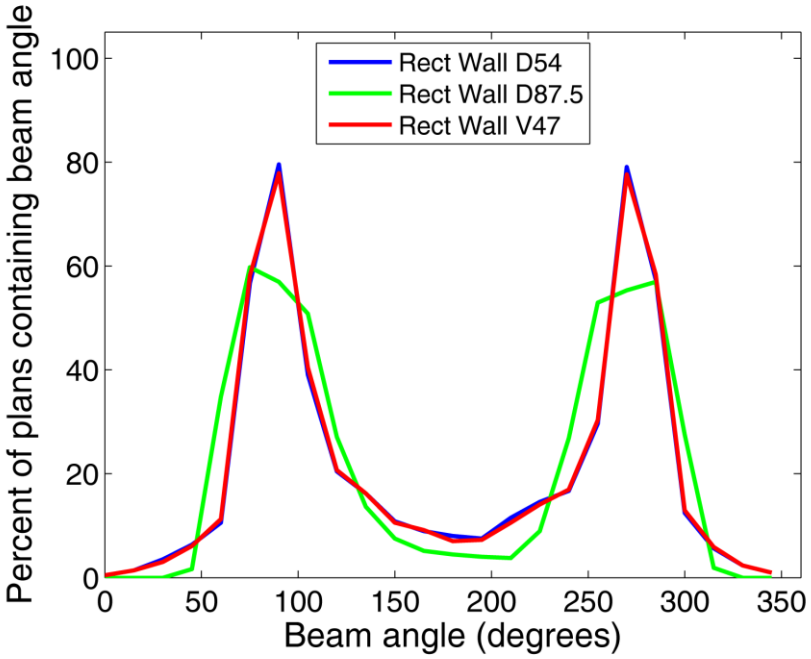
Number of plan beams (N)	Number of candidate beams (M)	$\Delta\theta$	Number of plans per patient
5	24	15°	42,504
6	20	18°	38,760
7	18	20°	31,824
8	18	20°	43,758
9	18	20°	48,620

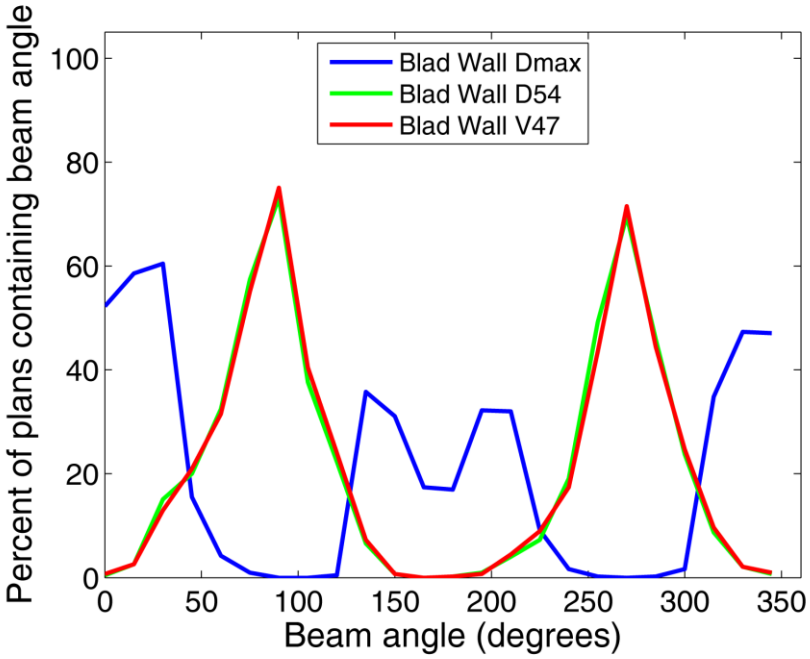
Methodology

- Additional constraints on the rectum (Rect_Wall) and bladder (Blad_Wall) were applied to bring forth differences in beam angle sets
- Plans were normalized so that Rect_Wall Dmax = 99%
- The best 1%, 2% and 5% of plans according to each OAR clinical dosimetric index were selected
- The frequency with which each beam angle appears in those best plans was calculated

Results

- Results are presented for 5-beam plans, where the choice of beam angles is more crucial
- Results are presented for the best 1% of plans. They are the same for the best 2% and 5% of plans





Conclusions

- Lateral beams are necessary to achieve low intermediate dose-volume endpoints
  - Rect_Wall D54, D87.5 and V47
  - Blad_Wall D54 and V47
- Posterior and anterior beams are necessary to achieve low Blad_Wall Dmax
- Optimal beam directions for low Rect_Wall Dmax are obscured due to normalization (Rect_Wall Dmax = 99%)