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Evaluation of xerostomia and effect of maxillofacial prosthesis use on mouth dryness in head and neck tumor patients

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ABSTRACT

Purpose: Xerostomia is a symptom of reduced oral functioning and can cause dysphagia and worsen dental disease. This study sought to investigate the actual status of xerostomia in head and neck tumor patients and the beneficial effects of maxillofacial prosthesis use on xerostomia.
Materials and Methods: We conducted a questionnaire survey on xerostomia and measured resting salivary flow rate and oral mucosa moisture levels in 26 patients who had been treated for head and neck tumor.
Results: After treatment, 16 of the 26 patients (62%) reported experiencing dry mouth. Moreover, 12 patients (46%) reported a tendency for dry mouth compared with before tumor treatment, indicating they perceived worsening of xerostomia after treatment. Mean resting salivary flow rate measured by the cotton roll method was 0.183 ± 0.178 g over 30 seconds. Resting salivary flow rate was significantly lower in patients who reported always having dry mouth than in those who did not report experiencing dry mouth. Patients who had been treated for mandibular/lingual tumors had a significantly lower resting salivary flow rate than those who had been treated for maxillary tumors. Mean moisture content in the oral mucosa measured with an oral moisture checker was 27.6 ± 1.6. Those who reported always having dry mouth had significantly lower oral mucosa moisture content than those who reported having dry mouth sometimes/a little. Five patients reported that wearing a maxillofacial prosthesis alleviated dry mouth.
Conclusion: This study demonstrated that the maxillofacial prosthesis use can improve xerostomia after head and neck tumor treatment. (*Int J Maxillofac Prosthetics 2021;4:9-17*)

Keywords

Xerostomia, head and neck neoplasms, salivation, maxillofacial Prosthesis.

INTRODUCTION

The widespread 80-20 Campaign (20 teeth at the age of 80) has promoted awareness of the number of remaining teeth among the general public in Japan. Yet, in clinical practice we often encounter cases where oral functions that are important for living, such as eating, swallowing, and speaking, are impaired despite a sufficient number of remaining teeth. This reduced oral functioning is often accompanied by the symptom of xerostomia.[1, 2] Xerostomia, also called dry mouth, can worsen caries and periodontal disease and cause frequent denture ulcers, taste disorder, and dysphagia. Xerostomia is a well-recognized symptom of patients with autoimmune diseases such as Sjögren's syndrome[3] but is also frequently seen in patients who have been treated for head and neck tumor.[4]

After treatment for head and neck tumors, patients have tissue defects and various symptoms of oral hypofunction due to surgery, radiation, and chemotherapy. In particular, damage to salivary gland cells by radiation therapy causes xerostomia.[4] A study by Murakami et al. involving patients who wore maxillofacial prostheses found that a history of radiation therapy and the time elapsed after radiation therapy were associated with xerostomia.[5] After treatment for head and neck tumor, patients tend to have problems in the oral cavity, such as taste disorder, speech disorder, masticatory dysfunction, and dysphagia, in addition to xerostomia. Since these symptoms are closely related to one another, an improvement in one symptom is expected to lead to improvements in other functions. Therefore, improving xerostomia can be expected to have the effect of improving patients' quality of life (QOL) after tumor treatment. However, few studies to date have investigated the severity of this condition in patients after treatment for head and neck tumor, and the actual situation is not clearly understood.

The following methods can be used to evaluate xerostomia: interviews to assess subjective symptoms

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using questionnaires, measurement of salivary flow rate, measurement of oral mucosa moisture content using an oral moisture checker, measurement of saliva viscosity, and conducting the repetitive saliva swallowing test.[6-8] In fact, a combination of methods is needed to evaluate the condition, and simple and less burdensome methods are desirable when examining patients with head and neck tumor, considering their impaired oral function after treatment.

Measurements of salivary flow rate include measuring resting and stimulated salivary flow. Resting salivary flow can be measured by the spitting method or the cotton roll method, and stimulated salivary flow can be measured by the gum chewing test or the Saxon test, which measures the secreted salivary flow while chewing gauze. The spitting method, gum chewing test, and Saxon test are difficult to perform for patients whose salivary flow rate is extremely low or whose chewing ability is significantly impaired due to tumor treatment, and the cotton roll method is much less burdensome.[6, 9] Previous reports have also demonstrated the effectiveness of the cotton roll method for measuring resting salivary flow rate, and impaired salivary output is suspected when the flow rate is 0.1g or less using the 30-s cotton roll method.[6, 9] Measurement of the oral mucosa moisture content with an oral moisture checker is also a simple and quick method.[9-11] Japan's national health insurance covers the use of this measurement device for assessing oral hypofunction, and xerostomia is suspected for a value <27.[1, 11] With the methods described above, xerostomia can be investigated with little burden on patients.

After treatment for head and neck tumor, many patients use a maxillofacial prosthesis. Kelimu et al. had reported a case in which xerostomia was improved by wearing a maxillofacial prosthesis.[12] A report by Usui also found that wearing a maxillary prosthesis reduced symptoms of xerostomia during sleep in many patients.[13] Thus, the possible beneficial effects of maxillofacial prosthesis use on xerostomia have been reported, but the effectiveness has not been confirmed. This study aimed to clarify the status of xerostomia in patients following treatment for head and neck tumor and to examine the effectiveness of maxillofacial prosthesis use.

MATERIALS AND METHODS

Participants in this study were 26 outpatients (14 men, 12 women; mean age, 73.6 ± 6.9 years) who attended the Clinic for Maxillofacial Prosthetics at Tokyo Medical and Dental University Dental Hospital following treatment for head and neck tumor. Patients with a defect in half or more of the tongue and patients who had undergone tongue reconstruction with a skin flap were excluded from the study. All patients provided informed consent to participate in this study. We conducted a questionnaire survey on xerostomia, measured resting salivary flow rate by the cotton roll method, and measured oral mucosa moisture content with an oral moisture checker. In patients used prostheses cases, the measurements were taken without prostheses. This study was approved by the Ethics Review Committee of the Faculty of Dentistry, Tokyo Medical and Dental University (receipt number, D2019-034).

Questionnaire on Dry Mouth

A questionnaire was created by partially modifying the questionnaire on the feeling of oral dryness used by Takayama et al.[14] and adding items for patients who had been treated for head and neck tumor (Appendix 1). In addition to the questions on subjective symptoms related to xerostomia, questions were added on the use of oral moisturizers, changes after tumor treatment, and effects of prosthesis use on dry mouth.

Measurement of Resting Salivary Flow

In the cotton roll method, a dental cotton roll was placed on the floor of the oral cavity for 30 seconds (Fig 1). The weight of a cotton roll before and after was measured using an electronic balance (Shimadzu Corporation, Kyoto, Japan). The difference in the weight was defined as the salivary flow rate (g).



Fig 1. Measurement of resting salivary flow by cotton roll method.

Measurement of Oral Mucosa Moisture Content

An oral moisture checker (Mucus, Life Co., Ltd., Saitama, Japan) was used (Fig 2). A dedicated sensor cover was attached to the device, the sensor was pressed against the measurement site for 2 s, and the displayed value was recorded. The measurement site was the dorsum of the tongue, and measurement was taken while sticking out the tongue (Figs 3a, 3b). Measurements were taken 3 times, and the median value was recorded as the oral mucosa moisture content.

In addition, the dental records, age, tumor site, and history of surgical treatment and chemoradiotherapy of the 26 patients were reviewed. Relationships of subjective symptoms with resting salivary flow rate, oral mucosa moisture content, and treatment history were statistically analyzed using SPSS 26.0 (IBM Japan, Ltd., Tokyo, Japan).

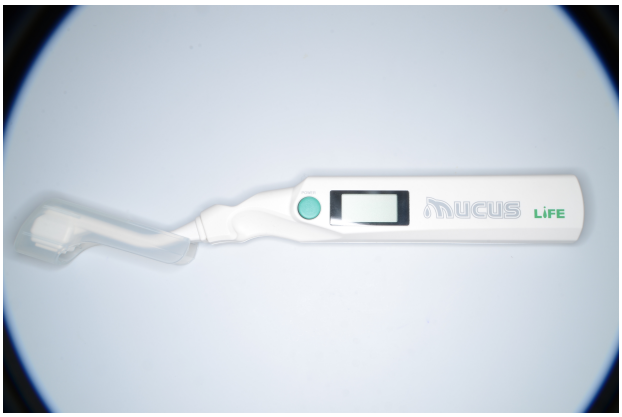


Fig 2. Oral moisture checker.



Fig 3a. Measurement of oral mucosa moisture content, frontal view.



Fig 3b. Measurement of oral mucosa moisture content, lateral view.

RESULTS

To the first questionnaire item about the presence or absence of a dried or parched feeling in the mouth, 8 of the 26 patients answered "yes," 8 answered "sometimes/a little," and 10 answered "no." These patients were classified based on their subjective responses into the dry mouth group, the mild dry mouth group, and the no dry mouth group, respectively. Table 1 shows the analysis results by group.

Among the three groups, there were no significant difference in sex, age, medication, or presence of systemic disease. Comparison by tumor site showed that the proportion of patients with mandibular/lingual tumor was high in the dry mouth group, while the proportion of patients with maxillary tumor was high in the mild dry mouth and no dry mouth groups. Comparison by treatment history showed a slightly higher proportion of patients with a history of radiation therapy in the dry mouth group. All patients who had multiple courses of treatment due to tumor recurrence were in either the dry mouth or mild dry mouth group. Mean time after tumor treatment was longest in the no dry mouth group and shortest in the dry mouth group, although the differences were not statistically significant.

Mean resting salivary flow rate and mean oral mucosa moisture content were 0.183 ± 0.178 g and 27.6 ± 1.6, respectively, in all patients. Resting salivary flow rate and oral mucosa moisture content were compared between the three groups by the Kruskal-Wallis test for independent samples. There was significantly lower resting salivary flow rate in the dry mouth group compared with the no dry mouth group ($p<0.05$). Oral mucosa moisture content was also significantly lower in the dry mouth group than in the mild dry mouth group ($p<0.05$; Figs 4a, 4b).

The 26 patients were divided into two groups by tumor site: 15 in a maxillary tumor group and 11 in a mandibular/lingual tumor group. Then, the oral mucosa moisture content and resting salivary flow rate were compared between the two groups by the Mann-Whitney test for independent samples. The results showed no significant difference in oral mucosa moisture content, but significantly lower resting salivary flow rate in the mandibular/lingual tumor group compared with the maxillary tumor group ($p<0.05$; Table 2, Figs 5a, 5b).

A correlation analysis was performed using Pearson's correlation coefficient for the questionnaire item about a dried or parched feeling in the mouth and the subsequent 12 items on xerostomia. Four items had a high correlation with a dried or parched feeling in the mouth: 2) frequently drinking water/ always carrying water, 4) having difficulty eating dry food such as crackers, 5) having difficulty swallowing food, and 6) the mouth feeling sticky/having difficulty talking-($p<0.05$; Table 3). In the dry mouth group, all 8 patients answered either "yes" or "sometimes/a little" to items 2), 4), and 6).

To the item about the use of oral moisturizers, 5 of the 26 patients (19%) answered "yes" or "sometimes/a little,"

Table 1. Analysis of results in the dry mouth group, mild dry mouth group, and no dry mouth group.

Group	Dry mouth group n=8	Mild dry mouth group n=8	No dry mouth group n=10
Male	4	4	6
Female	4	4	4
Age	72.3 ± 7.1	72.6 ± 7.3	75.5 ± 5.8
Maxillary tumor	2	5	8
Mandibular/lingual tumor	6	3	2
Oral surgery	7	8	9
Radiotherapy	7	4	5
Chemotherapy	5	4	3
History of recurrence	4	2	0
Years after treatment	6.5 ± 5.8	7.1 ± 3.5	10.3 ± 9.6
Resting salivary flow rate (g)	0.058 ± 0.033	0.140 ± 0.061	0.318 ± 0.215
Oral mucosa moisture content	26.4 ± 1.9	29.1 ± 0.70	27.4 ± 0.49

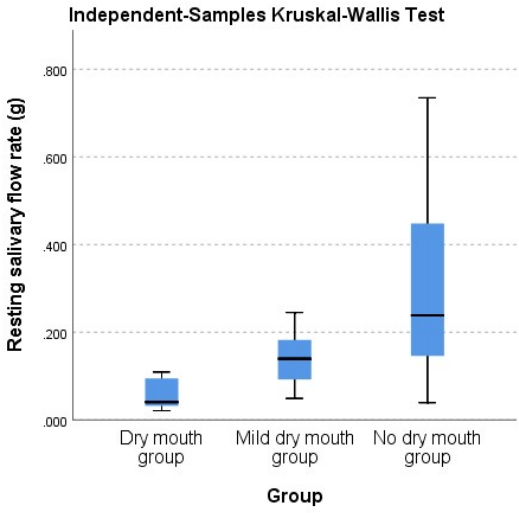


Fig 4a. Comparison of resting salivary flow rate between the dry mouth group, mild dry mouth group, and no dry mouth group.

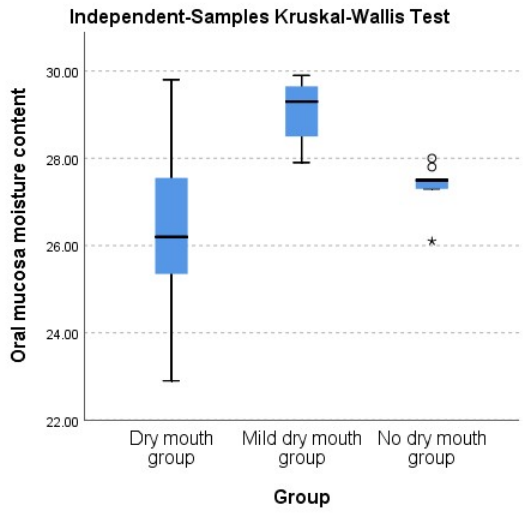


Fig 4b. Comparison of oral mucosa moisture content between the dry mouth group, mild dry mouth group, and no dry mouth group.

Table 2. Mean resting salivary flow rate and oral mucosa moisture content in the maxillary tumor group and mandibular/lingual tumor group.

	Maxillary tumor group n=15	Mandibular/lingual tumor group n=11
Resting salivary flow rate (g)	0.259 ± 0.194	0.080 ± 0.068
Oral mucosa moisture content	27.8 ± 1.1	27.3 ± 2.1

and all were in the dry mouth group. To whether the mouth tended to feel dry more often than before tumor treatment, 12 patients (46%) answered “yes” or “sometimes/a little”; 75% of the dry mouth group and mild dry mouth group experienced worsening of xerostomia after head and neck tumor treatment.

Of the 26 patients, 23 were maxillofacial prosthesis users. In the dry mouth and mild dry mouth groups, 13 were that prosthesis users: 7 used a maxillary prosthesis and 6 used a mandibular prosthesis. The items about dry mouth and prosthesis use included 16) whether they wore a prosthesis to alleviate dry mouth and 17) whether removing their prosthesis before going to bed made their mouth dry. To both of these questions, 5 answered either “yes” or “sometimes/a little,” of whom 4 were maxillary prosthesis users and 1 was a mandibular prosthesis user.

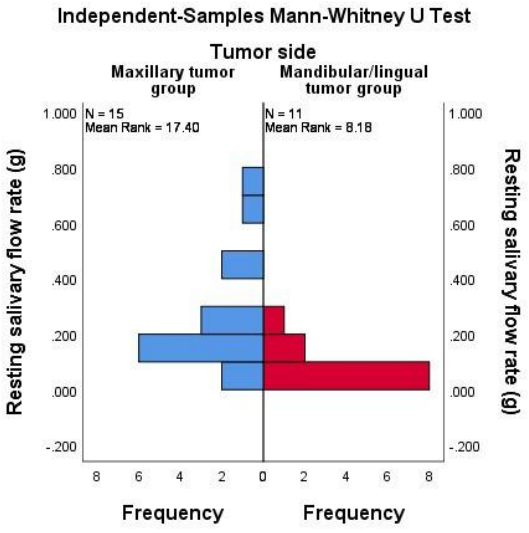


Fig 5a. Comparison of resting salivary flow rate between the maxillary tumor group and mandibular/lingual tumor group.

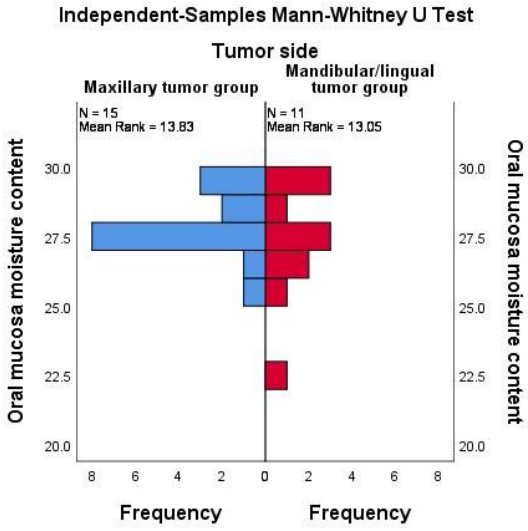


Fig 5b. Comparison of oral mucosa moisture content between the maxillary tumor group and mandibular/lingual tumor group.

Table 3. Pearson’s correlation coefficient for the questionnaire item about a dried or parched feeling in the mouth and the subsequent 12 items on xerostomia.

Correlations														
		1)	2)	3)	4)	5)	6)	7)	8)	9)	10)	11)	12)	13)
Symptom1) Dried or parched feeling in the mouth	Pearson correlation	1	.586**	0.244	.637**	.426*	.697**	0.326	-0.154	-0.156	0.192	-0.142	0.407	0.380
	Sig. (2-tailed)		0.002	0.229	0.000	0.030	0.000	0.104	0.453	0.448	0.348	0.490	0.054	0.098
	N	26	26	26	26	26	26	26	26	26	26	26	23	20

DISCUSSION

The questionnaire on xerostomia that we used in this study was created by adding 4 original question items for patients who had been treated for head and neck tumor. Questions about the use of oral moisturizers were considered to be an indicator of whether patients were taking measures against xerostomia on a regular basis. The question comparing dry mouth before and after treatment was considered effective for determining whether xerostomia occurred as an adverse effect of tumor treatment, but not other causes (e.g., other diseases or adverse effects of unrelated medications), in patients who had been treated for head and neck tumor. It was also considered a necessary item for investigating the actual situation of the proportion of patients who develop xerostomia as an adverse effect.

The question about maxillofacial prosthesis use and the feeling of dry mouth was an item added to investigate the beneficial effects of prosthesis use on xerostomia, which was one of the aims of this study. We examined the shape of maxillofacial prosthesis that effectively improved xerostomia by investigating the oral condition and the shape of prosthesis of those patients who reported prosthesis use relieved dry mouth or prosthesis removal caused dry mouth.

In this study, 26 patients were divided into three groups according to their responses to the first question of the survey about xerostomia, and analysis was performed by group. The dry mouth group showed a decrease in both resting salivary flow rate and oral mucosa moisture content. Mean resting salivary flow rate was 0.058 ± 0.033 g over 30 s in this group, and 7 of the 8 patients had a result of 0.1 g or lower, strongly indicating that decreased salivary output was the cause of xerostomia. Given that symptoms of oral discomfort associated with xerostomia are also commonly seen, care for dysphagia was also considered necessary, such as guidance on different forms of food and swallowing training. Also, 5 of the 8 patients in the dry mouth group answered that they used gel-type oral moisturizers or white petrolatum. Gel-type oral moisturizers are thought to be long-acting in the oral cavity for their stagnancy and viscosity.[15, 16] Patients in the dry mouth group felt dry mouth on a daily basis, which was considered to be why there were more users of gel-type moisturizers, which are longer-acting, than users of spray-type moisturizers. All 4 female patients in the dry mouth group used oral moisturizers, but only 1 of the 4 male patients did so, and some of the male patients did not know about the use of oral moisturizers. Thus, it seems necessary for attending physicians to propose the use of moisturizers and provide instruction for patients with symptoms of xerostomia and findings of oral mucosal dryness.

In the mild dry mouth group, no decrease was observed in the oral mucosa moisture content. The mean resting salivary flow rate was 0.140 ± 0.061 g, it is exceeded the cutoff value of hyposalivation and only 2 of the 8 patients had a value < 0.1 g. Although salivary output tended to be slightly lower in the mild dry mouth group compared with the no dry mouth group, many patients showed no notable decrease in salivary output. It is probable that these did not lead to decreasing of oral moisture content in mild dry mouth group. There might be causes of the feeling of dry mouth other than decreased salivary flow. There were responses indicating that the feeling of dry mouth occurs only during the night, suggesting that the occurrence of dry mouth is more limited in the mild dry mouth group than in the dry mouth group, who reported a constant feeling of oral dryness.

In the no dry mouth group, although almost no patients showed decreased salivary output, with just 1 of the 10 patients having a resting salivary flow rate of <0.1 g. Also, only 1 patient had oral mucosa moisture content <27, which suggests the possibility that xerostomia might develop while the patient is unaware of it. These results suggest that attending physicians should observe the patient's oral condition to always check whether there are any findings suggestive of xerostomia even when the patient does not report any symptoms.

While the patients who had been treated for mandibular/lingual tumors accounted for 75% of the dry mouth group, those who had been treated for maxillary tumors accounted for 63% of the mild dry mouth group and 80% of the no dry mouth group. In addition, resting salivary flow rate was significantly decreased in the group of patients who had been treated for mandibular/lingual tumors compared with maxillary tumors. This could be because salivary flow was decreased due to resection or atrophy of the salivary gland as a result of surgery or radiotherapy in the patients with mandibular/lingual tumors. In this study, oral mucosa moisture content was measured at the dorsum of the tongue; therefore, patients with a tongue defect in half or more of the tongue and those who had undergone tongue reconstruction with a skin flap were excluded. However, it is possible that patients who have undergone more extensive surgery may have more severe xerostomia. Since the oral moisture checker can be used to measure the buccal mucosa as well, it is necessary in the future to investigate oral dryness by measuring buccal mucosa moisture content in patients with tongue defects and following tongue reconstruction with a skin flap.

Although there were patients who showed reduced salivary flow following treatment for maxillary tumor, it occurred less commonly than after treatment for mandibular/lingual tumor, and the proportion of patients with the mild xerostomia following maxillary tumor treatment was high. On the other hand, although the subjective symptoms were commonly mild, about half of the patients who had been treated for maxillary tumor experienced dry mouth, feeling at least mild dryness even without a decrease in salivary flow. In patients who have undergone maxillary tumor surgery, outside air tends to flow into the oral cavity through communication between the nasal and oral cavities due to tumor resection, which is likely to create a condition similar to mouth breathing, resulting in dry mouth without a decrease in salivary flow.

In cases where xerostomia is caused by decreased salivary flow, the use of artificial saliva or oral moisturizers is expected to supplement the reduction in salivary output and improve the symptoms. On the other hand, in cases where the influx of outside air into the oral cavity causes dry mouth, wearing an

appropriate obturator prosthesis that blocks the communication between the nasal and oral cavities is expected to effectively improve xerostomia. Of the patients in this study, 5 reported that maxillofacial prosthesis use alleviated dry mouth or that sleeping without their prosthesis made their mouth dry. Of these 5 patients, 4 had undergone surgery for maxillary tumor and wore a prosthesis with an attached obturator part with an opening into the antrum that prevents the maxillary defect from communicating with the nasal cavity. In these patients, a maxillary prosthesis could effectively prevent the influx of the outside air through the jaw defect into the oral cavity. On the other hand, 1 of the 5 patients used a mandibular prosthesis. This type of prosthesis does not close defects through which outside air flows into the oral cavity but serves to restore lip support and assist lip closure. Mukohyama et al. reported a case in which a lip plumper was fitted to a patient after mandibular tumor surgery to improve oral function and demonstrated that recovery of lip support had beneficial effects on oral function after the surgery.[17] In the patient described above who used a mandibular prosthesis, recovery of lip support supplemented lip closure and prevented mouth breathing, which may have alleviated xerostomia.

Of the 26 patients in this study, 15 patients who had undergone maxillary tumor surgery used a maxillary prosthesis. Of them, 4 could not judge the effects of prostheses on xerostomia because they wore their prosthesis all the time, even when sleeping. Maxillary prostheses are often necessary for speech and swallowing, and many patients do not remove them because they are worried about the effect of doing so. In such cases, patients spend very little time without their prosthesis in place, and it may be difficult for them to notice whether wearing their prosthesis has an effect on xerostomia. Therefore, a method other than a questionnaire appears to be necessary. The effects of prosthesis use on xerostomia can be investigated by comparing the oral mucosa moisture content between when a prosthesis is worn and after it has been removed for some period of time. We plan to ascertain these effects using objective quantitative data in addition to questionnaire results in future research. Eight patients wore a mandibular prosthesis, and the extent of their mandibular/ lingual tumors and the shape of their prostheses varied. In a future study, we plan on increasing the number of patients and conducting a questionnaire survey with more patients who use a mandibular prosthesis to more clearly show the shapes of mandibular prostheses that effectively improve xerostomia.

CONCLUSION

We investigated the status of xerostomia in 26 patients who had been treated for head and neck tumor by conducting a questionnaire survey on xerostomia and measuring the resting salivary flow rate and oral mucosa moisture content. The results showed 16 patients (60%) had a feeling of dry mouth. Almost half of all patients (n=12), felt that xerostomia had worsened following tumor treatment. Among those patients who constantly experienced xerostomia, both resting salivary flow rate and oral mucosa moisture content were low, and many had symptoms of oral discomfort associated with the xerostomia. Decreased salivary flow was commonly seen in patients after mandibular/lingual tumor treatment, while mild dryness not associated with decreased salivary flow was observed in many patients following maxillary tumor treatment. Five patients reported that wearing a prosthesis alleviated xerostomia, suggesting the possibility that closure of maxillary defects and assistance of lip closure by maxillofacial prosthesis use may be effective in alleviating mouth dryness.

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Appendix 1. Questionnaire on dry mouth.

Questionnaire about mouth dryness			
Age	Sex	Height	Weight
Please circle each applicable item			
1. general condition			
0. No special disorder	1. Hypertension	2. Diabetes mellitus	3. Gastrointestinal disorder
4. Respiratory disorder	5. Cardiac disorder	6. Cardiac failure	7. Hepatic disorder
8. Blood disorder	9. Parkinson's Disorder	10. Renal disorder	11. Urinary tract disorder
12. Psychosomatic disorder	13. Psychiatric disorder		
14. Others (A. Bronchial asthma B. Allergic rhinitis C. Pollinosis D. Atopic dermatitis)			
2. Symptoms			0 (No)・1 (Sometimes/a little)・2 (Yes)
1. Dried or parched feeling in your mouth			0 ・ 1 ・ 2
2. Frequently drinking water/always carrying water			0 ・ 1 ・ 2
3. Waking up in the middle of night to drink water			0 ・ 1 ・ 2
4. Having difficulty eating dry food such as crackers			0 ・ 1 ・ 2
5. Having difficulty swallowing food			0 ・ 1 ・ 2
6. Your mouth feeling sticky/having difficulty talking			0 ・ 1 ・ 2
7. Food tastes strange			0 ・ 1 ・ 2
8. Breathing through the mouth (including during sleep)			0 ・ 1 ・ 2
9. Having bad breath/nervous about bad breath			0 ・ 1 ・ 2
10. Your eyes easily getting dry			0 ・ 1 ・ 2
11. Easily sweating			0 ・ 1 ・ 2
12. Easily getting scratches from your dentures			0 ・ 1 ・ 2
13. Upper dentures easily come out			0 ・ 1 ・ 2
14. Using oral moisturizers			0 ・ 1 ・ 2
15. Feeling dry mouth more often than before tumor treatment			0 ・ 1 ・ 2
16. Wearing your prosthesis alleviate mouth dryness			0 ・ 1 ・ 2
17. Removing your prosthesis before going to bed causes mouth dryness			0 ・ 1 ・ 2
3. Medications and alcohol intake			
0. No	1. Antihypertensive drug	2. Antihistaminic	3. Tranquilizer
4. Antidepressant	5. Antiparkinsonism drug	6. Diuretic	7. β-blocker
8. Antiallergic drug	9. Inhalant	10. Others	11. Alcohol
4. Smoking habits			
No / Yes			
About ( ) hours	after meal		
About ( ) hours	after tooth brushing		