Dominant intraprostatic lesions boosting: comparison of tomotherapy, VMAT and IMPT

Andrzejewski P1,2, Jodka A3, Kuess P1,2, Georg D1,2, Malicki J3,4, Piotrowski T3,4

1Department of Radiotherapy, Comprehensive Cancer Center, Medical University of Vienna / AKH Vienna, Austria
2Christian Doppler Laboratory for Medical Radiation Research for Radiation Oncology, Medical University of Vienna, Austria
3Department of Medical Physics, Greater Poland Cancer Centre, Poznan, Poland
4Department of Electroradiology, University of Medical Sciences, Poznan, Poland

Introduction and objectives

For patients with recurring prostate cancer around 90% of relapses occur at the location of the primary tumor. That motivates further local dose escalation to avoid enhanced doses to rectum and bladder. Boosting the dominant intraprostatic lesions (DIL) is currently explored in clinical studies. The purpose of this study was to assess the feasibility of DIL boosting with tomotherapy and to compare it dosimetrically to previously evaluated VMAT and IMPT strategies based on the same objectives [1].

Methods

For twelve patients the DILs were defined on MRI scans and propagated to the respective CT images. For each patient a tomotherapy plan (6MV; fixed field width 1 cm; pitch 0.287, modulation factor ranged from 2.5 to 2.9) aiming at the escalation of the physical dose up to 95 Gy to the PTV DIL with a dose prescription of 77 Gy to the PTV prostate, delivered in 35 fractions as simultaneously integrated boost, was calculated. The following hard dose constraints were applied for rectum and bladder: V32 Gy ≤ 5%, V72 Gy ≤ 1 cc and V80 Gy ≤ 1 cc, respectively. PTV DIL and PTV prostate margins were 4/5/4 mm in LR/AP/CC directions, respectively. Resulting tomotherapy plans were compared to VMAT and IMPT plans. Furthermore, pelvic floor muscles, femoral heads, urethra and penile bulb dose indices and equivalent uniform doses (EUDs) were evaluated.

Results

The median EQD2/3α/β dose to the DIL was 113.4 Gy (3α/β) for tomotherapy while it was 2.7 Gy (3α/β) less for VMAT and 0.8 Gy (3α/β) more for IMPT. V95% (of prescribed dose) of 83.4% and 98.1% for PTV DIL and PTV prostate were best for tomotherapy, while with VMAT and IMPT 64.5, 94.6% and 80.0 and 92.9% was achieved (cf. Figure 1). Mean dose to the rectal wall and bladder wall were 26.4±5.0 and 19.3±5.5 Gy (3α/β) for tomotherapy, 30.5±5.0 and 21.0±5.5 Gy (3α/β) for VMAT, and 16.7±3.6 and 15.6±4.3 Gy (3α/β) for IMPT. The EUD for the other delineated organs was significantly lower for tomotherapy in comparison to VMAT (4.3 Gy on average), but higher than for IMPT (2.1 Gy on average). Figure 2 shows an example set of a patient’s dose distributions for all three treatment techniques.

Conclusions

Tomotherapy is a suitable EBRT modality to deliver DIL boost treatments. It performs better than VMAT in terms of achievable boost doses, target coverage and OARs sparing. However, besides achievable coverage it does not surpass IMPT. Although the obtained OAR doses were higher than those for a standard treatment approach, the risk levels tend to be reasonably low when comparing doses to the most exposed small volumes of OARs. Further studies on using TomoEDGE™ (that enables dynamic jaws usage) and CyberKnife® for DIL boosting are ongoing.

References