Dosimetric Comparison of VMAT and IMRT for NPC and Ca Prostate

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Background and Objective

IMRT improves dose conformity and sparing of organs at risk as compared to previous techniques. Volumetric Modulated Arc Therapy(VMAT) is a newly developed technique. Dosimetry comparison was performed between IMRT and VMAT. Two Cancer cohorts were selected for this study i.e. Nasopharyngeal Carcinoma (NPC) and prostate carcinoma. VMAT was concluded to be better than IMRT as it gives better treatment efficiency with same benefits as IMRT.

Methods

This study was conducted in Radiation Therapy Department of Institute of Nuclear Medicine & Oncology Lahore(INMOL).

- Five patients with NPC and ten patients with prostate Carcinomas were selected. All patients were of Stage 3/4 with tumor spread to adjacent lymph nodes. Their simulations were done with the help of TOSHIBA AQUILON CT scanner..
- Oncologist drew all target volumes of primary tumors and lymph nodes. All organs present near tumor sites were also delineated. Doses were prescribed to each target volume. For sparing of OARs, QUANTEC limits were followed.
- ECLIPSE TPS (version 15.6.04) was used. For VMAT, 2.5 Arcs were applied for NPC cases and 1.5 Arcs for prostate cases (Figure 1). For IMRT plans, 9 beams were planned for NPC cases, while 7 beams planned for prostate cases. (Figure 2).

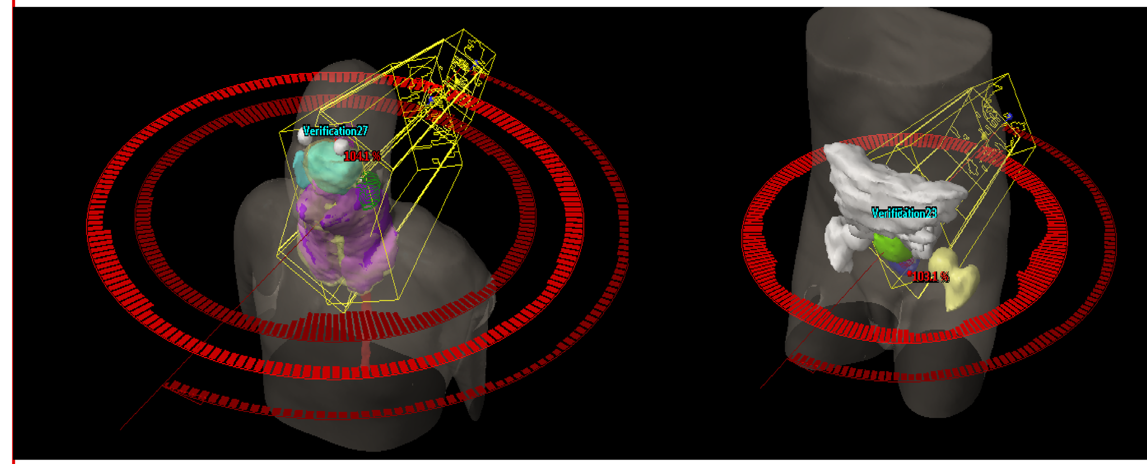

Figure 1: VMAT planned Arcs for this study.

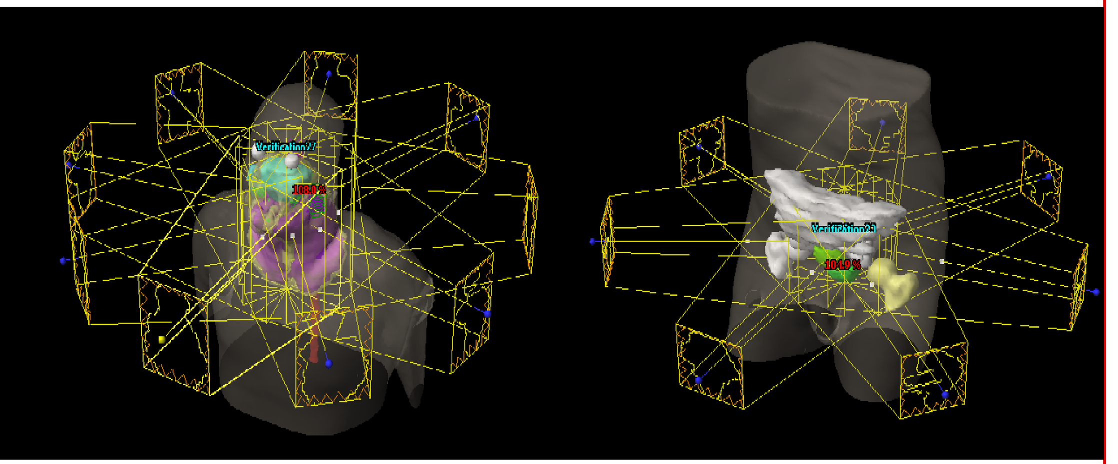

Figure 2: IMRT beams planned for this study.

Dose coverage according to ICRU 50 and ICRU 83.

- Conformity index (CI) CI = (D95 of Target Volume x Total Target Volume)/over lapping volume of above parameters
- Homogeneity Index (HI) HI = (D2 of Target Volume – D98 Target Volume) / Prescribe dose to target volume
- Tumor Coverage Factor (TCF) TCF = Target Volume receiving a reference dose / Total volume of Target
- Doses to OARs and Monitor Units required.

Results and Discussion

NPC Results:

Plans of both techniques achieved same level of dose coverage as of ICRU 50 criteria. Figure 3 shows dose coverage of one of NPC case of this study.

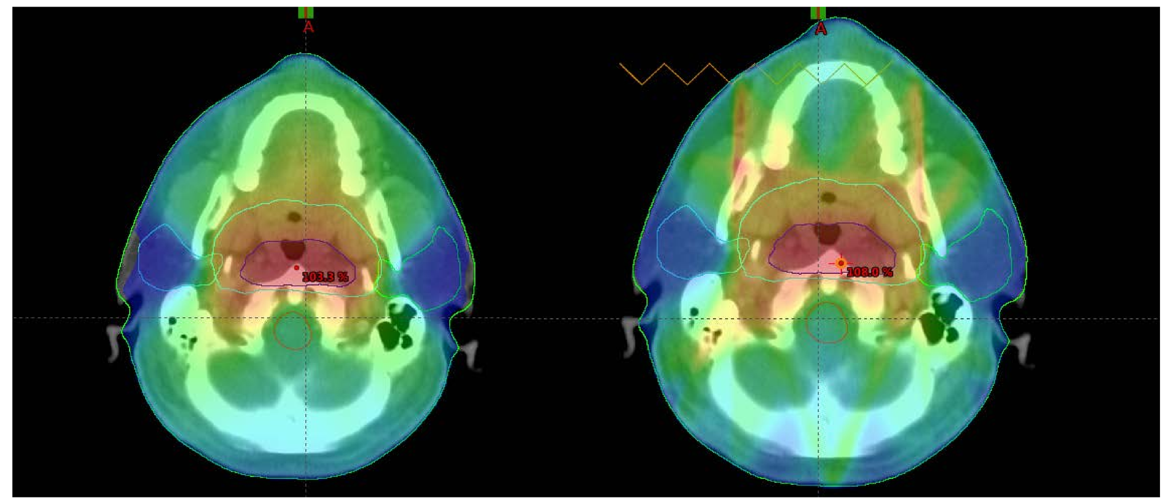

Figure 3: Dose Coverage of IMRT (right) and VMAT (left) in NPC case.

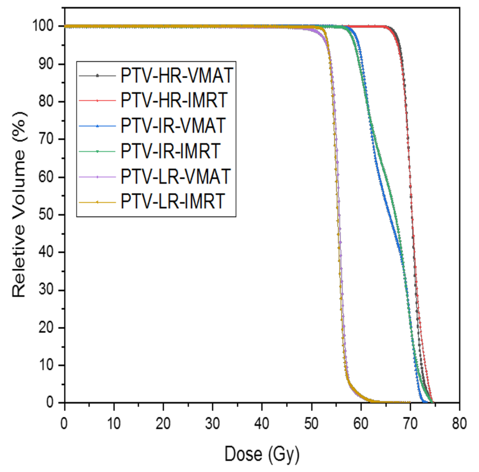

Figure 4: Average DVHs of PTV-HR, PTV-IR and PTV-LR in NPC Cases

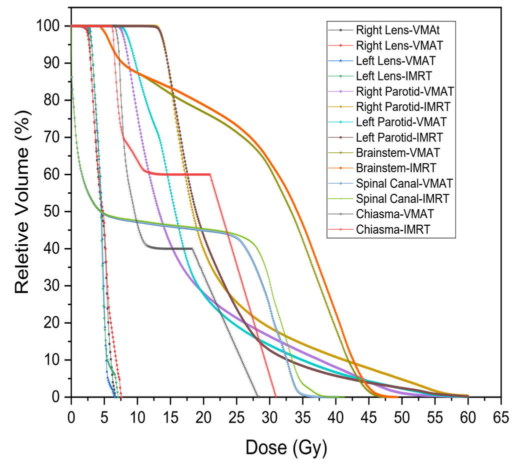

Figure 5: Average DVHs of Lenses, Parotids, Chiasma. Brainstem and Spinal Cord.

Following Table shows average values of some parameter evaluated for both techniques.

Parameter	VMAT	IMRT
Conformity Index	1.25	1.30
Homogeneity Index	0.08	0.07
TCF(PTV-IR)	0.966	0.974
TCF(PTV-LR)	0.964	0.984
Brainstem (Dmax)	48.42 Gy	49.26 Gy
Right Lens (Dmax)	6.74 Gy	7.56 Gy
Left Lens (Dmax)	6.59 Gy	6.91
Right Parotid (Dmean)	18.54 Gy	22.94 Gy
Left Parotid (Mean)	18.92 Gy	21.9 Gy
Chiasma (Dmax)	28.35 Gy	30.99 Gy
Spinal Canal (Dmax)	40.46 Gy	41.32 Gy
Monitor Units	468.4	2325.8

Prostate Results:

Plans of both techniques achieved same level of dose coverage as of ICRU 50 criteria. Figure 7 shows dose coverage of one of prostate case of this study.

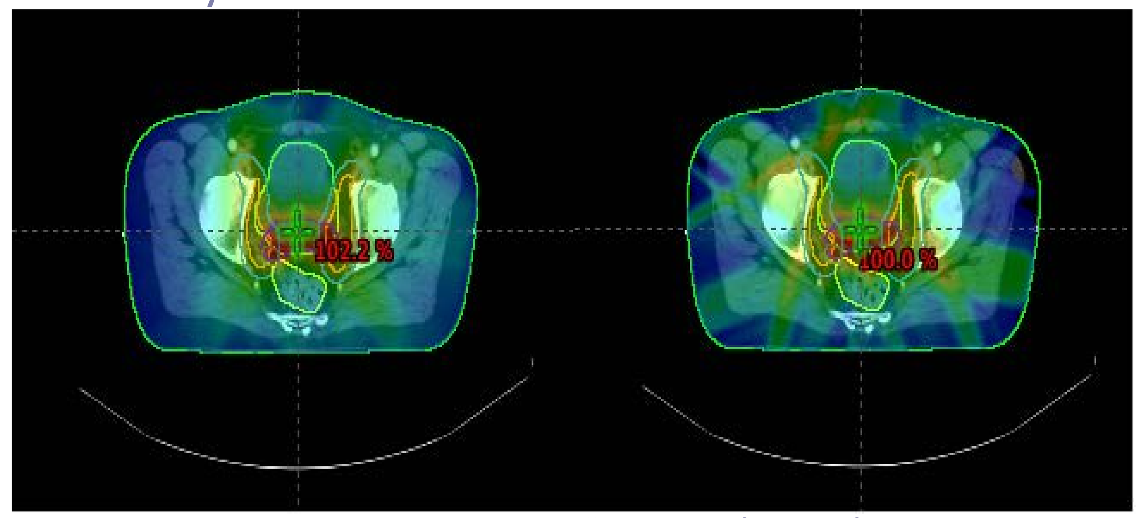

Figure 6: Dose Coverage of IMRT (right) and VMAT (left) in prostate carcinoma case.

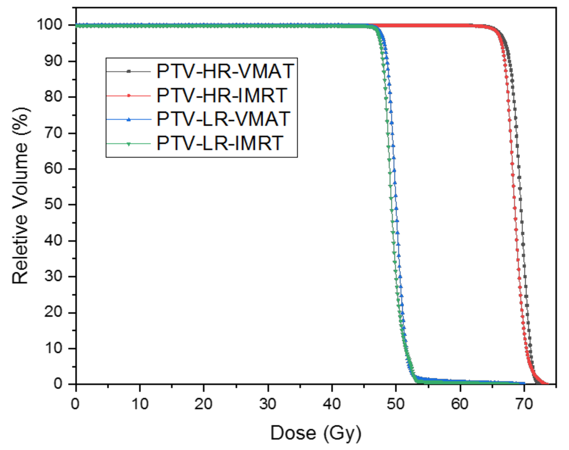

Figure 7: Average DVHs of PTV-HR and PTV-LR in prostate carcinoma cases.

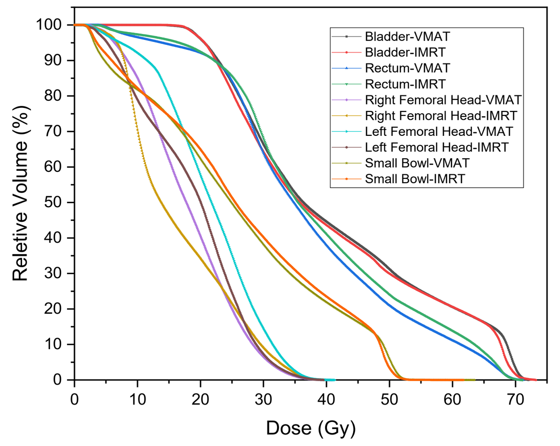

Figure 8: Average DVHs of Femoral Heads, Rectum, Small Bowl and Bladder.

Following Table shows average values of some parameter evaluated for both techniques.

Parameter	VMAT	IMRT
Conformity Index	1.16	1.24
Homogeneity Index	0.07	0.06
TCF(PTV-LR)	0.971	0.947
Bladder (V59,V68,V72)	(20.93,11.66,0.24)%	(21.38,8.09,0.25)%
Rectum (V45,V59,V68)	(29.07,12.26,2.55)%	(31.84,14.83,2.02)%
Right Femoral Head (Dmax)	40.1 Gy	39.77 Gy
Left Femoral Head (Dmax)	40.5 Gy	40.52 Gy
Small Bowl (mean)	25.79 Gy	26.58 Gy
Monitor Units	733.4	2149.1

Conclusions

- VMAT showed better conformity of doses in target volumes. IMRT was superior in homogeneity indices.
- All organs received lesser doses from VMAT except femoral heads. VMAT requires very less number of monitor units than IMRT.
- VMAT is superior than IMRT in terms of treatment efficiency and less scatter dose to patients.

References

[1] A. Mundit and J. Roeske, Intensity Modulated Radiation Therapy : A Clinical Prospective, London, BC Decker Inc, 2005.

[2] F. M. Khan and J. P. Gibbons, KHAN's Treatment Planning in Radiation Oncology, Wolters Kluwer, 2016.