COMPARISON OF PLANNING TARGET VOLUME USING 4DCT IN LUNG TUMORS OF THREE DIFFERENT LOBES

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INTRODUCTION

- Lung tumors are characterized by uncontrolled cell Growth In tissues of the lung . Classified as small cell (SCLC) or non-small cell carcinomas (NSCLC).
- Radiation therapy remains One of the important modalities for lung tumors.
- Involuntary organ motion like respiratory intra – fraction motion During radiotherapy are likely to introduce errors in dose delivery By irradiating excess of normal tissue and missing target volume.
- One of the method to overcome breathing motion is 4D-CT

WHAT IS 4 DIMENSIONAL COMPUTED TOMOGRAPHY (4DCT) ?

4-dimensional CT (4DCT) images consist of a series of images representing the patient's anatomy at different points in the breathing cycle. The fourth dimension refers to time/motion.

METHODS AND MATERIALS

PATIENT SELECTION

Three patients with lung tumors, one each involving Upper lobe, Middle lobe and Lower lobe, who were planned for SBRT were included in the study.

4DCT SCAN PROCEDURE

GE Advantage 4D software sorts the reconstructed 4DCT images into ten respiratory phases, following which MIP (Maximum Intensity Projection) CT images were reconstructed, images were reconstructed using a thickness of 2.5 mm.

GTV DELINEATION

GTV were manually delineated in each of 3DCT scans and 4D MIP scan

- GTV_Free breath
- GTV_4D MIP

ITV CREATION

For 3DCT scans acquired in free breathing, ITV_Free breath was created by giving an arbitrary margin to GTV_Free breath depending on location of lung tumor – 5mm margin for upper lobe lesion, 10mm margin for middle lobe lesion and 20mm craniocaudally and 10mm margin in other directions for lower lobe lesion.

PLANNING TARGET VOLUME

Individual PTV for each ITV was generated by a uniform margin of 3mm to account for setup errors.

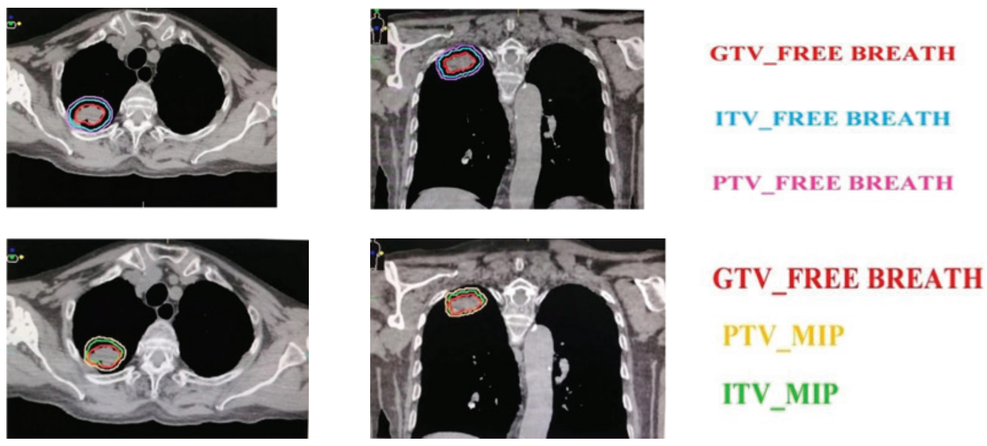
RESULTS

TARGET VOLUME COMPARISONS

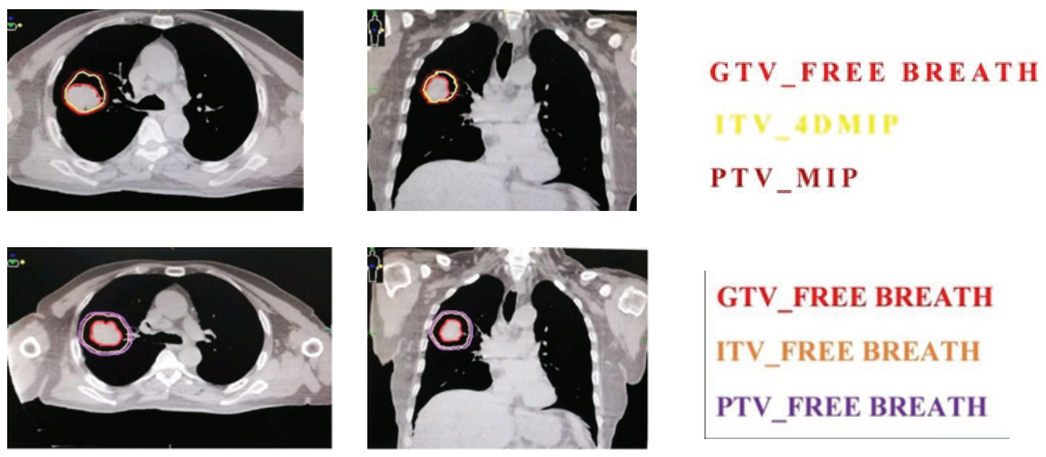
	Patient 1 - Upper Lobe lesion	Patient 2 - Middle Lobe Lesion	Patient 3 - Lower Lobe lesion
GTV (cc)	9.05	28.6	6.7
PTV 1 [PTV_Free breath] (cc)	44.9	155.9	109.7
PTV 2 [PTV_Inhale /exhale] (cc)	23.2	58.2	32.9
PTV 3 [PTV_4D MIP] (cc)	24.5	63.0	25.8
PTV 1 – PTV 3 (%)	45.4%	59.6%	76.5%
PTV 1 – PTV 2 (%)	48.3%	62.6%	70.0%

Average percentage reduction in PTV for all 3 patients with use of 4DCT and Inhale/Exhale breath hold methods is 60% compared to 3DCT free breathing method

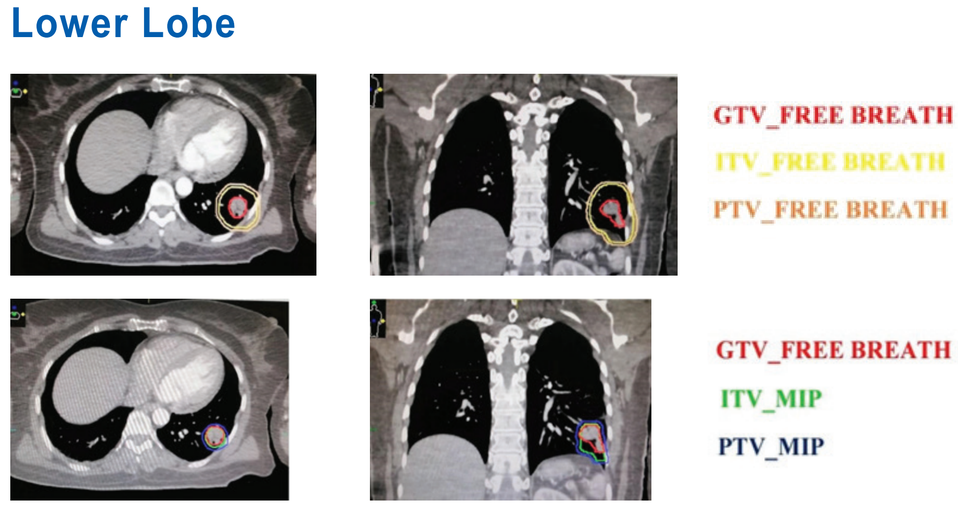
Upper Lobe



Middle Lobe



Lower Lobe



DISCUSSION

In this study, it was observed that use of 4DCT scans helped reduce PTVs by an average of 60% each in comparison with PTV in which ITV was obtained by an arbitrary margin based on location. This marked reduction was noted in all 3 tumor locations. The magnitude of reduction was seen to be progressively higher from upper > middle > lower lobe lesion as expected in view of progressively increasing tumor motion.

CONCLUSION

A Motion management technique is of utmost importance in the treatment of lung tumors using radiation therapy, irrespective of fractionation.

4DCT simulation scan provides an individualized approach to patients in encompassing the motion of lung tumors in different locations, correlating with respiratory cycle. It provides a reconstructed MIP and average Projection images which can help in a better ITV estimation and thus reduced the volume of normal lung irradiated.

Thus a safe balance between effective tumor control and Normal tissue toxicity is feasible.

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