*Research article*

# Effect of Radiotherapy on the Whole Mouth Salivary Flow Rate, Ph and Its Influence on Oral Hygiene Using Oral Hygiene Index

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## Abstract

**Aim:** The aim is to understand the alteration in the salivary flow, pH, and oral hygiene in patients undergoing radiotherapy.

**Objective:** I) To compare the SFR in patient undergoing radiotherapy with normal controls

II) To determine the pH in the content of saliva

III) To assess oral hygiene using oral health index

**Materials and Method**: A cross-sectional study was conducted among patients undergoing radiotherapy in Dr.Raii Cancer Institute, Chennai, Tamil Nadu, India. A total convenience sample of 20 adults aged between 24 and 60 years were selected, out of which 10 adults were undergoing radiotherapy for head and neck cancer and 10 age and sex matched controls.

**Conclusion:** Hence this study evaluates the salivary flow rate, pH and oral hygiene of patients undergoing radiotherapy, which is important for dental professionals to familiarize with these complications of radiotherapy to treat patients effectively to improve their quality of life.

***Key Words :*** *Oral hygiene index, salivary flow, xerostomia, radiotherapy, osteronecrosis*

## Introduction

Saliva plays a major role in maintaining the oral health. This becomes apparent when the amount and the quality of the saliva is significantly reduced by medications, salivary gland neoplasm, disorders such as Sjogren's Syndrome, and especially ionizing radiation therapy for tumors of head and neck [1].

Saliva in the mouth is a biofluid produced by three pairs of major salivary glands--the submandibular, parotid and sublingual glands--along with secretions from many minor submucosal salivary glands. Salivary gland secretion is a nerve-mediated reflex and the volume of saliva secreted is dependent on the intensity and type of taste and on chemosensory, masticatory or tactile stimulation. Long periods of low (resting or unstimulated) flow are broken by short periods of high flow, which is stimulated by taste and mastication [2].

Radiotherapy is a treatment option for malign tumors whose therapeutic agent is ionizing radiation, which is said to be the type of radiation that promotes ionization in the area in which it is applied, making it electrically unstable. Ionizing radiations are divided into the corpuscular and electromagnetic ones. The corpuscular radiations are represented by electrons, neutrons and photons whereas the electromagnetic radiations are called photons, being represented by X rays and by gamma rays. In the clinical practice, most radiotherapy treatments are done through the use of photons [3].

Ionizing radiations act on the nuclear DNA due to which its reproducing ability is lost or destroyed. Due to the fact of being in a continuous multiplying process, malignant cells can suffer the radiation effects. However, the multiplying ability varies according to cell type. Thus, there is a radiosensitivity scale both for tumor and normal cells. Embryonic malignancies and lymphomas are radiosensitive tumors, whereas carcinomas are moderately radiosensitive [4].

Radiation therapy for cancer of the head and neck can devastate the salivary glands and partially devitalize the mandible and maxilla. Tumors and elective nodal areas are often in close proximity to radiosensitive normal tissues, a factor due to which the success of radiotherapy is limited.

Acute radiation-induced adverse effects such as mucositis and skin reactions occur during the course of treatment. These effectes are reversible types and thus the patient tends to recover within 3-4 months. Late radiation reactions such as fibrosis and osteoradionecrosis occur more than 3 months after the treatment has been conducted. Such reactions are characterized by their gradual progression [5]. Xerostomia is the single most important factor leading to chronic loss of quality of life in head and neck cancer patients. As a result, the production of the saliva is drastically reduced and its quality is adversely affected.

Oral complication has hence been a common problem among patients undergoing radiotherapy for tumors of head and neck. Radiotherapy and Chemotherapy are known to slow or stop the growth of new cells. These therapies can cause changes in the epithelial lining of the mouth and the salivary glands. This can thus affect the salivary flow and the bacterial balance.

Adverse reactions to radiotherapy will depend on the volume and area being irradiated, on the total dose, on the fractioning, on the age, on the patient's clinical conditions and on the associated treatments. A small increase on tumor dosage is enough for a significant increase on the complications incidence. Acute reactions happen during the treatment and most of the time, they are reversible. Late complications are normally irreversible, leading to permanent incapability and to a worsening of quality of life [6], and they vary on intensity, being normally classified into mild, moderate and severe [7].

While radiation damage to salivary glands is well known in the clinic by its side effects, the mechanism of the ionizing radition causing destruction to the salivary glands is not known yet. Kowever, it is known that the serous acini are more radiosensitive than mucous acini [7]. The fibrous and glangular atrophy bein immediately after the treatment and they intensify until the treatment ends. There has been a debate regarding the complications associated with the radiation approximity. Some authors suggest that with only 20 Gy, 80% of the salivary function is lost but the complications remain reversible. And after 30 Gy the damage caused seems to be permanent [8].

On an average unstimulated salivary flow is 0.3-0.5mL/min and stimulated salivary flow is 1.1-3.0mL/min. This average rate tends to vary due to radiotherapy. The buffering capacity and microbial load of saliva is a very important for oral hygiene maintenance after radiotherapy.

This study aimed to explore the changes in salivary gland function in patients undergoing radiotherapy by performing individual functional performances and to plot the change tendency on every single patient examined.

## Materials and Method

A cross-sectional study was conducted among patients undergoing radiotherapy in Dr.Raii Cancer Institute, Chennai, Tamil Nadu, India. A total convenience sample of 20 adults aged between 24 and 60 years were selected, out of which 10 adults were undergoing radiotherapy for head and neck cancer and 10 age and sex matched controls.

The study protocol was in compliance with the Helsinki Declaration and an approval was obtained from the institution's ethical committee. An oral informed consent was obtained from all participants prior to the study procedure. The intraoral examination was conducted by a single examiner under favorable lighting conditions using a sterile mouth mirror, diagnostic probe, and explorer. The clinical findings were recorded and the oral hygiene index was obtained to determine the prevalence of oral hygiene.

The saliva sample collection procedure was standardized prior to the study. The collection of unstimulated whole saliva was performed under resting conditions between 9.30 am and 11.30 am, 90 mins after their meal. The subjects were advised to rinse their mouth several times with (distilled) water and then relax for 5 min before the procedure. The subjects were asked to sit comfortably with head tilted slightly forward and expectorate the saliva accumulated in the floor of the mouth into disposable plastic containers for duration of 30 seconds. The salivary samples were quantified volumetrically using graduated measuring cylinder. The salivary flow rate was expressed as ml/min. The collected fluid was also used to measure salivary pH using a pH strip. The oral hygiene index was taken into account after thorough examination of the oral cavity was done. The data obtained was subjected to statistical analysis using SPSS package.

## Results

A total convenience sample of 20 adults aged between 24 and 60 years were selected, out of which 10 adults were undergoing radiotherapy for head and neck cancer and 10 age and sex matched controls. Their salivary flow, pH and oral hygiene index was examined. The collected results were as such;

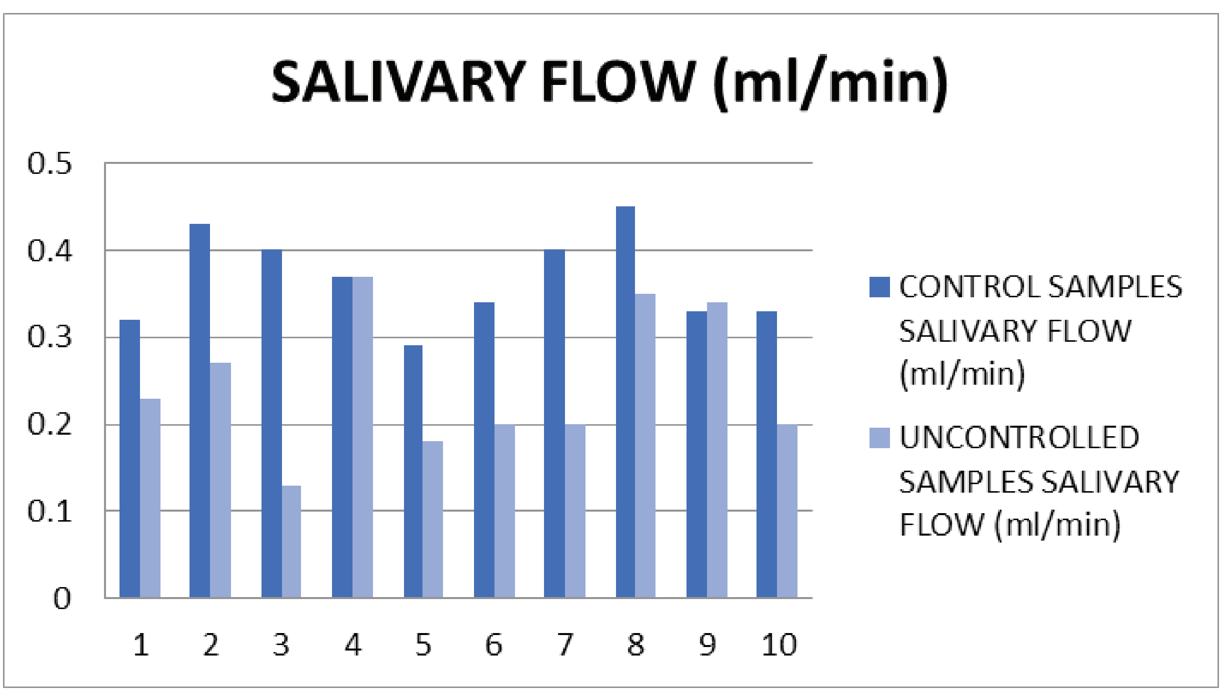
**Table 1- Comparison in the salivary flow, pH, OHI-S in patients undergoing radiotherapy and clinically healthy patients.**

| S.No. | AGE | SEX | CONTROL SAMPLES | | | UNCONTROLLED SAMPLES | | |
|---|---|---|---|---|---|---|---|---|
| | (years) | | SALIVARY FLOW | Ph | OHI-S index | SALIVARY FLOW | Ph | OHI-S index |
| | | | (ml/min) | | | (ml/min) | | |
| 1 | 52 | F | 0.32 | 7 | 0.8 | 0.4 | 8 | 1.83 |
| 2 | 27 | M | 0.43 | 7 | 0.82 | 0.27 | 7 | 1.49 |
| 3 | 24 | M | 0.4 | 7 | 0.3 | 0.13 | 8 | 0.8 |
| 4 | 63 | F | 0.37 | 6 | 4.16 | 0.37 | 7 | 1 |
| 5 | 57 | F | 0.29 | 7 | 0.8 | 0.18 | 7 | 1.2 |
| 6 | 32 | F | 0.34 | 8 | 1.5 | 0.2 | 8 | 1.1 |
| 7 | 43 | M | 0.4 | 6 | 1.3 | 0.2 | 6 | 1.3 |
| 8 | 68 | F | 0.45 | 7 | 1.3 | 0.5 | 8 | 0.83 |
| 9 | 35 | M | 0.33 | 6 | 1.46 | 0.34 | 8 | 0.82 |
| 10 | 55 | F | 0.33 | 8 | 1.6 | 0.2 | 7 | 0.8 |
| | | | | | | | | |
| RESULTS | | | | | | | | |
| MEAN | | | 0.366 | 6.9 | 1.404 | 0.279 | 7.4 | 1.117 |
| STANDARD DEVIATION | | | 0.052323778 | 0.737865 | 1.051847053 | 0.118457681 | 0.699206 | 0.345351673 |
| | | | | | | | | |

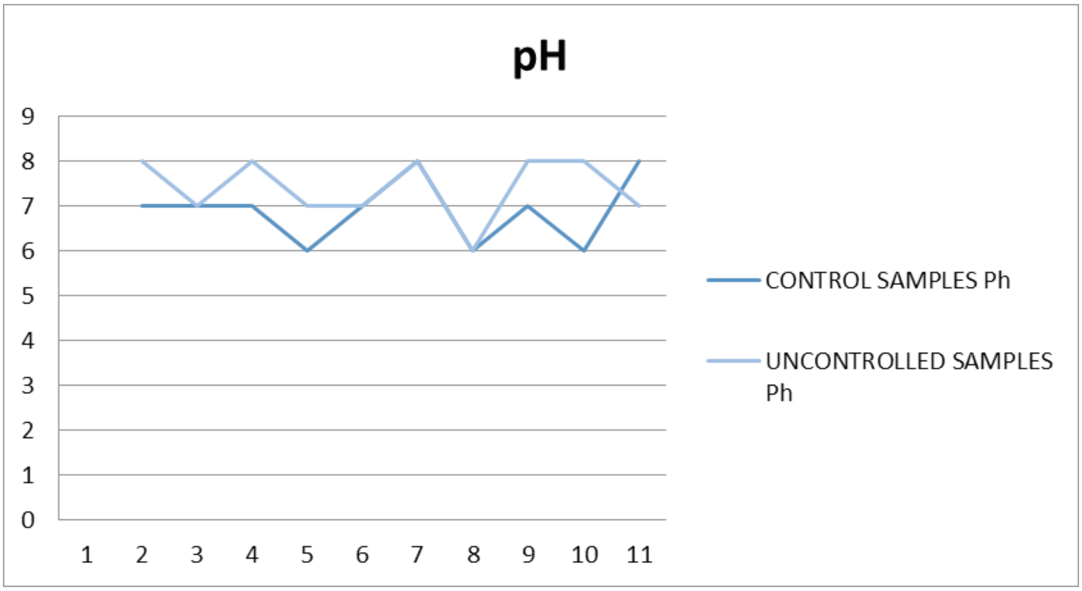
**Table 2: Statistics associated with the alteration in the salivary flow, Ph and OHI-S.**

| SALIVARY FLOW | | MEAN | STANDARD DEVIATION | T-SCALE STATISTICS |
|---|---|---|---|---|
| | | | | |
| CONTROLLED SAMPLE | | 0.366 | 0.052323 | 0.0165 |
| UNCONTROLLED SAMPLE | | 0.279 | 0.11845 | 0.0375 |
| | | | | |
| Ph | | | | |
| CONTROLLED SAMPLE | | 6.9 | 0.73786 | 0.2333 |
| UNCONTROLLED SAMPLE | | 7.4 | 0.699206 | 0.2211 |
| | | | | |
| OHI-S | | | | |
| CONTROLLED SAMPLE | | 1.404 | 1.05184 | 0.3326 |
| UNCONTROLLED SAMPLE | | 1.117 | 0.34535 | 0.1092 |

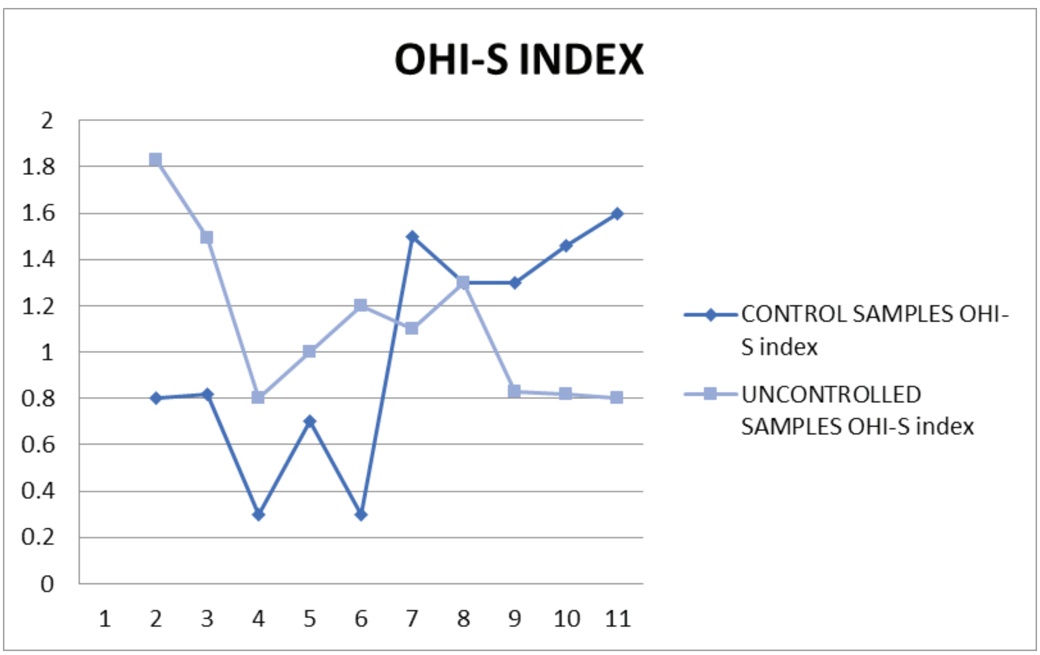
The alteration in the salivary flow seemed to have reduced in patients undergoing radiotherapy (0.279 ±0.11) (p=0.037). The ph had increased when compared with clinically healthy patients (7.4±0.699) (p=0.22). the oral hygiene index did not show any significant change (1.117±0.345) (p=0.109).




**Graph 1: alteration in the salivary flow (ml/min).**




**Graph 2: Alteration in the pH.**




**Graph 3: Alteration in the OHI-S index.**

## Discussion

The salivary glands are externally found contrasted at most to the head and neck tumors, and therefore, the ionizing radiation needs to elapse through the salivary organs to viably treat the tumor [9]. Early radiation event to alter cell signal transduction and the late radiation exposure to damage acinar progenitor cells in stem cells niche [10]. Therefore we investigated salivary flow rate, ph and oral hygiene index changes of HCN patients in different age groups after radiotherapy.

One of the main problems resulting from tissue damage generated by radiotherapy is the reduction of salivary flow. The radiation level necessary to cause severe dysfunction to gland tissue is >52 Gy. Some articles [11] indicated that there were relatively large inter individual differences with respect to salivary flow changes. In our study the salivary flow rate reduced from 0.36 (ml/min) to 0.27 (ml/min) [table-2, graph-1]. It was also reported that salivary flow rate reduced 50-70% after radiotherapy.

The major reduction in salivation after radiotherapy is observed in the period from the onset of radiotherapy to 3 months after completion. Amid radiotherapy, the initial 10 days are the most noticeably awful ones as a massive decrease in salivary production takes place; particularly in the first week, it could decrease by 50%– 60% [12]. After this period, the flow rate is reduced by <10% of the initial conditions [13]. CHENG et coll. [14] It is found that when 100 per cent of the parotid glands' volume was irradiated, the parotid glands did not produce saliva at all, but when even a small portion (10 to 20 per cent) of the parotid gland was outside the radiation fields the glands could be stimulated to produce saliva. This fact should be kept in mind when radiation treatment is planned. . Besides, Moller et al [15] also reported that flow rate would slowly recover 4-months after radiotherapy but cannot return to the original level. From the results of the single measurement group, age, sex, and time-interval after radiotherapy were all not significant predictor factors for salivary flow rate. This outcome was similar in our study too. Most articles only reported the data of total saliva or stimulated parotid gland saliva [16]. Kwong et al [17] reported that the mean dose to the parotid glands could be as high as 32.0–46.1 Gy for early stage NPC patients treated with IMRT. Eneroth et al [18] found that radiation as low as 2 to 3 doses of 2 Gy could cause radiation-induced xerostomia.

To examine the salivary Ph, the acid base titrations, pH test strips, and handheld portable pH meters were mentioned,[19] whereas the Modified Ericsson method, Dentobuff method, and Strip method were mentioned for buffering capacity.[20] We used the pH test strips for its advantages of noninvasiveness, simplicity, and elegance. Chia-Yung Lin et al. demonstrated that the pH(P) was 6.60 before radiotherapy, and declined steadily to the lowest 6.00 (P Z 0.148) [21]. Thus it indicated that there was not considerable change in the pH, whereas in our study there was a significant increase in the pH when compared with clinically healthy patients (7.4±0.699) (p=0.22) [Table-2, Graph-2]. Mo¨ller et al indicated the buffering capacity and flow rate were irreversibly reduced after radiotherapy [22]. Edmond H. N. Pow et al. [23] came to a conclusion that eduction in stimulated saliva flow and salivary pH was accompanied by sustained changes in anionic composition. At 2 months following radiotherapy, there was a significant increase in chloride, sulphate, lactate and formate levels while significant reductions in nitrate and thiocyanate levels were found. No further changes in these anion levels were observed at 6 and 12 months. No significant changes were found in phosphate, acetate, or propionate levels throughout the study period.

Oral hygiene habits in patients undergoing radiotherapy and clinically healthy patients were evaluated by recording oral hygiene method, frequency, and the material used. Oral hygiene status of the patient was examined using OHIS index by Green and Vermillion. They were analyzed using paired t-test. The test showed a statistically insignificant correlation for OHIS controlled and uncontrolled samples. This may be due to hyposalivation and poor oral hygiene maintenance by patients during the course of radiotherapy.

## Conclusion

The resulting salivary gland hypofunction and xerostomia arising from radiotherapy for HNC can cause a serious diseased condition [24]. The stomatologic complications could depend on the type of cancer treatment and the cumulative radiation dose to the gland tissue. They can be reversible or irreversible, transient, or enduring. The best approach to manage the radiotherapeutic patient begins with a careful clinical assessment of the individual case, followed by preventive therapy aimed to reduce oral complications when possible. To minimize patient discomfort and morbidity, an understanding of the deleterious effects of radiotherapy is required. Introducing good oral home care and more frequent oral prophylaxis visits to the dentists before radiotherapy will allow for continuing care during and after therapy. Therefore, the clinician must keep this kind of patients under careful control in order to palliate the symptoms of xerostomia and improve their quality of life.

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**Source of Funding:** Self

**Conflict of Interest**: Nil

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