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Impact of Adaptive Image Guided Radiotherapy on Parotid Sparing in Head and Neck Cancer

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Abstract: ***Objectives: The aim of this study was to assess volume change in parotid glands and its clinical implication in form of late xerostomia in patients receiving adaptive radiotherapy for treatment of primary squamous cell carcinoma of head and neck region. Materials & Methods: Clinical data of 50 patients who received adaptive radiotherapy was compiled for analysis. Dosimetric assessment was done using Dose Volume Histograms (DVH). Radiation induced xerostomia was documented at week 1, 3, 5 and 7 during the treatment and at 3 and 6 months on follow up. Results: Volume reduction of right parotid was 12.98%, 23.3% and 33.15% whereas percentage volume change in left parotid was 6.25%, 16.37% and 28.39% at these time intervals. Thirty percent patients had grade 2 or higher salivary gland toxicity at 3 months. Fifty two percent patients were free of any xerostomia reactions at 6 months follow up and only 9% had grade 2 or higher salivary gland toxicity. Conclusion: Volume change in bilateral parotid glands occurs continuously throughout the course of radiation treatment. Parotid gland sparing and reduction in grade 2 or higher xerostomia can be achieved with excellent precision in adaptive radiotherapy.***

Keywords: adaptive radiotherapy, head and neck cancer, xerostomia, image guided radiotherapy

1. Introduction

Head and neck cancer comprises of epithelial malignancy arising from paranasal sinuses, nasal cavity, oral cavity, pharynx, and larynx. Almost all of these epithelial malignancies are squamous cell carcinoma (SCCHN). [1-3] It is the most common malignancy in Indian males and constitutes of third of all cancers in India. Head and neck carcinomas are treated with a multi-modality approach. [4-6] Radiotherapy is an effective adjuvant and radical treatment option for head and neck cancers for improved tumor control and better survival. Image Guided Radiotherapy (IGRT) comprises of any imaging done before, during or after the delivery of radiation treatment, to improve and verify the accuracy of radiotherapy. [7]

With regular use of image guided radiotherapy, many patients of SCCHN receiving fractionated RT showed marked anatomical changes during the course of their treatment. These alterations in patient anatomy during treatment account for changes in both target volumes and OARs. This could have a dosimetric implication in form of differences in planned and delivered doses to the patients, which can alter the course and outcome of the treatment. [8] This has given rise to a new concept in form of adaptive radiotherapy (ART). ART has been utilized to compensate the uncertainties, including organ deformation and patient motion as well as dosimetric errors associated with these changes. This strategy has the potential to provide the delivery of the most conformal and most accurate dose distributions which may even help improve patient outcomes. [9]

2. Literature Survey and Aim

Initial retrospective studies have been able to identify prognostic factors for tumor volumetric reduction, patient factors which define need of ART, local control and toxicity profiles related to ART as well as the quality of life advantages of ART.[10-12] However there is no single consensus guideline regarding implementation of adaption during the course of radiotherapy.

The aim of this study was to assess volume change in parotid glands and its clinical implication in form of late xerostomia in patients receiving adaptive radiotherapy for treatment of primary squamous cell carcinoma of head and neck region.

3. Material & Methods

Data of 50 patients of primary squamous cell carcinoma of head and neck region presented at our institute who received adaptive radiotherapy was compiled for analysis. All the patients underwent CT simulation with a 4 clamp thermoplastic mask on GE Optima CT520 simulator. The scan was performed using a slice thickness of 2.5 mm with external fudicial markers and alignment lasers. The Digital Imaging and Communications in Medicine (DICOM) images were transferred for contouring to MIM Maestro v6.5.

The target and the organs at risk were contoured as per ICRU 83 guidelines. Gross tumor volume (GTV) was contoured to include gross visible disease on CT scan and Clinical Target Volume (CTV) included high and low risk sub clinical disease areas as per risk evaluation. Organs at Risk (OARs) were also marked on MIM Maestro contouring station. PTV margin of 3 mm was generated over CTV for all patients. The dose was prescribed to the PTV using 95% isodose line. The doses to OAR were also taken into account to prescribe PTV dose using Quantitative Analyses of Normal Tissue Effects in the Clinic (QUANTEC). MONACO v5.11.0 planning software was used to generate a VMAT plan using simultaneous integrated boost (SIB) technique. All the patients were treated with conventional

dose fractionation using a five days per week treatment schedule. Dosimetric assessment was done using Dose Volume Histograms (DVH). Treatment was executed on Elekta Versa HD Linear Accelerator. Online image guidance in form of X ray Volumetric Imaging (xvi) version R5.0 was taken daily or on alternate days as per institutional practice.

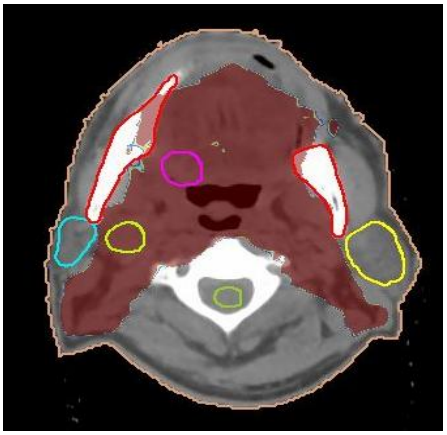

Figure 1: Radiation treatment plan showing Gross Tumor with bilateral parotid gland

All the patients were simulated again at start of 3rd week, 5th week and 7th week. Recontour and replanning were done using similar protocol on MIM Maestro. Predefined adaptive recontouring workflow which uses deformable image registration was applied on all the CT scans. Volumetric changes in Gross tumor volume and OARs were assessed for all patients. Plans were generate for all patients on MONACO 5.11.0. DVHs were generated for all the adaptive plans. The dosimetric analysis for Adaptive plans was done on MONACO and all the generated plans from repeated scans were sent to MOSAIQ. The plans were executed for the remaining fractions. All the patients were analysed on MIM Maestro 6.5 and MONACO 5.11.0 for multiple variables. Volume of Left Parotid (V-Parotid Lt) and Right Parotid (V-Parotid Rt) were assessed at week 1, 3, 5 and 7. Radiation induced adverse toxicity reactions were documented as per the RTOG Toxicity Criteria for acute xerostomia at week 1, 3, 5 and 7 during the treatment and late xerostomia at 3 and 6 months. Data was statistically analyzed on SPSS software (version 17, SPSS, Chicago, IL).

4. Results and Discussion

On demographic analysis mean age of presentation was 52 years. Forty one male patients were recruited in the study and 9 female patients were included. Most common site of presentation was Larynx (36%) followed by Oropharynx (24%). Most of the patients presented in stage III or IV.

Lee et al [10] observed continous reduction in the volume of parotid glands over the course of fractionated radiotherapy and concluded that dose to parotids can be reduced by almost 3 Gy with adaptive radiotherapy.

Table 1: Volume change in parotid during adaptive RT

Time Interval	Right Parotid (% change)	Left Parotid (% change)
Week 3	12.98	6.25
Week 5	23.30	16.37
Week 7	33.15	28.39

Table 1 shows percentage parotid volume change observed in our study at week 3, week 5 and week 7. Percentage volume reduction of right parotid was 12.98%, 23.3% and 33.15% whereas percentage volume change in left parotid was 6.25%, 16.37% and 28.39% at these time intervals.

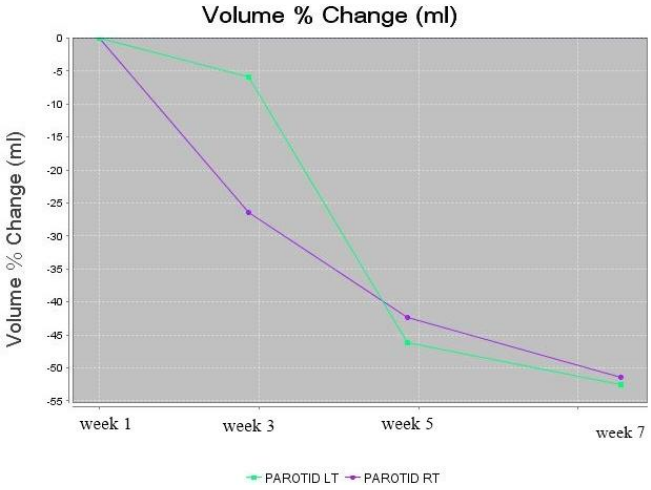

Figure 2: Volume change in bilateral parotid glands

Castelli et al [13] observed that adaptive replanning during radiotherapy in treatment of head and neck carcinoma reduces parotid gland volume being radiated in higher dose zone. this converts into reduction in xerostomia by 11% as compared to radiotherapy without adaption.

Table 2: Acute Xerostomia.

		Grade 0	Grade 1	Grade 2
Week 3	Count	17	28	5
	%	34.00%	56.00%	10.00%
Week 5	Count	5	27	18
	%	10.00%	54.00%	36.00%
Week 7	Count	2	9	25
	%	5.56%	25.00%	69.44%

In our study we observed population of patients having acute xerostomia (Table 2). At week 3, sixty six percent patients had grade 1 or higher reactions. The xerostomia increased in severity over the course of the treatment and almost 70% patients had grade 2 reactions at week 7.

Table 3: Late Xerostomia

		Grade 0	Grade 1	Grade 2	Grade 3
Month 3	Count	19	16	14	1
	%	38%	32%	28%	2%
Month 6	Count	26	13	11	0
	%	52%	26%	22%	0%

Kataria T et al [14] in their attempt to document late xerostomia in patients receiving adaptive radiotherapy observed that more than 40% patients had grade 1 or higher salivary gland reaction at follow up. Upon analysis of late xerostomia reactions thirty percent patients had grade 2 or higher salivary gland toxicity at 3 months. Fifty two percent patients were free of any xerostomia reactions at 6 months follow up and only 9% had grade 2 or higher salivary gland toxicity

5. Conclusion

From our study we conclude that volume change in bilateral parotid glands occurs continuously throughout the course of radiation treatment. Parotid gland sparing can be achieved with excellent precision in adaptive radiotherapy. Regular assessment of change in parotid volume and position in relation gross tumor makes dose escalation feasible in image guided radiotherapy. Adaptive radiotherapy has shown potential to help reduce xerostomia.

6. Future scope

Adaptive Radiotherapy is a newer modality that requires state of the art technology and increased man hours. Adaptive Radiotherapy when applied in carefully selected patient at proper time interval, holds potential for better treatment outcomes as compared to non adaptive radiotherapy. Detailed research work in the field of adaptive RT can provide practice changing evidence this new field of Radiation Oncology. With development of more robust planning and treatment delivery tools adaptive radiotherapy has the potential to become a routine practice.

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