RESEARCH ARTICLE

Evaluation of the Association of Oral Stereognosis with Malocclusion in Children

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Abstract

Aim and objective: To evaluate the association between oral stereognosis with malocclusion in children.

Materials and methods: Stereognostic investigation was made with a set of seven different geometric configurations (circle, square, triangle, star, clover, diamond, and heart shapes) cut out from fresh, raw carrots using preformed iron molds. Any five of the seven geometric forms were randomly placed inside the mouth on the dorsum of the tongue by the investigator with the subject's eyes closed. A minimum of three shapes correctly identified out of the five offered to each child was considered as an indicator of the adequate stereognostic ability of that particular child.

Results: Among the children under Index of Orthodontic Treatment Needs (IOTN) grade I group, 82.4% of children came under the positive response group. Among IOTN grades II, III, and IV, the percentages of children with positive responses were 72.1%, 58.1%, and 18.8%, respectively. There is a statistically significant ($p < 0.001$) decrease in positive response with increasing IOTN grades.

Conclusion: The observations from the present study show that there is altered oral sensory perception in children graded as with malocclusion according to the index used and belonging to the age group selected in the study.

Clinical significance: Sensory and motor components of the orofacial region, like any other part of the human body, are inseparable in their structure and function, the association between orofacial growth and development and sensory maturation cannot be overlooked.

Keywords: Index of orthodontic treatment needs, Malocclusion, Oral stereognosis, Sensory-motor development.

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Introduction

The various structures of the head and neck region including the jawbones, the temporomandibular joint, and craniovertebral articulation, the teeth, the muscles, the ligaments, the soft tissues of the oral cavity including the tongue and the lips, the organic spaces, the vascular, nervous, and lymphatic systems, the mucous membrane and the glands together form a functional unit. Functioning under the control of the nervous system, these components interrelate between each other and with the remaining organ systems, performing the different functions of the stomatognathic system including respiration, sucking, deglutition (swallowing), mastication (chewing), and speech.[1] Thus, oral sensorimotor development has always been an area of great interest for neonatologists, otolaryngologists, speech and language therapists, and other professionals working on child development.

The different functions carried out by the various parts of the human body result from the sensory-motor reflex mechanism, comprising of the sensory feedback and the accompanying motor response. Poor dental occlusion could affect the parts of the head and neck region such as teeth, jawbones, and neuromuscular components and can adversely affect the functions carried out by the orofacial complex.[2] Thus, the delicate equilibrium existing between the sensory input and motor activity is disturbed and could affect the functioning of the whole system.[3] This being the situation, a review of dental literature shows that the sensory mechanisms in and around the oral cavity and its influence on the orofacial development remains a factor poorly investigated and evaluated in general and specifically in association with the development of malocclusion and oral habits.

Oral stereognosis, in simple terms, can be explained as the combined ability of the oral structures to identify various geometric shapes. Similar to visual or manual stereognosis, shape recognition by oral structures too requires coordination between the loci collecting sensory inputs and those that distinguish or perceive shape.[4] Thus, disturbances of the oral sensory mechanisms and the resultant altered oral motor functions could lead to the development of malocclusions, oral habits like tongue-thrusting, and disturbances in speech, mastication, and occlusal disturbances.[5]

The present study was carried out, to explore and gather clinically relevant data on regional sensory perception and to investigate whether altered stereognostic ability could lead to the development of commonly observed malocclusions in mixed dentition.

Materials and Methods

The study was carried out among 325 children who reported to the pedodontic outpatient department of our dental institution.

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Healthy children of age 8–12 years of both sexes were selected based on Mini-mental state examination[6] to ensure a minimum intelligence level for all the participants. Children previously treated with orthodontic or orthopedic appliances or with any mental or physical disability were excluded from the study.

First, a thorough visual examination of the child's oral cavity was performed and any malocclusion, if the present was graded according to the Dental Health Component of the Index of Orthodontic Treatment Needs (IOTN).

The investigation of stereognostic ability was made with a set of seven different geometric figures (circle, square, triangle, star, clover, diamond, and heart shapes) cut out from fresh, raw carrots using preformed iron molds. The pieces were 12 mm in diameter and 3 mm thick. The carrot pieces were secured using sterile suture threads of 20 cm length to prevent swallowing or aspiration by children. Any five of the seven geometric forms were randomly placed inside the mouth on the dorsum of the tongue by the investigator with the subject's eyes closed (Fig. 1). The child was allowed to explore the form inside the mouth for a maximum of 30 seconds and then asked to identify the shape by correlating it with the same seven geometrical shapes drawn on a chart kept in front of them after opening the eyes (Fig. 2) and the inferences were recorded simultaneously. A minimum of three shapes correctly identified out of the five offered to each child was considered as an indicator of the adequate stereognostic ability of that particular child.

The observations were noted on the pro forma sheet at the chair side and were tabulated and statistically analyzed using computer software, Statistical Package for Social Sciences (SPSS) version 16.

Results

Data were expressed in its frequency and percentage as well as mean and standard deviation. To elucidate the associations and comparisons between IOTN grades, Chi-square (χ^2) test was used as a nonparametric test. Analysis of variance (one-way ANOVA) was performed to compare different indices between IOTN grades. Duncan's multiple range test was also performed as a *post hoc* test to compare between variables within ANOVA. For all statistical evaluations, a two-tailed probability of value, <0.05 was considered significant.

Out of these 325 children, 200 (61.5%) belonged to the age group of 8–10 years and 125 (38.5%) were in the age group of 11–12 years. One hundred and seventy-nine (55.1%) were boys and 146 (44.9%) were girls. Of the 325 children included in the study, 210 children (64.6%) belonged to IOTN grade I, 68 (20.9%) to grade II, 31 (9.5%) to grade III, and 16 (4.9%) to grade IV, respectively. Since only 2 out of the 325 children belonged to grade V they were included under group IV (Table 1). Two hundred and forty-three participants (74.8%) identified at least three of the total five shapes presented to them at random and were considered as positive responses. The rest of 82 children (25.2%) who failed to identify at least three shapes were considered as the negative response group. Among the children under IOTN grade I group, 82.4% of children came under the positive response group. Among IOTN grades II, III, and IV, the percentages of children with positive responses were 72.1%, 58.1%, and 18.8%, respectively. There is a statistically significant ($p < 0.001$) decrease in positive response with increasing IOTN grades (Fig. 3).

Discussion

Movements of the jaws and sucking/swallowing motions have been documented in fetuses as old as 10–12 weeks using ultrasound.[7] Motor functions of the lips, cheeks, jaws, and tongue play a crucial role in the maturation of the orofacial structures which in turn affect the feeding process and speech development in the child. The majority of the processes required for the early refinement of oral functions occur during the early years of life, and hence the sensorimotor and cognitive experiences from this age are considered to be the basis for more advanced sensorimotor functions.[1] Progressive development of higher levels of brain function is termed encephalization. Encephalization and local sensory maturation is intimately related to the maturation of motor functions of the head and neck.[3] This association can be disrupted

Table 1: Distribution of children in various IOTN grades

IOTN grade	*Frequency*	*Percent*
Grade I	210	64.6
Grade II	68	20.9
Grade III	31	9.5
Grade IV	16	4.9
Total	325	100

Fig. 1: Placement of the shape on the dorsum of the tongue with eyes closed

Fig. 2: Identification of the shape from the chart

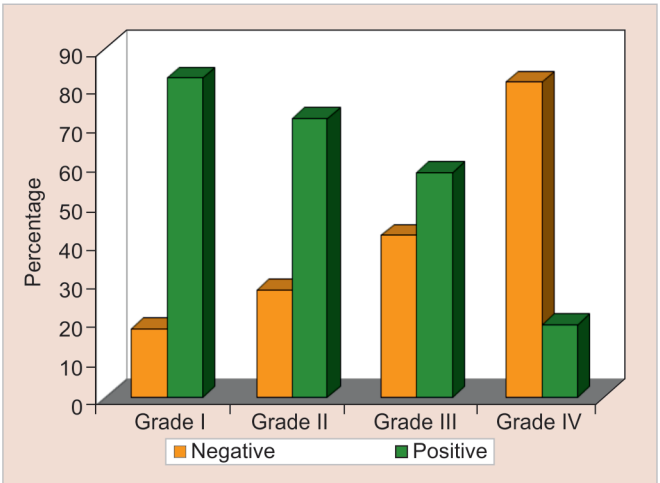

Fig. 3: Association between IOTN grade and shape score

by the presence of dentofacial deformities (DFD), and malocclusions associated with skeletal disorders, and are characterized by the disharmony between the maxilla and the mandible. The jawbones being the basis for the dental arches, the altered pattern and direction of their growth affect the occlusal relations and functions, which may lead to malocclusion and/or malfunction.[8] Thus, this study was carried out to investigate the association, if any, between altered sensory perception and malocclusion seen in the mixed dentition period.

To ensure a minimum intelligence level appropriate for the age group selected in the study, a mini-mental state test was done before recruiting the participants. The index used for grading malocclusion in this study is the Dental Health component of the IOTN, described by Brook and Shaw and modified by Richmond.[9–11] This index ranks malocclusion in terms of the significance of various occlusal traits for the person's dental health and perceived esthetic impairment. In the present study, the esthetic component of the index was not considered because the study subjects belonged to the early and middle mixed dentitions and are difficult to assess for esthetics due to various transitional stages common in this age group. The IOTN has been used to examine malocclusion in various populations and its reproducibility evaluated with the values showing substantial agreement in the age group under investigation.[12,13]

Among the 325 children examined, 61.5% belonged to the age group of 8–10 years and 38.5% were in the age group of 10–12 years. When the association between IOTN grades and age of the children are compared, a significant association could not be drawn which can be inferred as the lack of significant difference in the incidence of malocclusion in both the age groups. This could be due to the fact that both the age groups considered are in the mixed dentition stage and is too narrow for any notable difference to occur. But there is a significant difference in the shape identification scores of the two age groups which could be attributed to the improved stereognostic ability for the higher age group children.

The majority of children in the present study population belonged to IOTN grade I or the group with insignificant orthodontic problems and do not require any treatment at this point. The decrease in the percentage of children in the higher IOTN grades shows that there is a decreased prevalence of the higher grades of malocclusion in the study population. The number of children in the highest IOTN grade was just two and hence for the statistical purpose, they were included in the immediately less grade. This observation of low prevalence of malocclusion contradicts the findings of many authors.[14–17] However, it is in agreement with the report by Shivakumar et al.[18] who investigated the prevalence of malocclusion and orthodontic treatment needs among middle and high school children and found that 80.1% of schoolchildren had no or minor malocclusion which required no or slight treatment.

55.1% of the subjects in the present study were boys and 44.9% were girls. When their IOTN grades were compared with their gender, there was no association noted between the IOTN grades and gender. This is in correlation with the study conducted by Laganà et al.[14] who used IOTN to grade malocclusion and found that no significant differences existed between the genders and prevalence of malocclusion.

When the total percentage of correct shape identification is related to the IOTN grade, we can see that there is a statistically significant decrease in the percentage of positive identification between the IOTN grades I and IV. This decrease is seen in the case of all the seven different shapes used in the study irrespective of their complexity or familiarity. This can be considered as an indicator of the difference in the oral stereognostic ability of individuals with and without malocclusion according to the criteria followed in this study.

Similar to the findings of the earlier authors in this study also a significant association could not be drawn between the gender of the children and their sterognostic ability.[19–21] There were similar proportions of both boys and girls among the positive responders.

Koczorowski et al.[22] conducted a study in patients with anterior open bite and found that stereognostic ability was impaired in children with anterior open bite. There was also a considerable decrease in the ability after the application of a 5% topical anesthetic gel on the surface of the tongue. From this, they concluded that the tongue plays an important role determination of the oral stereognostic ability and in patients with open bite the tongue is not properly positioned and its motor activity is reduced, thereby impairing the stereognostic ability. Premkumar et al.[3] conducted a study to compare the difference in the stereognostic ability of children in the age group of 12 to 17 years with and without anterior open bite and showed that children and adolescents with anterior open bite associated with a tongue thrust showed significantly impaired ability to identify shapes and textures when compared with the control group with normal occlusion. Though anterior open bite, in particular, was not statistically evaluated in the present study a decrease in the stereognostic ability was noted in children with anterior open bite.

Individuals with cleft palate have demonstrated significantly inferior oral stereognostic ability than the normal individuals.[23] In contradiction, Grasso and Catalanatto concluded in their study that palatal coverage does not seem to affect stereognostic ability.[24] In this study, the single untreated cleft palate individual examined, correctly identified all the five stereognostic forms within the prescribed 30-second time span. Though no statistical significance could be attributed, this finding again can be considered as a finger pointing toward the prominent role of the tongue, especially the tip, when compared with the palate in perceiving the oral sensations. This is in unison with the observation in the present study that, the one individual with a tongue tie and restricted mobility of the tongue could only identify two of the five shapes and was

considered as having a decreased stereognostic potential as per the criteria adopted in the study.

The relatively smaller sample size and the decreased prevalence of malocclusion observed in the study population have certainly affected the evaluation of its association with oral stereognostic ability. More conclusive statistical inferences could be expected from studies conducted among children with malocclusion.

Conclusion

Although a causal relationship could not be established, the observations from the present study show that there is altered oral sensory perception in children graded as with malocclusion according to the index used and belonging to the age group selected in the study. Since, sensory and motor components of the orofacial region, like any other part of the human body, are inseparable in their structure and function, the association between orofacial growth and development and sensory maturation cannot be overlooked. More structured investigations in groups with malocclusion can serve as a pointer toward establishing evidence-based relationships and are hence warranted in the subject.

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