Research Article

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The Effect of Anterior Palatal Surface Modifications of Complete Denture on Oral Perception Time: Preliminary Report

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ABSTRACT

Aim: The purpose of this study was to evaluate the Oral Perception Time (OPT) in complete dentures wearers with a small opening in an anterior palatal base and compare it with the conventional and functionally contoured palatal base.

Material and methods. Forty healthy completely edentulous individuals' divided in two groups. Group A: 60 to 70 years and Group B: Above 70 years participated in the perception test. The time required to sense a nylon thread embedded in test food (Low Calorie Butter cube) was measured. The test was performed in four phases of study. Response times (sec) were analysed using a 1-way ANOVA for repeated measurements followed by the Bonferroni test for multiple comparisons (p =.05).

Results. A significant difference was observed in response time in nylon fiber perception between bases with or without a small opening ($p < 0.001$). OPT is found maximum in with denture in both groups A and B 13.08±0.74, 13.74±1.46 respectively.

Conclusions. The small-opening type of palatal coverage improved oral perception.

Keywords: Perception, Compete dentures, Stereognosis, Palatal Coverage.

INTRODUCTION

Stomatognatic system has been closely examined using neuro-physiological approaches[1-3]. It is well known that a central feedback system controls masticatory movement. Palatal mucosal mechanoreceptor also functions to identify the precise position of food bolus in the mouth [4]. It was reported that oral size perception results from a combination of sensory inputs from the palate and the tongue [4,5]. Receptors located in the palatal mucosa were closely related to masticatory performance and swallowing[5]. Hirano et al[6] also reported that positive correlation existed between masticatory ability and oral sensorimotor ability.

Oral sensory ability controls masticatory movement even for edentulous people when chewing with their dentures [7,8]. However, conventionally designed dentures covers palatal mucosa completely. The effects of palatal covering with a base, includes those related to speech, oral perception and sensory function in the oral cavity. [9-20] It has been reported that constant pressure on the palatal mucosa from the palatal base may cause hypoesthesia.[21] Such pressure may also result in the loss and degeneration of Merkel cells, mechanoreceptors that are abundant in the palatal rugae, as well as degeneration of adjoining nerve fibers.[22] In addition, palatal coverage may reduce

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Fig 1: Conventional complete dentures

Fig 2: Modification Type I- Functionally contoured modified palate of the maxillary complete denture.

Fig 3: Modification Type II-small-opening (SO) in the anterior region of the palatal base of the maxillary complete denture.

Fig 4: Cuboid pieces of low calorie butter (Amul butter lite Co, Ltd, Gujrat, India)

masticatory efficiency and disturb sensorimotor function.[23] The anterior region of the palate contains many oral sensory receptors for tactile sense, pressure sense, algesthesia and thermesthesia.[22] It has been reported that palatal coverage reduces sensory function,[9,24] which results in prolonged bolus propulsion time and decreased oral perception.[10] It has been shown that when the polished surface of the anterior region of the palatal base is customized for a patient, the time required for food recognition during eating is reduced.[11] Another study noted that the shape of the palatal base affected pronunciation.[12] These findings demonstrate that pressure on the palatal mucosa and extensive palatal coverage by a palatal base adversely affects oral function, as well as brain function activity as sensory feedback mechanism is reduced resulting in reduced brain functions. According to the reports the tissues in the anterior and middle part of the palate remains stable and that morphological changes in this area is less than the any other area after extraction. This proposes the following question that is, the coverage of the palate by denture possibly may induce impairment of natural contour of palate, leading to disturbance of oral functions like mastication, oral perception, speech and many more. This coverage also interferes and diminishes the oral sensory and motor ability. These consideration hypothesizes that palatal coverage by dentures disturbs the masticatory efficiency, oral perception time, speech etc[7,8].

Since many years, no improvements have been made in the shape of complete dentures, as any change in the shape of complete maxillary dentures may adversely affect retention. However, Takashi Koike et al, [21] in 2011, described that the small-opening type of palatal coverage improved the oral perception and demonstrated sufficient retention force.

So, this study was planned evaluate the effect of anterior palatal surface modifications of complete denture on oral perception time (OPT). Two types of anterior surface modifications (Modification Type I-functionally modified palate. Modification Type II-small-opening (SO) in the anterior region of the palatal base [21]) were evaluated with conventional palatal coverage dentures and without dentures.

MATERIALS AND METHOD

Materials and Methods

The present study was carried out in the Department of Prosthodontics and Crown & Bridge, Career Post Graduate Institute of Dental Sciences and Hospital, Lucknow. In this study, the Oral Perception time was evaluated in completely edentulous patients in four phases. The study involved 40 completely edentulous patients who were divided in two groups. Group A: 60 to 70 years and Group B: Above 70 years. In each group 20 subjects were taken following the mentioned, inclusion and exclusion criteria.

Inclusion criteria- Cooperative patient, completely edentulous patients of same ethnicity and area, Patients with completely healed well rounded ridges. (Evaluated using the method described by Ohnuki et al.[25]), No history of tongue tie and related treatment, Edentulous patient with moderate level of education. Exclusion Criteria - Uncooperative patient, Patient with any congenital or acquired maxillofacial defects, Patient with any intraoral or extraoral pathology, edentulous patients with any neuro-muscular defects. Written informed consent was obtained from each Patient and the ethical clearance was obtained from the institute's ethical committee. For all the subjects complete dentures (maxillary and mandibular) were constructed following standardized method (Boucher's guidelines [26]) (Fig.1).

Modification made in complete denture. Modification Type I-functionally contoured modified palate (FCMP). Mouth temperature wax was to functionally contour the palatal vault of the maxillary complete denture (Fig.2). Modification Type II-small-opening (SO) (Fig. 3) in the anterior region of the palatal base (as suggested by Takashi Koike[21] - It extends from the incisive papilla to the third palatal rugae).

Each subject was tested for OPT in four phases.

Phase-1 – Subject without complete denture.

(At the time of diagnosis & treatment planning)

Denture insertion

↓

Phase -2 – Subject with conventional complete denture.

(At first recall visit after denture insertion)

Denture Modification type I

↓

Phase -3- Subject with modified (Type I) complete denture.

(After 2 hours of Denture Modification type I)

Denture Modification type II

↓

Phase -4- Subject with modified (Type II) complete denture.

(After 2 hours of Denture Modification type II)

Recording of oral Perception time:-

A perception test was used to determine the response time with dentures. The test consists of test food made of cuboid pieces of low calorie butter (Amul butter lite Co, Ltd, Gujrat, India) (10 mm x 10 mm x 5 mm), each containing one nylon thread (diameter: 0.5 mm; length: 5 mm). (Fig.4) The experimental dentures were given to patients with the instruction to keep their eyes closed and mouth open, after which the test food was placed on the anterior area of the tongue. Patients were informed about the thread in the test food. They were asked to perceive the thread as quickly as possible only by using their tongue and palate. Biting or chewing the food was not allowed. The test was performed 3 times. The time required to perceive the nylon thread was noted with the help of stop watch and the mean was taken as oral perception time for the patient.

The data so obtained was tabulated and statistically analyzed. In statistical analysis, the data was summarized as Mean ± SD (standard deviation).The Groups were compared by one way analysis of variance (ANOVA) of repeated measures and the *F* values and *p*- values were calculated. A two-sided (α=2) p value less than 0.05 ($p<0.05$) was considered statistically significant. The statistical analyses were performed on SPSS software (IBM

SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp)

RESULTS

On comparing the OPT in group A (Age 60-70 years), (Table 1) OPT is found maximum in with denture (13.08±0.74).One way ANOVA (repeated measures) shows that the mean OPT difference among four techniques is found statistically significant (F=1590,df=3,p<0.001). Post hoc multiple comparison depicts the significant differences in various pairs as mentioned in table 2. Table 3 shows comparison of OPT in group B (Age >70 years). OPT is found maximum in with denture (13.74±1.46).One way ANOVA (repeated measures) shows that the mean OPT difference among four phases is found statistically significant (F=298.5,d.f=3,p<0.001).Post hoc multiple comparison depicts the significant differences in various pairs as mentioned in table 4.

DISCUSSION

Stereognosis is the appreciation of the form of the object by means of touch by oral cavity structures. Oral Stereognosis is used to investigate the relationship of oral perception to diagnostic and therapeutic procedures in dental treatment. It compares the level of oral discriminatory skill to age, to the presence or absence of teeth, to speech articulation and to patient evaluation of their prosthesis[27]. It has been reported that the trigeminal nerve innervates the periodontal ligament and masticatory muscle, and that when trigeminal nerve sensory information is attenuated due to multiple tooth loss, higher brain activities, such as learning and memory, are inhibited [28,29-31]. The tooth loss is a risk factor for Alzheimer's disease, reported by joint epidemiological investigation of the World Health Organization (WHO) and the National Institute on Aging (NIA).[28]

Complete dentures remain a common prosthesis for edentulous patients. But the changes or improvements in its shape had not been considered for many years, as any change in the shape of complete maxillary dentures may adversely affect retention. In 2011, a new recommendation was made by Takashi Koike et al [21], they demonstrated that a small-opening in the palatal surface of maxillary denture improve the

Table 1: Comparison of OPT in group A (Age 60 - 70 years)

Variable	Without Denture (N=20)	With Denture (N=20)	FCMP Modification I (N=20)	SO Modification II (N=20)	Significance
OPT	4.51±0.82	13.08±0.74	11.56±0.73	7.55±1.05	F=1590,d.f=3, p < 0.001

***OPT – Oral Perception Time, FCMP – Functionally contoured modified palate, SO – Small opening**

Table 2: Post Hoc Multiple comparisons of OPT in group A (Age 60 - 70 years)

Bi-Comparisons Using Bonferroni Post-Hoc Test	Without Denture		With Denture		FCMP Modification I		SO Modification II	
	Mean Diff.	*p*-value	Mean Diff.	*p*-value	Mean Diff.	*p*-value	Mean Diff.	*p*-value
Without Denture			8.57	<0.001	7.045	<0.001	3.035	<0.001
With Denture					1.525	<0.001	5.535	<0.001
FCMP Modification I							4.01	<0.001

***OPT – Oral Perception Time, FCMP – Functionally contoured modified palate, SO – Small opening**

Table 3: Comparison of OPT in group B (Age >70 years)

Variable	Without Denture (N=20)	With Denture (N=20)	FCMP Modification I (N=20)	SO Modification II (N=20)	Significance
OPT	4.30±0.98	13.74±1.46	11.35±0.83	7.86±1.35	F=298.5,d.f=3, p < 0.001

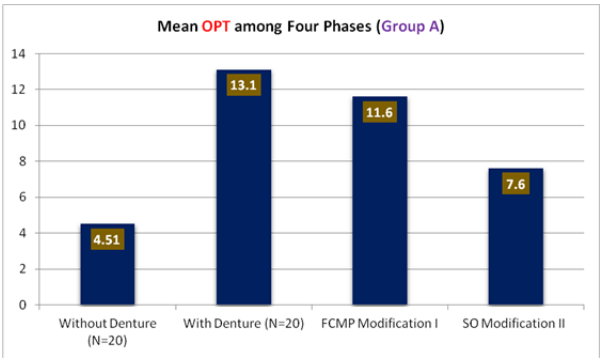
***OPT – Oral Perception Time, FCMP – Functionally contoured modified palate, SO – Small opening**

Table 4: Post Hoc Multiple comparisons of OPT in group B (Age >70 years)

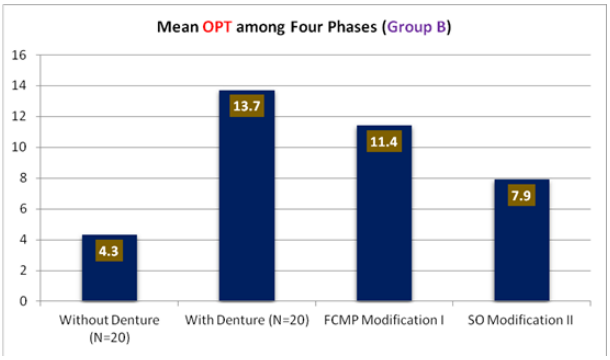
Bi-Comparisons Using Bonferroni Post-Hoc Test	Without Denture		With Denture		FCMP Modification I		SO Modification II	
	Mean Diff.	*p*-value	Mean Diff.	*p*-value	Mean Diff.	*p*-value	Mean Diff.	*p*-value
Without Denture			9.4	<0.001	7.005	<0.001	3.515	<0.001
With Denture					2.39	<0.001	5.88	<0.001
FCMP Modification I							3.49	<0.001

***OPT – Oral Perception Time, FCMP – Functionally contoured modified palate, SO – Small opening**

oral perception and demonstrated sufficient retention force. They put forward that complete maxillary dentures are subject to dislodgement due to gravity, mastication, and adhesive forces from food[32] and tissues around the peripheral border of the denture. Complete dentures must, therefore, exhibit sufficient retention to remain in place. The elements of adhesion, cohesion, and interfacial force



Graph 1: Mean OPT among Four Phases (Group A).



Graph 2: Mean OPT among Four Phases (Group B).

that underlie retention are proportional to the area of supporting tissue covered by the denture base[33-34]. For atmospheric pressure to increase retention effectively, dentures must be sealed around their borders.[35-37] Therefore, to achieve maximum retention, denture bases must extend as far as possible without interfering with the functions of the oral tissue.

In using complete dentures with an anterior palate opening, it is, therefore, necessary to consider methods of managing lateral forces. These include modification of the shape of artificial teeth and use of lingualized occlusion. Residual ridge conditions are also important for dentures with

anterior palatal openings. Dentures with a small anterior palatal opening should be used in patients where resorption of alveolar bone in the anterior maxilla is not severe.[21] In the present study the OPT was evaluated for complete denture with small-opening in the palatal surface of maxillary denture and compared in patients without dentures, with conventional dentures and with functionally contoured palatal base dentures. For assessing the oral perception the low calorie butter cube with nylon thread method was used [21].

After analyzing the data for OPT, it was found that time required to distinguish the content of a bolus was least in phase 1 without dentures, subjects were able to detect the thread in the sample food very fast. The mean value & standard deviation of OPT after statistical analysis in Group A; phase 1 (without denture) was 4.51±0.82, phase 2 (with denture) was 13.08±0.74, phase 3 (FCMP) was 11.56±0.73, phase 4 (small opening) was 7.55±1.05. (Table.1). The Mean value & standard deviation of OPT after statistical analysis in Group B; phase 1 (without denture) was 4.30±0.98, phase 2 (with denture) was 13.74±1.46, phase 3 (FCMP) was 11.35±0.83, phase 4 (small opening) was 7.86±1.35 (Table.2).

In both the groups the OPT was maximum in phase 2 followed by phase 3, 4 and least in phase 1 (Graph 1& 2). When after phase 1 dentures were inserted the shortest time for oral perception was in phase 4 where a small opening was present in dentures. This could be most likely because subjects were able to use the tactile and pressure sensory receptors in the palate. However, when no opening was present as in phase 2, 3, they were limited to using the tactile and pressure sensory receptors of the tongue to distinguish the content of the test food. On comparing the phase 2 and 3, it was revealed that FCMP helped in early detection of nylon thread.

These results indicate that even a small opening in the anterior palate of a complete denture enhances food recognition. These results also supported the hypothesis that complete coverage of the palate by the dentures adversely affect the oral perception time because it covers the proprioceptors present on the anterior part of the palate thus resulting in delayed recognition of the thread in the sample food. The small opening in the anterior part of the palate of complete denture proved its significance as best alternative to conventional dentures.

The results of the present study were in correlation with previous studies by Muller[38], Tanaka[39], Litvak [40] where FCMP was providing better results for OPT but the hypothesis of providing small opening suggested in this study was proved to be more advantageous compared to the FCMP as suggested in the previous studies. But the studies of Kapur et al in 1964 [41] and Chauvin JO in 1974 [42], in edentulous patients, showed results which were in contrast to the present study. The efficiency of food transport by the tongue and cheeks may be reduced because of their added function of retaining the denture, when they checked it in open palate maxillary denture. This variation may be due to the difference in the size of opening made in the denture. In the present study, a small opening in the anterior part of palate – as proposed by Takashi Koike et al [21] was made. This opening extended from the incisive papilla to the third palatal rugae only compared to open palate complete denture or large opening [21] in the palatal part of maxillary denture. This is one of the reasons why there was less stereognostic ability in open or large opening palate maxillary denture because of the extent of opening, due to less retention, tongue and other soft tissue are not free to perceive any sense of food shape as the tongue engaged for denture retention. On the other hand in the current study, although an small anterior palate opening does reduce retention force, but retention was still sufficient for general oral requirements and also those patients were selected where resorption of alveolar bone in the anterior maxilla was not severe.[21]

The results of this study can be strengthened by regard for the particular research design established in the present study. A varying number of factors may have had an effect on OPT such as denture flange thickness, Posterior palatal seal, stereognostic ability of the particular individual etc. Further studies are necessary to investigate the influence of these factors on OPT. Therefore, further randomized clinical trials with a larger sample size are needed to investigate the factors that are crucial for alterations of OPT in

patients wearing complete dentures with proposed modification in the present study. Also there is a necessity to evaluate the effects of proposed modification in dentures for longer duration of time and its adaptation on all parameters and satisfaction of the patients.

CONCLUSION

It has been reported that loss of teeth is a risk factor in Alzheimer disease [28,43] and one of the important factor in health deterioration. In Japan, the program for the promotion of national health in the 21st century (Health Japan 21) has set dental health improvement and tooth loss prevention as targets to prevent dementia and a bed-ridden state, and to achieve healthy longevity[28]. In edentulous individuals complete denture replaces the missing teeth and covers the entire palate. This palatal coverage hinders the tactile feedback mechanisms to a large extent, and therefore limits the ability to properly perceive the food. [21,44]. Additionally, in the conventional denture design, the palatal coverage itself and its influence on the geometry of the oral cavity are known to be main factors for reduced oral perception in wearers of complete dentures.

In the present study making of small opening in the maxillary complete denture in the anterior part of the palate was suggested and judged for OPT by sample food.

The results showed that –

- In phase 1 (individual without dentures) the oral perception time was least among all phases.
- In phase 4 individuals with complete dentures having modification type II (SO) had least oral perception time compared to phase 2 and 3 when conventional denture and functionally contoured modified palate dentures were used respectively.

It is suggested that the small opening in the maxillary complete denture in the anterior part of the palate allows direct contact of the tongue with the palate and restores the appropriate mechanism for conveying sensory information to the trigeminal nerve and eventually activate brain function activity and patient can enjoyed the food with better perception. It is necessary that the OPT be further analysed through diversified research in such type of dentures. Studies on oral perception may have a clinical impact because many patients attach great importance to oral perception after dental treatment.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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