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Comparison of CT and PET-CT based gross tumor volume (GTV) and organs at risk (OAR) in IMRT of head and neck cancers: institutional experience

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Aim- To compare the gross tumor volume **(GTV)** and organ at risk **(OAR)** identified on CT to that obtained from fusion of PET and CT images i.e. hybrid PET-CT in IMRT planning for head and neck cancer.

Material and Methods - Twenty five patients with primary carcinoma of the oropharynx and hypopharynx were included in this study after thorough history, physical examination, laboratory, histological and imaging testing. Patient immobilization was done by four clamp thermoplastic device. Separate CT and PET-CT simulation was done. Target volume (GTV) and Organs at risk (OAR) delineation was done by the same physician on separate CT and PET-CT images. A treatment margin was added to the CT GTV and PET-CT GTV separately to create the PTV. The planning dose prescribed for the study was 66Gy/33#@ 2Gy per fraction to the PTV containing the gross tumor volume. Different PTV pertaining to the macroscopic extension and microscopic extension (low dose PTV) were drawn. Two different IMRT plans were made for PET_CT and CT. Two different plans were made, one for the CT_PTV and other PET-CT_PTV and DVHs were generated for all critical normal structures. All the plans were generated with the standard dose prescriptions and the dose constraints of all the organs at risk were respected according to QUANTEC.

Observations and Results –The following parameters were observed-

- The effect of PET and CT image fusion on change in Staging,
- Gross Tumor Volume
- Dosimetric Comparisons of Organs At Risk between the CT only and PET-CT Plans. Hybid PET/CT imaging led to a change in staging in 7 out of 25 patients i.e. 28% as compared to CT alone in our study. Out of these 7 patients, Upstaging was seen in 5 patients and the remaining 2 were downstaged. In the rest of 18 patients i.e. 72% there was no change in the staging. The mean target volume of GTV as defined by CT alone, PET alone and PET/CT combined is 28.52 ± 15.08, 19.35 ±9.31 and 32.42 ± 15.92 cc. PET-GTV was smaller than CT-GTV in 20 out of 25 cases i.e. 80% and larger than CT-GTV in 5 out of 25 cases i.e. 20%. The mean CT-PTV AND PET-CT-PTV were found to be 252.17 ± 91.74 cc and that of pet-ct-ptv was 228.90 cc. The statistical tests between the CT-GTV & PET-CT-GTV and CT-PTV and PET-CT-PTV were found to be significant (p value 0.004 and 0.017 respectively).The mean dose received by different organs at risk as a result of CT and PET-CT based planning was calculated and found to be significantly different for spinal cord, pharyngeal muscles and both cochlea ('p'value 0.057, 0.06 and 0.02 respectively).However, that of brainstem and bilateral parotid was found to be insignificant.('p' value –0.34 and 0.58).

CT is still considered the standard for treatment planning volumes and PET can be used for greater target delineation to avoid the geographical misses. But the larger gross tumour volumes would also put greater demands on complex planning to reduce the dose to organ at risk. Thus the added benefit of including the geographical misses can be impacted negatively by the close approximation of dose to the critical organs and this needs further prospective studies.
With the advent of adaptive radiotherapy, using the fusion of PET and CT images during the course of radiotherapy is a promising approach to changing dose distributions and can be utilised for dose escalation strategies.

Conclusion- 18F-FDG in oncology is a Gold standard as non-invaive functional imaging. In head and neck cancer, it has not been recommended for primary tumour as a lone modality, but only in conjunction with CT/MRI. Fusion of PET and CT images i.e. combined PET-CT can improve the GTV delineated on CT alone, highlight the unknown areas of disease and prevent geographical misses which possibly can over a long time, reduce the local recurrences and FDG- avid nodes can also be used for dose escalation.
Based on our data as well as review of literature results, the incorporation of PET information may act as an adjuvant for radiotherapy planning and allow usage of highly conformal and biologically effective treatment.

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