Optimal Choice of Flattening Filter Free Beam for SBRT in Carcinoma of Lung

R KINHIKAR[1] P AGARWAL[2], R Barman [3], S Kale[s] , E Dandpani [6], N Mummudi [7] , A Tibdewa1[8] , J AGARWAL[9], S Hazarika[4],

1,2,3,4,5,6,7,8,9 Tata Memorial Centre, Mumbai, 1,9 Homi Bhabha National Institute, Mumbai

JULY 12–16 2020 VIRTUAL JOINT AAPM | COMP MEETING
EASTERN TIME [GMT-4]

INTRODUCTION

Stereotactic Body Radiation Therapy (SBRT) has become a preferred choice to treat patients with Lung Cancer as seen in its clinical advantages over other modalities. Challenging to treat, because of

- Complex shaped target, Lung Motion
- proximity to other critical organs (Normal Lung, Spinal Cord, Heart, Esophagus etc.)
- Tissue – Air heterogeneity

AIM

To estimate the dosimetric differences of various energies (6XFF, 6XFFF and 10XFFF) in case of Lung Stereotactic body radiotherapy (SBRT) volumetric modulated arc therapy (VMAT) treatment planning in terms of following dosimetry indices to choose the optimal energy

- Coverage Index (CI)
- Conformity Index (COIN)
- Homogeneity Index (HI)
- Treatment Time (TT), &
- Organ at Risk doses (Normal Lung, Heart, Spinal Cord, Esophagus)
- Delivery Quality Assurance

METHODS

- Eleven patients (5 left lung and 6 right lung) of stage I non-small cell lung cancer (33 plans) treated with SBRT using 6MV FF photon beams were selected for the study.
- All three plans for one patients were generated using two partial arcs, same optimization constraints on Eclipse treatment planning system (version 13.5) & calculated using Acuros Algorithm.
- The prescription dose to PTV was 60 Gy in 8 Fractions .
- The clinical acceptance of plan was set using RTOG guidelines 0813 & 0913.
- The three VMAT plans were analyzed qualitatively and quantitatively for PTV and organ at risk (OAR) doses.
- All 6XFFF and 10XFFF plans were scaled w.r.t. 6XFF plans for OARs comparison.
- Delivery quality assurance (DQA) for each plan performed with PTW Octavious-4D Phantom.
- In addition, point dose measurements performed by cc-13 thimble chamber.

RESULTS

Quantitative Analysis for PTV :- The dosimetric parameters for PTV evaluations were tabulated below.

Index	6MV FF Mean ± SD	6X FFF Mean ± SD	10X FFF Mean ± SD
CI	96% ±0.008	96% ±0.008	94% ±0.012
COIN	0.956±0.036	0.957±0.037	0.936±0.043
HI	1.109±0.01	1.108±0.01	1.128±0.02
TT (min)	3.37 ±0.41	**1.55±0.21**	**1.13±0.13**

Table 1:- Quantitative Analysis for PTV and Treatment time (min)

Quantitative Analysis for OARs :- The OARs doses obtained with 6XFFF and 10XFFF, normalized w.r.t. 6XFF were given below in the pattern of Bar diagram.

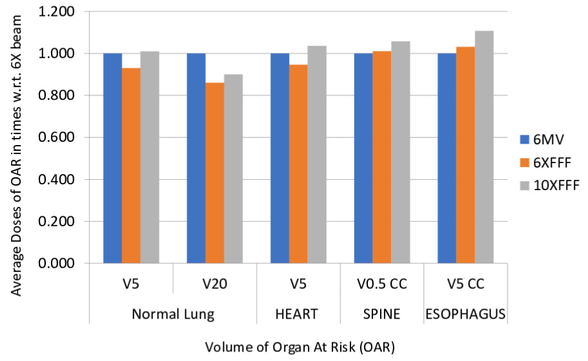

Fig1:- Bar Diagram between the Volume of OAR vs Average doses of respective OAR, normalized w. r. to 6X Beam value.

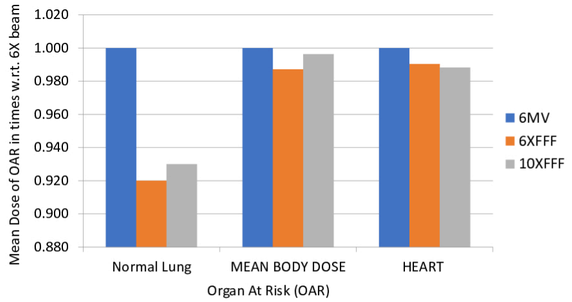

Fig 2:- Bar Diagram for OAR vs Average of mean dose Values of OAR, normalized w. r. to 6X Beam value.

Delivery Quality Assurance :-

Energy	Gamma Value	Range in % (min - max)	Gamma Value	Range in % (min - max)	Difference between TPS & Measurements	Range in % (min - max)
	3%, 3mm		2%, 2 mm		in %	
6XFF	96.5 ± 1.12	(94.7 - 98.7)	86.1 ± 3.28	(80.8 - 90.3)	2.22 ± 0.38	1.16 - 3.08
6XFFF	96.± 1.04	(94 - 97.5)	84.7 ± 3.08	(78.5 - 89.1)	2.40 ± 0.97	1.06 - 4.15
10XFFF	97.4 ± 1.31	(94.1 - 99.1)	88.4 ± 3.41	(81.4 - 93.6)	2.68 ± 0.96	0.75 - 4.23

TABLE 2: Summarizing the DQA for 3%, 3mm fluence, 2%, 2mm fluence and Absolute Dose variation between TPS & Measurements with range

Qualitative Analysis for PTV :-

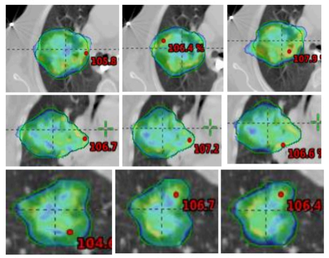

Fig 3 :- 95% dose of prescription dose to PTV in Axial, Frontal and Sagital views for 6XFF, 6XFFF & 10XFFF beams respectively from left to right.

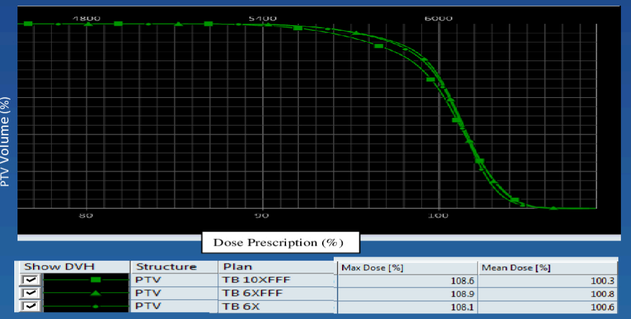

Fig 4: - Dose Volume Histogram analysis for PTV Coverage Index for all three energies 10XFFF, 6XFFF & 6XFF plans respectively

CONCLUSIONS

- FFF beams with relatively higher dose rate were certainly beneficial to reduce treatment time which may help to reduce intra fraction error. less
- Observed significant reduction in normal lung volume (v5 & v20)

The optimal plan can be obtained with **6X_FFF** fordelivered dose rate of 1000-1200 Mu/min with no compromise with coverage index, conformity index and OAR doses.

ACKNOWLEDGEMENTS

None, No conflict of interest.

REFERENCES

- Hrbacek J, Lang S, Graydon SN, Klöck S, Riesterer O. Dosimetric comparison of flattened and unflattened beams for stereotactic ablative radiotherapy of stage I non-small cell lung cancer. *Med Phys*2014; 41: 031709.
- Fogliata A, Nicolini G, Clivio A, Vanetti E, Cozzi L. Critical appraisal of Acuros XB and anisotropic analytic algorithm dose calculation in advanced non-small-cell lung cancer treatments. *Int J Radiat Oncol Biol Phys* 2012; 83: 1587–95.

CONTACT INFORMATION

Rajesh A. Kinhikar, Professor & Head, Department of Medical Physics, Tata Memorial Centre, Mumbai, India 400012. Email: rkinhikar@gmail.com