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ORIGINAL ARTICLE

Effects of radiotherapy on salivary gland function in patients with head and neck cancers

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Abstract *Background/purpose:* We explored changes in salivary gland function of head-and-neck cancer patients after radiotherapy, including pH of saliva, stimulated salivary flow rate, and saliva buffering capacity. The pH of saliva included that of parotid gland, submaxillary gland, and total resting saliva. We also investigated whether the acidity of dental plaque lowered pH of saliva.

Materials and methods: From a total of 62 patients, 11 had repeated measurements taken before and every month after radiotherapy. The remaining 51 patients had a single measurement taken after radiotherapy. Seven normal patients served as the control group.

Results: In the repeated measurement group, all examinations decreased dramatically in the 1st month after radiotherapy ($P < 0.0001$), and recovered from the 3rd month to the 6th month, but the flow rate could not return to pretreatment level. In the single measurement group, unilabiate linear regression analysis showed that the time-period after radiotherapy was a significant predictor influencing the pH of the submaxillary gland and total resting saliva. Pearson correlation coefficient analysis showed that the pH of dental plaque had a positive linear correlation with that of saliva. Concerning the influence of time-period, within 1 year after radiotherapy, all examinations were dropped. After 1 year the pH of resting saliva and plaque began to increase over time. The stimulated flow rate, pH of stimulated saliva, and buffering capacity, dropped < 1 year after radiotherapy group, increased 1–5 years after radiotherapy group, but dropped again > 5 years after radiotherapy group.

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Conclusion: Our results indicated that oral hygiene care is important especially during the early period after radiotherapy.

Introduction

Head-and-neck cancer (HNC) is one of the leading causes of cancer mortality in Taiwan. For these patients, radiotherapy plays an important role in the treatment. However, xerostomia caused by salivary gland dysfunction is a common complication in HNC patients after radiotherapy.[1] Considerable acute and long-term side effects severely reduce life quality of HCN patients.[2] At present, there is no effective therapy for xerostomia.[3] Understanding detailed saliva change of HCN patients after radiotherapy is mandatory for prevention of dental caries, periodontitis, mucositis, etc. As salivary glands are in the path of ionizing radiation and very radiosensitive, the striking reduction in saliva output accompanied by significant increases in saliva Na^{+}, Cl^{-}, Ca^{++}, Mg^{++}, protein concentrations, and a decrease in HCO_3^{-} content are frequently observed after radiotherapy.[4] Stimulated salivary production is largely (60—70% of total) derived from the parotid glands, with the balance from other glands; resting (unstimulated) salivary production is primarily due to the submaxillary and sublingual glands and numerous small oral salivary glands.[5,6] On average, unstimulated flow rate of saliva is 0.3—0.5 mL/min, whereas stimulated flow rate is 1.1—3.0 mL/min.[7] Saliva functions in the following areas: (1) modulate pH and the buffering capacity of saliva; (2) cleanse oral microorganisms and dental plaque; (3) modulate demineralization and remineralization; and (4) provide antibacterial action.[8] The buffering capacity of saliva is very important for oral hygiene maintenance of HCN patients after radiotherapy, works more efficiently during stimulated high flow rates but is almost ineffective during periods of low flow with unstimulated saliva.[9,10] There are different types of acinar cells in different salivary glands. Serous acinar cells, mainly in the parotid glands, are more easily damaged than mucous acinar cells in the sublingual and submaxillary glands after radiotherapy.[11] This study aimed to explore changes in salivary gland function of HCN patients after radiotherapy. Individual functional examinations were performed and all detailed data were collected to plot the change-tendency of every single salivary function. We also figured out whether the acidity of dental plaque decreased the pH level of saliva after radiotherapy.

Materials and methods

Eligibility criteria

Saliva samples from a consecutive clinical cohort of patients were collected during 2010—2011. We obtained samples from 62 head and neck cancer patients (45 male and 17 female participants) at the Department of Oral and Maxillofacial Surgery, National Taiwan University Hospital, Taipei, Taiwan. The study samples were required to be from patients over 18 years old and new to radiotherapy. Those who had already received radiotherapy, taken any medication, or suffered any systemic disease interfering with salivary gland function, and had trouble in communication were excluded. The age distribution of 62 patients was 26—70 years (Table 1). The study was approved by the Institutional Review Board of the National Taiwan University Hospital. All participants provided informed written consent before being included. Among these 62 patients, 11 (7 male and 4 female) had repeated measurements taken before and every month after radiotherapy (Table 2). In this repeated measurement group, functional examinations were performed to track salivary gland changes due to radiotherapy. The remaining 51 patients (38 male and 13 female) had a single measurement taken at an arbitrary time after radiotherapy (Table 3). Additionally, seven normal patients (2 male and 5 female) agreed to participate in this study (Table 4). The following functional examinations and observations were performed and recorded by one person. Salivary samples were collected using GC Saliva-Check Buffer kits (GC America INC. http://www.gcamerica.com/products/preventive/Saliva_Check_BUFFER/index.php.). Samples were collected before meals

Table 1 The age distribution and tumor classification of 62 patients were demonstrated.

Study group	
Patient no.	62
Male/female	45/17
Median age (range)	52 (26—70)
Tumor site	
Nasopharngeal	42
Nasal cavity/paranasal sinus	2
Oral cavity/oralpharngeal	13
Throat/hypopharngeal	2
Parotid gland	2
Others (neck)	1
Tumor characteristic	
Squamous cell carcinoma	59
Lymphoma	2
Melanoma	1
Tumor stage	
I	5
II	14
III	9
IVA	12
IVB	7
Unknown	15