ORIGINAL ARTICLE

ASSESSMENT OF PAROTID SALIVARY GLAND FUNCTION IN HEAD AND NECK CANCER PATIENTS RECEIVING RADIATION THERAPY USING QUANTITATIVE SALIVARY GLAND SCINTIGRAPHY

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Background: Radiation therapy for cancer of the head and neck region often causes salivary gland dysfunction and xerostomia. Several reports suggest that the submandibular and sublingual glands may be less radiosensitive than the parotid glands. The effect of radiotherapy on parotid gland function was studied by salivary scintigraphy in patients irradiated with different doses of radiation in the head and neck region. The purpose of this study was to evaluate differential dose of radiation effects on the parotid glands using quantitative salivary gland scintigraphy (QSGS). **Methods:** Thirty-five patients with head and neck tumours were enrolled in a prospective salivary function study using Scintigraphy. Twenty-seven of thirty-five patients received different doses of radiation and remaining 8 patients did not receive radiation and they were considered as control. Stimulated parotid flow rate was measured in all the patients from scintigraphy of parotid glands. **Results:** Patients who received radiation dose of ≥50 Gy showed severe salivary dysfunction when compared to patients who received radiation dose <50 Gy. Overall, patients who received radiation showed significant dysfunction of parotid gland when compared to patients who did not receive radiotherapy. **Conclusion:** Dysfunction of the parotid salivary gland increases as the radiation dose increases. QSGS appears to be a useful toll in qualitatively and quantitatively evaluating the grade of dysfunction following radiotherapy.

Keywords: Head and neck cancer, parotid glands, radiotherapy, salivary scintigraphy xerostomia

INTRODUCTION

Radiation therapy is one of the primary modalities for treatment of head and neck cancers. Radiation therapy in this region is associated with acute & late side effects related to the salivary glands, mucosa etc, as these regions are within the irradiation beam.[1] The reduction in salivary flow due to salivary gland damage is of particular clinical concern.[2] The parotid salivary glands produce the majority (60-65%) of the oral salivary output.[3] Unintentional exposure of the parotid glands to radiation during cancer treatment results in reduced flow of saliva. Without adequate parotid gland function, an individual will experience severe impairment of oral health,[4] which contributes to several complications like dry mouth, difficulty in speaking & swallowing, loss of taste, dental caries and ulceration of oral mucosa. In many studies, xerostomia (dry mouth) was found to be the most common late side effect of irradiation of head and neck malignancies and the major cause of decreased quality of life.[5-8] Salivary flows is reduced significantly following 10-15 Gy (Gray) delivered to most of the glands.[3] While recovery of function is possible over time. Following higher doses radiation doses upto 40-50 Gy, to most of the glands cause irreversible hypo function and permanent xerostomia.[9] The dose-response relationship between delivered radiation and resultant salivary flow diminution has been clinically observed; because cumulative radiation doses generally exceed 50 Gy in most head and neck cancer patients where higher dose are used with curative aim of treatment, excepting those with small laryngeal portals, who will experience some salivary gland hypofunction.[10] There is a general agreement that fully irradiated parotid glands receiving doses higher than 60 Gy produce permanent salivary damage without recovery of function.

QSGS is a noninvasive tool for evaluating salivary function and allows quantitative assessment of salivary dysfunction due to radiation changes. We prospectively investigated the function in the parotid salivary gland in a group of patients treated with radiotherapy for head and neck cancers using QSGS, to establish the relationship between different dose of radiation and the parotid gland function.

The purpose of this study was to evaluate the usefulness of quantitative salivary gland scintigraphy (QSGS) in evaluating parotid salivary gland dysfunction during Radiotherapy.

MATERIAL AND METHODS

Thirty-five patients who were planned for radiotherapy (on Telecobalt Machine) for various malignancies in the head and neck region were included in study. None of the patients had received previous radiotherapy or surgery of the parotid glands; neither had they suffered from malignancies or other disease of the parotid glands. If patients had evidence of distant metastatic disease, they were not included in the study. Characteristics of the patient population are shown in Table-1.

Table-1: Patient and tumour characteristics (n=35)

Mean age (range) years	55 (35−70)
Gender	
Male	26 (74%)
Female	9 (26%)
Tumour site	
Oral cavity/Flour of mouth	13 (37%)
Larynx	3 (9%)
Oropharynx	8 (23%)
Nasopharynx	1 (3%)
Hypoharynx	9 (26%)
Unknown Primary	1 (3%)

Twenty-seven patients had received different doses of radiation ranging from 14 to 70 Gy and 8 control patients had not receive the radiotherapy, were subjected to QSGS test to know the parotid salivary excretion rate at various radiation doses to the parotid salivary gland. From the excretion rate we calculated the severity of dysfunction of parotid glands.

Radionuclide studies were performed with the patients in the supine position under a gamma scintillation camera. After i.v. administration of 188 MBq ^{99m}Tc – pertechnetate, 10 sequential frames of 60 s (anterior view) were acquired. After 10 min, limejuice was administered orally to induce salivation. Time activity curves were generated with region of interest drawn around the right and left parotid gland. The difference between the maximum count and the minimum count after stimulation using limejuice divided by the maximum count was calculated and the percentage of this value was defined as the excretion rate.[9,10] (Figure-1).

When the time-activity curve showed a flat pattern with no response to stimulation test, the excretion rate values was assigned minus 1.0 referring to the values of obstructive pattern because a flat pattern implies an end-stage of salivary gland dysfunction.[13]

We then defined a scoring system with 4 grades; severe dysfunction= 3 (excretion rate <25), moderate dysfunction= 2 (25% ≤excretion rate <40%), mild dysfunction= 1 (40% ≤excretion rate <50%) and normal function= 0 (50% ≤excretion rate).

Fisher Exact test has been used to find the significant association of radiation dose and left and right parotid glands function. The Statistical software namely SPSS-11 and Systat-8 were used for the analysis of the data.

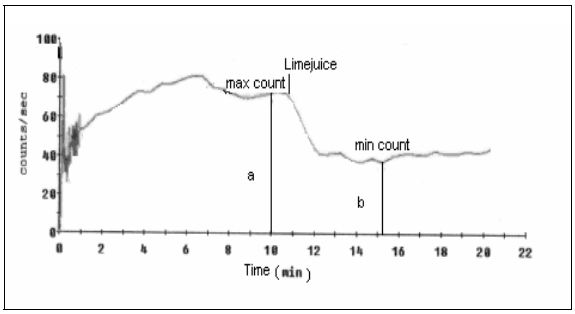

Figure-1: Definition of excretion rate

Excretion rate={maximum count (a)-minimum count (b)}/ maximum count (a)×100 (%)

RESULTS

As shown in the Table-2, among the patients who received different doses of radiation, 15 (55.6%) patients showed severe left parotid gland dysfunction, 5 (18.5%) moderate dysfunction, 3 (11.1%) mild dysfunction, and 4 (14.8%) normal function. Among the patients who did not received the radiotherapy, 1 (12.5%) patient showed mild dysfunction and 7 (87.5%) showed normal functioning of the left parotid gland.

Patients whose salivary gland received radiation dose ≥50 Gy were 4.5 times more likely to have severe dysfunction when compared to patients who received radiation dose <50 Gy (p=0.069). Patients who received radiation dose <50 Gy were 19.25 times more likely to have dysfunction when compared to control patients who did not received radiotherapy with p=0.009, and patients who received any dose of radiation were 40.25 times more likely to have left parotid gland dysfunction when compared to patients who did not received radiotherapy (p<0.001).

Among the patients who received different doses of radiation, 16 (59.3%) patients showed severe right parotid salivary gland dysfunction, 6 (22.2%) moderate dysfunction, 3 (11.1%) mild dysfunction, and 2 (7.4%) normal function. Among the patients who did not receive radiotherapy, 2 (25.0%) patients showed mild dysfunction and 6 (75.0%) showed normal functioning of the right parotid gland. Patients who received radiation dose ≥50 Gy were 7.5 times more likely to had severe dysfunction when compared to patients who received radiation dose <50 Gy (p=0.047).

Table-2: Correlation of radiation dose and function of left parotid gland

No. of Patients	Radiation dose	Function of Parotid gland			
		Normal Function	Mild dysfunction	Moderate dysfunction	Severe dysfunction
8	Control (non irradiated)	7 (87.5%)	1 (12.5%)	-	-
6	10–20 Gy	2 (33.3%)	2 (33.3%)	1 (16.7%)	1 (16.7%)
9	21–50 Gy	2 (22.2%)	-	2 (22.2%)	5 (55.6%)
12	≥ 50 Gy	-	1 (8.3%)	2 (16.7%)	9 (75.0%)

DISCUSSION

Radiation therapy is an important treatment modality for head and neck cancers. The salivary flow-rate has been reported to be associated with wide interindividual variations, as it is governed by a complicated mechanism.

QSGS using ^{99m}TC-pertechnetate is easy to perform and is gaining wider usage as a method of choice for clinicians because of its superiority over other morphologic and functional tests.[13] QSGS appears useful in predicting the grade of dysfunction following different dose radiation.

In our study, the stimulated salivary output depended on the parotid gland dose. Scintigraphy seemed to be a good indicator of gland function. A significant correlation between the salivary excretion rate and radiation dose was shown. In this study, the salivary excretion rate was measured in patients who received the different doses of radiation and in patients who did not received radiotherapy, to know the function of the parotid glands. We observed that patients who received any dose of radiation showed significant decline in the function of the parotid glands when compared to patients who did not received radiotherapy.

CONCLUSION

As the dose increase the severity of dysfunction also increases significantly. QSGS appears useful in predicting the grade of dysfunction following different dose radiation. Our findings need to be explored for greater accuracy in a large scale studies.

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