Denture Treatment Improves Oral Discomfort Accompanying Dry Sensation

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Abstract

Aim: In recent years, the number of patients complaining of symptoms of oral discomfort such as dry mouth, tongue pain, and burning sensation of the mouth has been increasing. This study aimed to determine whether denture treatment improved oral discomfort accompanying dry and sticky sensations. Methods: Forty-eight partial and/or complete denture wearers complaining of oral discomfort were recruited from non-xerogenic patients with normal salivary flow after obtaining informed consent. Measurement outcomes were: 1) subjective symptoms evaluated by self-administered questionnaire, including five questions on oral discomfort; 2) objective symptoms such as congestion and erosion of the tongue, erosion and congestion of the palate, and angular stomatitis evaluated by one dentist; and 3) unstimulated and stimulated salivary flow rates. Outcomes were evaluated before and after denture treatment. Mean differences in outcomes between before and after denture treatment were analyzed by Wilcoxon signed-rank test, then multiple regression analysis was applied to determine predictive variables associated with each score. Results: All outcomes were improved by denture treatment. Both unstimulated and stimulated salivary flow rates were significantly increased ($p=0.042$, $p=0.014$). Multiple regression analysis revealed that new denture fabrication improved stimulated salivary flow much more than only adjustment of the existing denture, and stimulated salivary flow significantly reduced objective symptoms ($p=0.020$), and sensations of dryness ($p=0.010$), pain or burning in the mouth ($p=0.029$). Conclusions: The results suggest that denture treatment improves salivary flow and reduces oral discomfort.

Key Words: Denture, Discomfort, Multiple regression analysis, Salivary flow, Xerostomia

Introduction

In recent years, the number of patients complaining of symptoms of oral discomfort such as dry mouth, tongue pain, and burning sensation of the mouth has been increasing [1-3]. In particular, dry mouth has become a big issue, since many patients worldwide suffer from oral discomfort accompanying dry and sticky sensations, causing significant declines in quality of life by decreasing gustatory sensation and impairing chewing ability [4]. An epidemiological survey in Europe reported that over 25% of the population was aware of dry mouth, also called xerostomia [5].

Xerostomia has several causes, including Sjögren's syndrome, iatrogenic damage to the salivary glands (e.g., from radiotherapy or surgical resection), side effects of pharmacotherapy, metabolic diseases, and stressors and psychological disturbances that involve no specific salivary gland pathology [3,6,7]. Aging is another factor associated with xerostomia. Xerostomia and dry mouth is common among elderly peoples [8].

Central to the discussion of xerostomia is salivary flow, since salivary flow rate is used for the diagnosis of xerostomia. The diagnostic criterion for xerostomia is defined as salivary flow under 1.5 ml/15 min at rest (unstimulated) and/or under 10.0 ml/10 min during stimulation [9]. However, even with apparently normal salivary flow, people complaining of a dry, sticky feeling and saliva with a stringy or foamy consistency are frequently encountered in dental practice.

One of the most productive ways to improve the sensation of dry mouth is to stimulate oral receptors by physiological means and hence stimulate salivary function. Some reports have suggested that reduced chewing ability would decrease the salivary flow rate and exacerbate atrophy of the salivary glands [4]. For this reason, research indicates the importance of physiologically stimulating the salivary glands by chewing or gustatory stimuli such as chewing xylitol gum or sucking sugar-free hard candies [10,11]. In case reports, patients wearing incompatible dentures have shown decreased salivary flow rates [12]. However, the relationship between improvement of chewing ability by denture treatment and oral discomfort remains unclear.

Based on this background, we conducted the present study to clarify whether denture treatment can improve oral discomfort accompanying dry mouth sensation in non-xerogenic patients with normal salivary flow.

Materials and Methods

Participants

Participants comprised 48 patients with normal salivation (≥1.5 ml/15 min unstimulated salivary flow and/or ≥10.0 ml/10 min stimulated salivary flow) who had complained of oral discomfort. These patients were examined at Kanagawa Dental University Affiliated Hospital and were subsequently admitted for denture treatment of missing molars. Informed consent was obtained from all participants, and the study

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protocol was reviewed and approved by the ethics committees of Kanagawa Dental University (approval no. 260).

Evaluation of existing denture

Occlusal relationships at the physiological rest position and at the centric occlusal position were examined to confirm vertical occlusal dimensions. Occlusal contact points of the existing denture at the centric occlusal position were examined by one dentist using an articulating paper. Furthermore, denture fit was examined using silicone-based fit-checking material (Fit Checker II; GC, Tokyo, Japan). The dentist then evaluated whether the patient needed new dentures according to denture conditions.

Throughout the study period, treatment with diagnosis by prosthetic specialists was conducted to ensure consistency of diagnosis and treatment. Participants were randomly assigned to either the denture adjustment group or the new denture fabrication group.

Measurement outcomes

Measurement outcomes were subjective symptoms, objective symptoms and salivary flow rate evaluated before and after denture treatment (about 1 month after denture showed stabilization without pain).

Subjective symptoms: Participants answered a validated self-evaluation questionnaire that included five questions on oral discomfort (*Table 1*). Each question used a numerical rating scale (NRS) with an 11-point scale ranging from 0 (no awareness of the symptom) to 10 (strong awareness of the symptom) [13].

Table 1. Questionnaire for subjective symptoms of oral discomfort.

Q1. Do you have a dry sensation in your mouth?
Yes/Severity: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
No: 0
Q2. Do you have pain or a burning sensation in your mouth?
Yes/Severity: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
No: 0
Q3. Do you have a damaged sensation in your mouth?
Yes/Severity: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
No: 0
Q4. Do you experience difficulty eating or drinking?
Yes/Severity: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
No: 0
Q5. Do you have pain or discomfort of the tongue?
Yes/Severity: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
No: 0
The scale of 1-10 represents awareness of the symptom, ranging from very little awareness (1) to strong awareness (10).

Objective symptoms: One dentist examined oral conditions using visual inspection and palpation, as follows: 1) congestion and erosion of the tongue; 2) erosion and congestion of the palate; and 3) angular stomatitis. Symptoms were then scored by one dentist as 0-6 points according to how many of these signs were present.

Salivary flow rate: Both unstimulated and stimulated salivary flow rates were measured using the spit method [9,14-16]. Saliva was collected for 15 min in a paper cup and the volume was measured. The unstimulated salivary flow test was passive, whereas participants were instructed to chew gum for the stimulated salivary flow test (Lotte Free Zone; Lotte, Tokyo, Japan) for 10 min [9]. Measurements were conducted in quiet surroundings at least 1 h after the participant's last meal and were completed by 10:00 a.m.

Statistical analysis

Mean differences between before and after denture treatment of subjective symptoms, objective symptoms, and salivary flow rate were analyzed using the Wilcoxon signed-rank test as an initial analysis to confirm whether denture treatment improved outcomes.

Multiple regression analysis was applied to test the following hypotheses: 1) which denture treatment (denture adjustment or denture renewal) exerted a greater effect on subjective symptoms, objective symptoms, and salivary flow rate; and 2) whether changes in unstimulated and stimulated salivary flow affected subjective and objective symptoms. Multiple regression analysis was also applied to adjust for baseline characteristics such age, sex, and medication, since these act as confounders. Dependent values were change in score between before and after treatment, calculated by subtracting the value before treatment from the value after treatment. Values of $p< 0.05$ were considered significant. All statistical analyses were performed using the SPSS® Statistics 21 IBM® statistical package (SPSS-IBM., Chicago, IL, USA). The conclusion of this study was derived from the results of multiple regression analysis.

Results

Participant characteristics

Table 2 provides baseline characteristics of the 48 participants. The male:female ratio was 5:7, and over 90% of participants were not taking any medications. New denture fabrication was performed for 54.2% of participants (fit of denture largely unsuitable on both left and right sides or occlusal contact showing no bite on both left and right sides), and 45.8% of participants received adjustment of the existing denture.

Table 2. Baseline characteristics of patients.

Variables	
Age (years)	65.0 (11.7)
Sex (male/female)	20/28
Medication (%: patients)	
Participants with medication	8.3: 4
Participants without medication	91.7: 44

Prosthetic treatment (%: patients)	
Only old denture adjustment	45.8: 22
New denture fabrication	54.2: 22

Subjective and objective oral symptoms

Scores for subjective symptoms decreased significantly from before to after denture treatment in all questions (*Figure 1*; Q1:p=0.005, Q2:p=0.018, Q3:p=0.003, Q4:p=0.002 and Q5:p=0.001). Objective symptoms also showed significant reductions from 1.98 ± 2.23 before to 0.52 ± 1.44 after denture treatment (*Figure 2*; p=0.028).

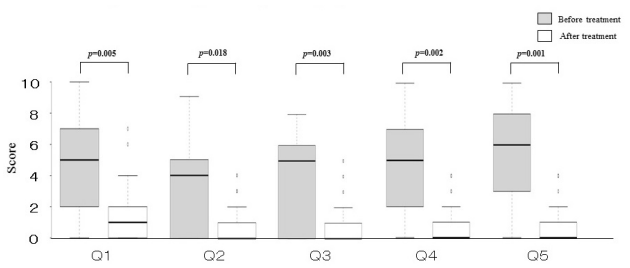

Figure 1. *Changes in subjective symptoms of oral discomfort.*

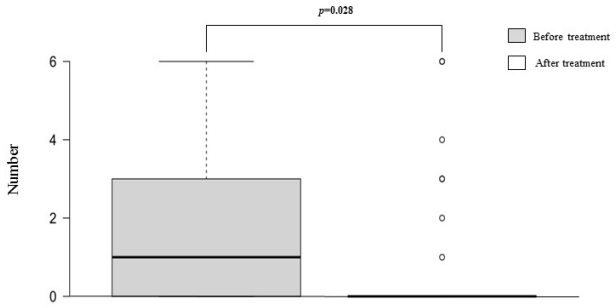

Figure 2. *Changes in objective symptoms.*

Salivary flow rate

Unstimulated salivary flow rate was above the reference value (1.5 ml/15 min) at 3.19±1.16 ml before denture treatment (*Figure 3*), and increased significantly to 3.56 ± 1.21 ml after treatment (p=0.042). Stimulated salivary flow rate was also above the reference value (10.0 ml/10 min) at 10.43 ± 2.74 ml before treatment, increasing significantly to 12.78 ± 2.39 ml after treatment (p=0.014).

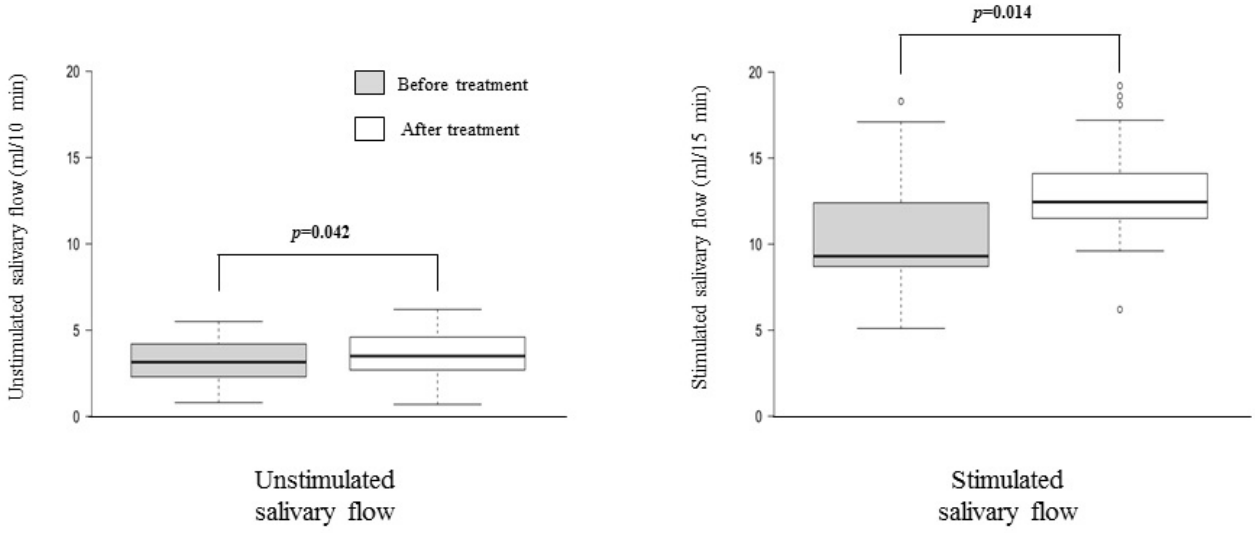

Figure 3. *Changes to unstimulated and stimulated salivary flow rates.*

Table 3. *Multiple regression analyses.*

Subjective symptoms			
Q1: Dry sensation in mouth	Age (years)	-0.082	0.004*
	Sex (male / female)	1.521	0.019*
	Medication (with / without§)	-1.888	0.109
	Existing denture treatment (new denture fabrication / denture adjustment§)	-0.116	0.83
	Change of unstimulated salivary flow	0.389	0.712

	Change of stimulated salivary flow	-0.441	0.010*
Q2: Pain or burning sensation in mouth	Age (years)	-0.051	0.075
	Sex (male / female)	0.793	0.224
	Medication (with / without§)	-2.464	0.045*
	Existing denture treatment (new denture fabrication / denture adjustment§)	-0.26	0.651
	Change of unstimulated salivary flow	1.258	0.251
	Change of stimulated salivary flow	-0.381	0.029*
Q3: Damaged sensation in mouth	Age (years)	-0.023	0.427
	Sex (male / female)	1.812	0.010*
	Medication (with / without§)	-2.656	0.038*
	Existing denture treatment (new denture fabrication / denture adjustment§)	0.01	0.986
	Change of unstimulated salivary flow	0.21	0.852
	Change of stimulated salivary flow	-0.34	0.06
Q4: Difficulties eating or drinking	Age (years)	0.002	0.953
	Sex (male / female)	1.464	0.041*
	Medication (with / without§)	-2.162	0.1
	Existing denture treatment (new denture fabrication / denture adjustment§)	-0.1	0.872
	Change of unstimulated salivary flow	-1.007	0.392
	Change of stimulated salivary flow	-0.219	0.238
Q5: Pain or discomfort of tongue	Age (years)	-0.03	0.301
	Sex (male / female)	0.956	0.148
	Medication (with / without§)	-4.308	0.001*
	Existing denture treatment (new denture fabrication / denture adjustment§)	-0.663	0.257
	Change of unstimulated salivary flow	1.822	0.102
	Change of stimulated salivary flow	-0.222	0.202
Objective symptoms	Age (years)	-0.045	0.058
	Sex (male / female)	0.842	0.08
	Medication (with / without§)	-1.226	0.172
	Existing denture treatment (new denture fabrication / denture adjustment§)	0.207	0.684
	Change of unstimulated salivary flow	1.317	0.071
	Change of stimulated salivary flow	-0.269	0.020*
Unstimulated salivary flow	Age (years)	0.004	0.339
	Sex (male / female)	0.027	0.756
	Medication (with / without§)	0.21	0.19
	Existing denture treatment (new denture fabrication / denture adjustment§)	0.15	0.1
Stimulated salivary flow	Age (years)	-0.035	0.151
	Sex (male / female)	-0.637	0.227
	Medication (with / without§)	0.925	0.328

	Existing denture treatment (new denture fabrication / denture adjustment§)	1.707	0.002*
*p<0.05			
§ Reference category for multiple linear regression analysis			

Multiple linear regression analysis of subjective symptoms, objective symptoms, and salivary flow rate

The results of multiple regression analysis are shown in *Table 3*.

Dry mouth sensation was associated with age (p=0.004), sex (p=0.019), and change of stimulated salivary flow (p=0.01). Pain or burning sensation in the mouth was associated with pharmacotherapy (p=0.045) and stimulated salivary flow (p=0.029). Damaged sensation in the mouth was associated with sex (p=0.01) and pharmacotherapy (p=0.038). Difficulty eating or drinking was associated with sex (p=0.041). Pain and discomfort of the tongue was associated with medication (p=0.001). Objective symptoms were associated with stimulated salivary flow (p=0.02). Stimulated salivary flow was associated with denture treatment; that is, flow was significantly more improved with new denture fabrication than with only adjustment of the original denture (p=0.002).

Discussion

The present study investigated whether denture treatment affected variables related to oral discomfort accompanying dry and sticky sensations in non-xerogenic patients with normal salivary flow and exclusion of organic disorder involving the salivary glands. This study showed that all outcomes were significantly improved after denture treatment compared to before treatment. In this study, potential confounders such as age, sex, and medication needed to be adjusted by statistical methods to clarify whether denture treatment affected improvements in outcomes. Consequently, multiple regression analysis was used and revealed that new denture fabrication improved stimulated salivary flow much more than adjustment of the existing denture, and stimulated salivary flow significantly reduced objective symptoms, sensations of dry mouth, and pain or burning sensation in the mouth.

Decreased salivary flow is attributed to changes in masticatory ability induced by muscle weakness or incompatible dentures [17,18]. The fitting of prosthetic appliances can improve salivary flow and, in particular, lead to increase in stimulated salivary flow [17,19,20]. Previous reports showed how denture quality can influence salivary flow. The present results demonstrated that salivary flow was significantly increased both at rest and during stimulation, with marked improvements observed for the amount of stimulated salivary flow in particular. The results of this study were therefore consistent with those of past reports concerning the effects of prosthetic treatment (*Figure 3*).

Several reports have stated that salivary flow is closely related to various symptoms of discomfort, such as dry mouth, dysphagia, and burning mouth sensation [2,3,21-23]. This suggests that when the volume of saliva decreases, various symptoms of discomfort in the oral cavity are likely to develop. Such reports support the present findings. Furthermore, scores for subjective symptoms such as congestion and erosion of the tongue and palate, as well as angular stomatitis, were significantly affected by stimulated salivary flow. Decreased salivary flow has been shown to be related to subclinical inflammation in the mouth [23]. Our results also agreed with these previous reports. The present study found that decreased salivary flow at the initial examination correlated with high scores for all five items related to subjective symptoms of oral discomfort and objective signs applicable at the initial examination, similar to the observations in previous studies. The increase of salivary flow after prosthetic treatment improved subjective symptoms and objective signs in all items (*Figures 1,2*).

Multiple regression analyses showed that improvement of stimulated salivary flow correlated significantly with improvement of dry mouth sensation and pain or burning mouth sensation in the mouth. Fabrication of a new denture significantly increased stimulated salivary flow when compared to adjustment of the existing denture. Considering such findings, the reason fabrication of a new denture improved stimulated salivary flow much more than simple adjustment of the existing denture. The new denture might provide much better chewing ability, resulting in enhanced salivation through effects on oral baroreceptors. In addition, stimulation of taste receptors may also contribute to enhanced salivary flow. Interestingly, stimulated salivary flow related to improvement of subjective symptoms, but unstimulated salivary flow did not. Furthermore, while stimulated salivary flow was improved more by new denture fabrication than by existing denture adjustment, unstimulated salivary flow was not. These findings suggest a robust imaging model that denture fabrication can reduce patient complaints of troubles involving the mouth by allowing suitable mastication and improved salivary flow, eventually resulting in the resolution of oral discomfort.

On the other hand, multiple regression analyses of questionnaire results on oral condition revealed that individuals receiving pharmacotherapy showed less discomfort of the tongue and mouth after treatment than those without medication. This disagreed with the idea that medication use is partially responsible for pain or discomfort in the mouth, such as burning mouth sensation. Over 500 medications are known to be associated with oral discomfort [24]. However, not all medicines are equally likely to induce such problems as side effects. For example, medicines for mental disorders are considered more likely to reduce dry mouth and burning sensation [25]. Associations between pharmacotherapy and pain or discomfort in the mouth remain controversial. Furthermore, 4 patients (8.3%) in our study were taking medications. Further studies on this issue should be undertaken.

Finally, multiple regression analyses identified age and sex as confounders in this study. Even though potential confounders measured at the start of study, such as age and sex, were adjusted for in the statistical methods, our study design could not control for potential confounders not measured before the start of the study. This represents a limitation to the present study. In conclusion, denture treatment was suggested to improve salivary flow and reduce oral discomfort in patients.

Acknowledgements

This study was conducted in accordance with the Declaration of Helsinki, and each subject received oral and written information about the study and provided informed consent prior to participation. The study protocol was reviewed and approved by the Human Ethics Committees of Kanagawa Dental University (approval no. 260). The authors declare no conflict of interest.

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