ABSTRACT

INTRODUCTION: In the carcinoma lung patient, endobronchial brachytherapy (EBBT) is used as treatment modality. The radiation dose to the tumor is planned in the treatment planning system (TPS) on the CT scan of the patient and treatment delivered by the machine. Treatment plan verification, dosimetric, volumetric analysis is necessary to perform for accurate treatment delivery to the patient, which requires a tissue equivalent phantom model mimicking the actual thoracic body structure because in the actual patient, dosimetry is not possible. In this study, the dosimetric analysis is performed in the locally fabricated human tissue equivalent thorax phantom with the help of Radiochromic film dosimeters. Dosimetric and volumetric analysis is performed on patients treated with EBBT technique.

AIM: (i) A method for treatment plan verification for high-dose-rate endobronchial-brachytherapy using Radiochromic film dosimetry system. (ii) Dosimetric and Volumetric analysis in endobronchial brachytherapy in Lung carcinoma patients. (iii) To analyze the target volume variation between third and first Endobronchial brachytherapy sessions in carcinoma lung patients.

MATERIALS AND METHODS: A thorax human body tissue equivalent phantoms was fabricated using the tissue equivalent material. The phantom was scanned in the PETCT Scan machine (GE Healthcare Pvt. Ltd.) and transfers the scanned CT data into the treatment planning system (TPS) Oncentra Master Plan (Elekta Medical System Pvt. Ltd.). An endobronchial brachytherapy plan was created in the TPS and exported to the microSelectron HDR brachytherapy machine for irradiation. Placed Gafchromic EBT3 film at the desired locations in

the phantom and irradiate the TPS plan. The 3D TPS calculated dose values in the phantom were compared with film measured dose values in the phantom.

Ninety EBBT sessions of carcinoma lung patients were analyzed for dosimetric and volumetric assessment. Two groups with equal number of patients in each group of left and right side lung tumor were made to analyze the effect of tumor location, site and target volume (TV) on OARs doses. Position the catheter in or very close to the tumor growth. Computed tomography (CT) scan was acquired with dummy source in the catheter after checking the catheter with source position simulator tool in all EBBT sessions. Exported the CT scan to TPS where an optimized treatment plan was created. Delineation of the TV and OARs were done by the Radiation Oncologist on each patient's CT image set. The dose per fraction was 7Gy and prescribed at 1.0cm from the catheter. Each patient was planned for three EBBT sessions.

Doses to OARs and effects of TV on OAR's doses were assessed from "Dose Volume Histogram (DVH) tool" in TPS. These doses were entered in the excel worksheet and import this data into SPSS software to perform the statistical analysis.

RESULTS: The experiment was carried out in the tissue equivalent phantom with Radiochromic film placed at the dosimetric location and irradiation with the Ir-192 microSelectron HDR brachytherapy unit. The TPS calculated and Film measured dose values were found with 2.5%, 3.2% 7.1% & 9.4% more for Heart, Esophagus, Pulmonary trunk & Lt. coronary artery respectively and 3.8%, 2.4%, 5.3%, 17.75% & 7.1% lower dose for spinal cord, descending aorta, Ipsi-lateral Lung, Ipsi-lateral lung (2cm depth) & contra lateral lung respectively.

Dosimetric and volumetric assessment was performed in study group and sub group. The OARs mean doses received in 1^{st}, 2^{nd} and 3^{rd} session of EBBT in all thirty patients were analyzed and

found the doses were in the tolerance limit for all the OARs. The average mean and maximum dose to Esophagus, Heart and average max dose to Contralateral Lung, Left Coronary artery, Spinal cord, Descending Aorta and Trachea were higher in left lung carcinoma than right lung carcinoma patients and doses to OARs in subgroup middle_lower bronchial section were higher compared to lower bronchial region. The effects of TV on OAR's doses were significantly differ in TV>22cc group, amongst left side and right-side tumor while no significant difference was found in OAR's doses in TV<22cc group amongst left and right-side tumor lesion patients except Contralateral Lung maximum dose.

The average volume of Target volume was 24.49cc and 17.20cc in first and third EBBT session respectively. This showed Target Volume reduced in 3rd session compared to first session of EBBT. The Conformity Index was calculated for 1^{st} and 3^{rd} EBBT sessions of the patients where CI is found better in 3^{rd} session compared to 1^{st} session of EBBT.

CONCLUSION: It is found that there is a variation in the doses measured in phantom and calculated in TPS. This variation is due to the calculation algorithm in brachytherapy TPS so it is important to perform a quality assurance verification of the treatment plan before the execution in the patient to assure the accuracy of the treatment delivery to the patient. The fabricated phantom is cheaper and can be utilized in the brachytherapy patient specific quality assurance of carcinoma lung patients.

The doses to OAR's were evaluated and found that in left lung carcinoma doses increased significantly than right lung carcinoma patients. Also, the target volume was large in middle_lower bronchial region then lower bronchial region so the doses found more in middle-lower bronchial region as compared to lower bronchial region. It showed that the doses to OARs

increased when volume of the target was large. The effect of the target volume on OAR's doses was found significant for TV>22cc and not significant for TV<22cc except Contraleteral Lung maximum dose. EBBT is found effective treatment in endobronchial lesion.

This study showed that in thirty patients the target volume was reduced significantly in EBBT treatment. CI is found better in 3rd session compared to 1st session of EBBT. This implies that the EBBT is better technique in the lung carcinoma patient where the disease is in endobronchial region and applicator catheter can be placed easily.

KEYWORDS: Thoracic tissue equivalent phantom, Film dosimeter, lung tumor, TPS, PET CT. "Endobronchial brachytherapy, Oncentra Master Plan Treatment Planning System, Organ at Risk, Target Volume, Fraction, dose-volume-histogram",