Oral Stereognosis - A Review Article

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Abstract: Stereognosis is known as Haptic perception or tactile gnosis or ability to receive and register form of an object in absence of visual and auditory information by using tactile information, provided clues from texture, size, spatial properties and temperature. The physiologic function of the masticatory system is primarily dependent upon the integration of sensory feedback and motor neuron response. Oral stereognosis involves functions of parietal cortex. Most of the denture wearer patients should show perception or this may lead to dissatisfaction to the denture. Therefore Dentist’s understanding of oral stereognosis is important to understand the expectations of patients during complete denture treatment.

1. Introduction

“Oral stereognosis is the neurosensory ability of the oral mucous membrane to recognize and discriminate the forms of objects in the oral cavity”

Ruch and Patton¹ stated that simplest motor actions are initiated by sensory organs and most complex motor actions are initiated by sensory organs. The process of oral perception involves sensory innervation of periodontal membrane, epithelial surfaces of oral cavity, muscles of tongue, muscles of mastication, temporomandibular joints. The function of masticatory system is very dependent on input of neural system by proprioception and perception. A defect may result in poor function or pathological changes to parts of system.

Perception of oral cavity: The sensory innervation of epithelial surfaces of oral cavity plays a key role in function of oral structures. Ringel² stated the hypothesis that oral tactile perception may be related to disturbances in speech or other oral activities. It is possible that defects in sensory feedback may be responsible for some patients’ ability to function with prosthodontic replacement. Grossman³ found that the upper lip was most sensitive after testing the relative sensitivity of upper lip, tongue tip and incisive papilla. Brill and co-workers⁴ believed that loss of natural tooth perception is compensated for by the composite results of sensory signals from the joints and receptors in the denture foundations. Brill, Tryde and Schubeler⁵ found that there is significant decrease in retention of complete dentures following application of surface anesthesia to the supporting tissues; this is due to loss of sensory input from the receptors in the supporting tissues preventing the stabilization of denture.

Muscle proprioception: Muscle spindles act as proprioceptors. Afferent fibers from the muscle spindles of jaw closing muscles have their cells in trigeminal mesencephalic nucleus⁶. Cooper, Daniel and Whitteridge⁷ detected similar responses and detected that cell bodies of this proprioceptors formed part of mesencephalic nucleus. Gill⁸ found that most of the muscle spindles of masticatory muscles are distributed throughout the anterior, middle aspects of both upper and lower heads of human lateral pterygoid muscle. Jensen and Matthews believed that receptors in muscle signal both length and rate of change of length.

There is a controversy about tongue muscles spindles. Some investigators have reported presence of muscles spindles in human and animal tongue⁹ while others could not demonstrate it¹⁰. Cooper¹¹ observed afferent impulses from hypoglossal nerve. Kawamura and Adachi¹² observed increase in activity of hypoglossal nerve after stretching of cat tongue. Kawamura¹³ believed that fine movement of tongue may be due to some special sensory feedback. Matthews and Yemm¹⁴ also studied muscle receptors following the tooth tapping; they found primary response of tooth tapping was activation of digastrics muscle followed by stretch response in Masseter muscle

Temporomandibular proprioception: Some believed that the mandibular position when the teeth are not occluding is maintained by the receptors in the human temporomandibular joint. Kawamura and associates¹⁵ studied on decerebrated and decerebellated cats about sensory innervation of the temporomandibular joint. They noted points of discharge in bulbar and spinal trigeminal sensory nuclei while moving the mandible. It was observed spots were distributed in rostral parts of nuclei in closing motion while opening motion spots were located in caudal part of nucleus. From these studies they suggested that proprioception from the joint also participates in control of muscle activities of the jaw. Ransjo and Thilander¹⁶ studied the perception of mandibular position in TMJ disorder patients and concluded pathological changes impaired joint receptors. They also believed that sensory innervation is not affected by muscle dysfunction Oral stereognosis can be classified as” General Stereognosis: recognize the shape of objects Homostereognosis: self body recognizing capacity like teeth, tongue and palate organ stereognosis: recognizes muscular units as target areas Heterostereognosis: recognize foreign body inside oral cavity. Many studies have been done on proprioception and perception. The purpose of this article is to review this literature and discuss its significance to prosthodontics.

The oral stereognosis involves functions of the parietal cortex. part of somatosensory cortex¹⁷ is composed of Brodmann areas (3a, 3b, 1, 2), sensory input of skin is conducted to 3b and input of muscle and articulation are conducted to 3a and processed in area 1, combined with
other information in area 2. The S-1 area signals to other locations of parietal lobe, where the somatosensory impulses are used for learning of new sensations. The sensorial area for tongue, lips, thumbs and index fingers is greater than other sensorial parts for rest of body.

2. Dimensional Proprioception

Dimensional proprioception studies of oral cavity fall under two categories-those that discriminate changes in thickness and those that determine the minimal thickness which can be perceived between the incisal and occlusal surfaces of the teeth. Thiel⁹ tested 150 subjects to know the minimal thickness perceived between the incisal and occlusal surface of natural teeth and found that sensory threshold was between 20 and 100 µ when using thin platinum foil. Kraft³⁰ reported that it was impossible to detect if the object between occlusal surfaces is below thickness of 20 µ.

Langer and Michman²¹ observed that experienced denture wearer patient could discriminate the different grades of hardness better than new wearers by having the patients incise lightly on rubber rods of varying grades of hardness. Manly and associates²² used graded quantities of calcium carbonate suspended in bland pudding in percentages of 0.1, 1.0, 2.0, 2.9, 4.8, 7.4, 9.1, 17.23 and 29 for comparing discrete changes in food texture in patients with natural and artificial teeth. They concluded that most of the denture wearer patient has less sensitivity compared to natural tooth patients as the normal teeth could detect the 2.9 percent of cacao or less while patient required over 9 % for detection.

Tactile sensitivity of teeth to load: Munch and Schriever²³ reported that a load as little as 1.5 Gm was perceptible in human dentitions. Adler²⁴ found that thresholds were higher for axial surfaces of mandibular teeth than maxillary teeth and threshold increased from anterior to posterior part of mouth. Lowenstein and Rathkamp³¹ determined that minimal load thresholds increased from canine to 1 st molar and then decreased to 2 nd molar. Wilkie²⁶ found axial threshold for central incisors-0.44 to 0.52 Gm; lateral incisor-0.66 to 0.78 Gm; canines-1.26 to 1.32 Gm. Nishiyama, Funakoshi, Kawamura applied 20 Gm loads to 833 natural teeth in 31 patients to assess the judgement of load. The patient judgement was better in localizing the stimulated tooth among anterior than the posterior teeth.

Location of dental receptors: Pfaffman²⁷ found that there is no change of response after removal of pulpal tissue by studying the potentials from posterior alveolar nerves after applying pressure to the teeth. Hannam stated that he didn’t get the similar results with extremely light pressure. Pfaffman and Hannam both felt that majority of receptors giving rise to impulses came from periodontal ligament. Lowenstein and Rathkamp²⁸ found that the thresholds were 57% higher with nonvital than with vital teeth and also found placement of a cast crown in a non vital teeth did not influence the threshold whereas in vital teeth it is increased by 127%. these findings suggest receptors other than those in periodontal ligament were involved.

Tests to verify oral stereognosis level: This involves manipulation of test pieces inserted into oral cavity and their interactions with lips, tongue and teeth. The aim of current studies is identification of particle size regardless of an object shape since it has direct implication on bolus formation and swallowing. The parameters (3) applied for recognition of forms are 1) no sharp angles for pieces 2) to 3 mm of length is adequate 3) metallic pieces are not tolerable and flexible forms are not correctly identified. 4) Simple forms like square, round or triangle 5) a small number of pieces must be used. Different OS scores are given which lead to several interpretations.

OS and Patient Satisfaction: Before initiation of therapy with complete dentures, verify the sensorial perception in order to advise the patient further complications. Oral perception levels are similar in both satisfied and unsatisfied denture wearers.

Age: The oral perception levels²⁹ are higher in young dentate individuals and lower in elderly individuals. There is no difference in dentate and edentulous subjects between 50 to 60 years of age.

Dentate Status: Oral perception levels were similar in dentate or edentulous patients without relationship between stereognosis and masticatory ability although dentate individuals more often correctly recognised the test forms in shorter time when compared with edentulous patients³⁰.

Gender: Studies are few and inconclusive³¹.

Denture Experience: Denture wearers who had experience of 11.5 years OS levels did not effect the patient adaptive capacity with new dentures whereas in new denture wearers who has been edentulous for 8 years has less capacity³².

OS and Oral Motor Diseases: Edentulous patients with stroke and Parkinson’s disease, the oral perception and oral motor ability can improve if dentures are worn during rehabilitation with no statistically significant differences between two groups.

3. Discussion

The phenomenon oral stereognosis have been difficult to understand. Some factors discussed in the literature needs more standardization. From a sensorial point, oral stereognosis constitutes the highest level of learning. The recognition process can be hypothesized in below given sequence: after the completion of oral stereognosis, heterostereognosis suffers a transition period, adapts and identifies the foreign body, weighing particle size. Since aging decreases muscular ability and increases the time needed for the recognition of forms. The tongue and palate constitute more than one third of somatosensory cortex area, further studies are needed to determine the role of gingival exteroceptors. The very high ratio of sensory innervations of oral cavity is shown by the size of sensory division of trigeminal nerve and its innervations areas which has very large representation in the cerebrum compared to innervations dealing with peripheral areas. Canines are proprioceptive and are last tooth to be lost. To preserve the sensory input, it is important to retain these canines for a conventional prosthesis or for overlay dentures. Any force
on an individual tooth evokes a specific neural response in the trigeminal nucleus. Placement of fixed partial denture or clasp in a partial denture produces new sensory inputs and may present with problems relating to successful integration of masticatory function. Change of sensory input is due to forces from fixed partial denture or forces from opposite side of arch in partial denture. The extraction of natural teeth results in complete loss of tooth proprioception, directional sensitivity, dimensional proprioception and tactile sensitivity to load. The perceptive sensations sent to higher areas by the areas contact with dentures are not discrete or discriminatory as the receptors in the periodontal ligament. Many areas which are in contact with dentures are not very sensitive. This fact is stated in the literature that posterior parts of mouth and tongue have fewer sensory nerve endings and is less sensitive. The capacity of stereognosis and localization also decreases significantly in the posterior part of the mouth. The literature reveals that patients with complete dentures do not possess as much perception as natural teeth. Kawamura and Watanabe found that denture wearing patients could not discriminate small dimensional differences as compared to persons with natural teeth. Manly and coworkers observed that sensitivity of food texture judgment was considerably low in complete denture wearers than non denture wearers. The literature showed that anterior teeth were more sensitive than posterior teeth. The patient could locate a stimulated anterior teeth with more ease than that of posterior teeth. This fact shows the importance of establishment of incisal guidance as the precursor of oral rehabilitation and importance of anterior teeth as abutments for prosthesis. This literature also showed that receptors around the roots of teeth continued to send impulses even though most of the root was removed and was mechanically stimulated by extremely light pressure. It supports the retention of natural tooth roots can be used for stud attachments or overlay dentures to preserve this sensory input. It also supports conservative treatment to the patients with advanced periodontitis and concomitant loss of bone support. Any non integration or pathosis of masticatory system including the periodontal ligament, the epithelial surfaces of the oral cavity, the muscles, and temporomandibular joint may result in proprioceptive inputs which are out of synchrony. This results in multiplicity of asynchronous sensory inputs which may lead to disharmony in function of masticatory system. Since most of the treatment modalities are conceived in the form of implant-supported or implant retained over dentures. Thus, the role of oral stereognosis cannot be underestimated.

4. Conclusion

This review of literature indicates the following
1) Oral cavity has very high level of sensory innervation
2) The capacity of stereognosis decreases significantly in the posterior part of mouth.
3) Stereognosis ability decreases with age
4) Complete denture wearers do not possess as much perception as patient with natural teeth.
5) Degree of satisfaction is not related to a high or low perception level.
6) Stereognosis can improve with training.
7) The use of complete dentures during oral-motor disorders (bruxism, dystonia, dyskinesia, and drug induced dystonic extra pyramidal reactions) rehabilitation enhances oral sensation.
8) Implant supported prosthesis provides stereognostic levels near to that of natural dentition.
9) A lack of standardization exits in tests for shape of objects and recognition of forms.

This entire field of oral proprioception and the proprioceptive effect of prosthodontic replacement need much additional research and study.

References


