Evaluation of Oral Stereognosis in Dentate and Edentulous Subjects with and without Cleft Lip and Palate Before and After Chewing

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Abstract
The purpose of this study was to evaluate the differences in oral stereognosis ability between dentate individuals and denture wearers with and without cleft lip and palate before and after chewing. Fifty subjects were divided into three groups: Group 1 was 20 dentate subjects (ages between 21–49 years), Group 2 was 20 denture wearers without cleft lip and palate (ages between 42–70 years), and Group 3 was 10 denture wearers with cleft lip and palate (ages between 24–60 years). All complete dentures had a mean use time of three months, good retention, clinical stability, and supporting tissues with no signs of inflammation. The subjects were asked to recognize six different test pieces. Pieces were inserted and manipulated between the maxillary and mandibular central incisors, before and after chewing a slice of raw carrot. Only correct responses received one point. Data analysis on oral stereognosis levels before and after chewing was conducted with statistical software, with a level of significance of p<0.05. Statistically significant differences in the oral stereognosis levels were observed before and after chewing only in the dentate group. Oral stereognosis levels of dentate subjects were higher than those observed in edentulous subjects. Oral stereognosis levels of denture wearers with cleft lip and palate were lower than those observed in edentulous subjects without clefts; chewing did not influence the oral stereognosis levels in edentulous patients. Further studies are necessary to evaluate the effects of repeated chewing on the oral stereognosis levels.

Keywords:
oral stereognosis, complete dentures, cleft lip and palate, chewing

Introduction
Oral stereognosis (OS) is the neurosensorial ability of the oral mucous membrane to recognize and discriminate the forms of objects in the oral cavity (1). The sensorial abilities of the tongue, lips, thumbs, and index fingers are greater than those of other parts of the body. Therefore, a dentist’s understanding of oral stereognosis is important to understand the expectations of patients receiving complete denture treatment.

In edentulous patients, the loss of tactile sensitivity from the periodontal ligament leads to reduced OS levels (2–5). In addition, the atrophy of the oral mucous membrane associated with decreased salivary flow rate leads to a change in patients’ dietary habits, impairing food manipulation and chewing performance (6). In individuals with a cleft lip and palate, the severe loss of hard and soft tissues in the palatal and pre-maxillary areas have greater implications on speech, chewing, and swallowing than on other functions. One study (7) reported that patients with a cleft lip and palate had decreased OS levels, while another study (8) showed the opposite. Rehabilitation of patients with complete dentures constitutes a great challenge.

Nevertheless, because the human masticatory
The apparatus is involved in various body activities and is probably interrelated with other systemic functions, Funakoshi et al (9), suggested that mastication stimulates the brain and accelerates its energy-consuming metabolism.

Traditionally, tests to verify OS level involve some manipulation of test pieces inserted into the oral cavity (10). A published study has suggested that OS levels may be improved with proper training (11). Until now, no one has evaluated the possibility that chewing can serve as a training modality to enhance the OS index, even with the anatomical relationship between the sensory and motor areas. To date, one positron emission tomography and magnetic resonance imaging study by Momose et al (12), showed that mastication increases regional cerebral blood flow in the oral region of the primary sensorimotor cortices, the supplementary motor areas, the insulae, the cerebellum, and the striatum.

During mastication, continuous information from food characteristics (shape, size, texture) is transmitted to the areas previously listed, similar to what happens in the OS tests and perhaps by the same neuronal circuitry. Chewing may stimulate the cortex, improving the OS levels, faster than the test for recognition of forms when applied alone.

The purpose of this study was to evaluate the OS levels of dentate patients and denture wearers with and without cleft lip and palate before and after chewing.

**Materials and Methods**

**Study groups**

After approval by the Local Ethics Committee, fifty patients were selected and divided into three groups: in Group 1 were 20 dentate individuals (10 males, 10 females) from the Hospital of Rehabilitation of Craniofacial Anomalies, University of São Paulo (HRAC/USP), ages from 21–49 years (mean age, 35 years); in Group 2 were 20 denture wearers (10 males, 10 females) treated at the Department of Prosthodontics, Bauru School of Dentistry, University of Sao Paulo, ages from 42–76 years (mean age, 59 years); and in Group 3 were 10 denture wearers (5 males, 5 females) with complete cleft lips and palates from the HRAC/USP, ages from 24–60 years (mean age, 42 years). Group 3 members were treated at the Prosthodontics Sector of the HRAC/USP and previously rehabilitated by means of surgical treatment, yet they displayed palatal fistulae of different sizes.

Patients signed an informed consent form before the experiment. A questionnaire was used to assess the patients’ opinions about their dentures, satisfaction degree, chewing function, speech, esthetics, and comfort, followed by a detailed examination of the prosthetic appliances and a clinical examination of the lips, tongue, alveolar ridges, and mucosa, as well as the oral hygiene status. The mean use time of the complete dentures was at least three months. The dentures presented good stability and retention, with no signs of mucosal inflammation.

**Oral stereognosis tests before and after chewing**

The objects used for the oral stereognostic tests were made of self-cured acrylic resin (Clásico Artigos Odontologicos, São Paulo, Brazil) measuring 10 mm × 10 mm × 2 mm, affixed in a toothpick to prevent swallowing or aspiration. They were made in six standardized forms chosen from the 20 items used by the NIDR (13) (National Institute of Dental Research) for stereognostic tests, namely a circle, a semi-circle, a square, a triangle, a rectangle, and a cross. All objects were disinfected in a 2% glutaraldehyde solution for 30 minutes before utilization (LM Farma, São Jose dos Campos, São Paulo, Brazil).

Oral stereognosis tests on the edentulous subjects were performed with the maxillary and mandibular dentures in the mouth. All tests were conducted by a single examiner. Initially, a chart illustrating all test pieces was presented to the subjects to facilitate the responses. During the test, the patients were not allowed to see the objects. The objects were affixed to a toothpick and inserted one by one between the maxillary and mandibular central incisors, avoiding contact with the lips, tongue, and cheeks. The subjects were instructed to use only their maxillary and mandibular central incisors to identify the shape of the objects. The toothpick was moved with the tested
piece in contact with the central incisors. The selected pieces were tested for seven times twice; patients chewed a 10-mm thick slice of raw carrot before and after each test. Patients had to point out on the chart the form they identified in their mouths. A correct response received one point, whereas an incorrect response did not receive any points. The values employed for statistical analysis corresponded to the number of forms correctly identified by each patient at the study completion.

Statistical analysis
Data analysis of OS levels before and after chewing was conducted with the aid of a statistical software program (Sigma Stat 2.0, Statistical Software, Jandel Corporation, California, USA). Intragroup comparisons before and after chewing were performed with the paired \( t \)-test for parametric results and with Wilcoxon signed ranks for non-parametric results \((p<0.05)\). Intergroup comparisons before and after chewing were performed with the Kruskal–Wallis test \((p<0.05)\).

Results
Table 1 shows the OS levels for the three groups tested. Statistical analysis showed significant differences for intra-group comparisons before and after chewing only in Group 1 (Wilcoxon signed rank test, \(p<0.05\)). In Groups 2 and 3 before and after chewing, no statistically significant differences were observed (paired \( t \)-test, \(p>0.05\)). Significant differences for inter-group comparisons were seen before chewing (Kruskal–Wallis, \(p<0.05\)). Dunn’s all pairwise multiple comparisons revealed differences between Groups 1 and 3 and between Groups 2 and 3 \((p<0.05)\); after chewing, Kruskal–Wallis and Dunn’s all pairwise multiple comparisons tests revealed that all three groups showed statistically significant differences among them \((p<0.05)\).

Discussion
Grossman (19) suggested the first oral stereognosis test by placing small plastic objects on the tongue dorsum of patients. This test has been performed by many investigators and has remained without significant modification up to now.

To our knowledge, no one (14–18, 20) has evaluated chewing as a training modality to enhance OS levels. Because OS may improve with proper training (11), it was hypothesized that the constant stimulation of the sensory and motor areas by chewing could do it. One of the assumptions that encouraged this study was given by Momose et al (12), who considered that if brain function slows with age, the chewing of food with efficient dentures would appear to be very effective for stimulating brain function in edentulous patients.

In the dentate group, necessity for training is minimized due to the presence of periodontal receptors. Because this group’s members had all of their teeth, mastication could be exerted more easily and the level of constant sensory information transmitted to the motor areas would be higher than in edentulous individuals with or without clefts. Surprisingly, the OS levels before chewing between Groups 1 and 2 did not show significant differences \((p>0.05)\), although the OS levels were higher for Group 1. Although magnetic resonance images could explain the observed results, they were not taken in conjunction with this experiment.

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (years)</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (n=20)</td>
<td>21–49</td>
<td>5.75±0.91 A, a</td>
<td>6.35±0.81 C, b</td>
</tr>
<tr>
<td>2 (n=20)</td>
<td>42–76</td>
<td>4.80±1.60 A, c</td>
<td>4.85±1.42 D, c</td>
</tr>
<tr>
<td>3 (n=10)</td>
<td>24–60</td>
<td>2.60±1.77 B, d</td>
<td>3.10±0.87 E, d</td>
</tr>
</tbody>
</table>

Mean values with the same letters are not significantly different \((p>0.05)\). Capital letters represent intergroup comparisons within the same column. Small letters represent intragroups comparisons within the same line.
In the edentulous groups, as expected from previously published results (20), the OS values obtained were a little lower than in Group 1. Differences in the OS levels of edentulous patients before and after chewing were expected. In this study, some differences may not have been observed between Groups 2 and 3 before and after chewing because true training (testing and chewing performed many times at regular intervals) was not conducted.

The OS level of Group 3 members, denture wearers with a cleft lip and palate, was the lowest in this study. Jacobs et al (2). stated that the presence of a cleft lip with or without a cleft palate is not accompanied by a reduction in intraoral sensitivity and that intraoral sensitivity is not decreased after the manipulation of the tissues in these areas during surgery. However, the presence of palatal fistulæ and the decreased amount of bone in these regions could increase the instability of prosthetic appliances, thus increasing the difficulty in muscular control by the patient and impairing the manipulation of objects inside the mouth. This may explain the differences observed before and after chewing between Groups 2 and 3.

Differences between the edentulous groups (Groups 2 and 3) may not have been observed due to the lack of similar patient age and number between the groups. The difficulty in obtaining groups of similar ages should be considered, because the numbers of patients who seek treatment for a cleft lip and palate is reduced due to factors like avoidance of social contact, poor economic status, and a lack of knowledge. Surgical treatment is not routinely performed in a dental office and few specialized centers exist around the world to treat this problem. In addition, lack of adequate treatment in childhood can lead to death because mastication is impaired, further reducing the number of adults available for study.

Further studies are necessary to evaluate the effects of repeated chewing on OS levels. Magnetic resonance imaging showing spatial activation of cortex areas before and after chewing in edentulous individuals with and without clefts could be an important addition to future OS studies.

Conclusions
1. Oral stereognosis of dentate subjects was higher than that observed in edentulous subjects.
2. Oral stereognosis of denture wearers with a cleft lip and palate was lower than that observed in edentulous subjects without clefts.
3. The chewing function did not influence the oral stereognosis levels in edentulous patients.
4. Further studies are necessary to evaluate the effects of repeated chewing on OS levels.

References