Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 12250 - 12259
Received 05 March 2021; Accepted 01 April 2021.

# Comparative Assessment of the Influence of Aging and Presence of Teeth on the Oral Haptic Perception and Its Relevant Clinical Application in Oral Diagnostic/Therapeutic Procedures

**Suheel Manzoor [1], Khurshid Mattoo[2*], Vishwadeepak Singh[3], Shailesh Jain[4]**

[1,] Department of Restorative Dental Science, College of Dentistry, King Khalid University, Abha (KSA)
[2,] Department of Prosthetic Dental Sciences, College of Dentistry, Jazan University (KSA)
[3,] Department of Prosthodontics, Vananchal Dental College, Neelambar Peetambar University, India
[4,] Department of Prosthodontics, School of Dental Sciences, Sharda University, India
* **Corresponding author**: Khurshid Mattoo, Assistant Professor, Department of Prosthetic Dental Sciences, College of dentistry, Jazan University (KSA), Mobile – +966595086078, E mail address – drkamattoo@rediffmail.com

## ABSTRACT

Oral haptic perception (OHP) is a potential clinical tool for diagnostic/therapeutic procedures in medical (endoscopy/intubation) and dental (oral appliances/prosthesis) science. This study was aimed to evaluate the influence of age and tooth loss on OHP scores and the response time (RT) alongwith the impact of denture wearing on the same. The study was conducted on 120 adult subjects, distributed in two groups, Group A [Dentulous (D)] (n=40) and Group B [Edentulous (E)] (n=80). Each group was further divided into subgroups [Group A1 (20-30 yrs), Group A2 (60-70 yrs), Group B1 (No dentures), B2 (maxillary denture), B3 (mandibular denture) and B4 (both dentures)]. Six acrylic specimens (circle, semicircle, ellipse, square, rectangle and triangle) in two different sizes were identified by the patient using oral cavity to quantify an OHP score. Unpaired "t" test was used to compare the means while one way ANOVA (F-test) judged the significance of the different p values. The OHP was found to decrease with age [46.05(20-30 yrs) vs 42.2 (60-70 yrs)] and tooth loss [42.2 (D) vs 24.95 (E) while RT was found to increase as one ages [66.6 (20-30 yrs) vs 277.45 (60-70 yrs) and with loss of tooth [277.45 (D) vs 372.4 (E)]. While the differences for the OHP scores were statistically significant at different levels of p values, the scores of RT were significantly different for only group. OHP scores improved with wearing of both dentures (33.7) as compared to remaining edentulous (24.95). Sensory capabilities of the oral cavity vary with individuals, age and the presence of teeth/dentures. Determination of OHP can predict difficulties to be encountered in diagnostic/therapeutic procedures like endoscopy/intubation/ denture wearing.

**Keywords:** Stereognosis, proprioception, receptors, edentulous, denture base resin

## Introduction

Oral sensory capability (stereognosis / haptic perception / tactile gnosis) and associated response time (RT) of an individual can have both diagnostic and prognostic value in medical and dental practice. Both can aid to predict the rapidity of adaptation by an individual to his new prosthesis, which would allow the clinician to modify his treatment plan accordingly. Oral haptic perception

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 12250 - 12259
Received 05 March 2021; Accepted 01 April 2021.

(OHP) is the use of tactile discrimination to identify the shape of an object by means of manual palpation (tongue and surrounding tissues), without the use of eyesight [1]. OHP is a protective mechanism of oral cavity to identify objects that it may consider harmful. Increased or a hypersensitive OHP capability complexed with a gag reflux at times acts as a deterrent in introducing instruments/ tools associated with endotracheal intubation or endoscopic procedures. Its significance to dentists is more clinically relevant where the patient is asked to wear an appliance or a prosthesis for long term. Sensory abilities (visual, hearing, tactile and chemosensory) of individuals diminishes with age [2]. Humans reach an optimum sensory capacity by twenties, sustain the peak for several years and then decline varying individually [3]. OHP is also associated with masticatory efficiency as well as masticatory protection of an individual [4],[5]. Decline of OHP is a significant factor linked to the masticatory disorder especially those that lead to eating difficulties in older age [6]. Periodontal mechanoreceptors of natural dentition play key role in sensory discrimination and control of jaw function. When teeth are extracted, periodontal tissues break down, leaving some periodontal receptors within the bone. The state of complete edentulism therefore lacks a significant source of tactile sensory input to the brain [7]. OHP has been employed to evaluate the integrity of sensory feedback and is used in the neurological evaluation of the central nervous system. It involves identification of forms of objects without the aid of vision [3]. Oral recognition requires coordination between the loci that collect sensed data and those that distinguish or perceive shapes. The science of OHP has been studied in completely edentulous patients and has been related to denture satisfaction [8],[9], food combination [10], shape perception [11], denture adaptation [12], denture success [13], signs of aging [14] and masticatory performance [3],[15] with a complete denture prosthesis. While a large number of studies have focussed on the stereognositic abilities in elderly, very less studies have reported or compared OHP at different ages (young and old) and differences between the natural dentition and artificial dentures. This study was objectively aimed to analyze the OHP scores in young and old subjects, as well as influence of natural and artificial dentition on OHP scores and associated RT. The study is intended to help in understanding that why some young patients find it difficult to wear appliances like space maintainers and why some prosthodontic patients take long time to adapt to the new dentures. The study can also throw light on various difficulties involved in endotracheal intubation and endoscopy procedures.

## Methodology

***Ethics:*** This in vivo study was conducted in the post graduate section of the department of prosthodontics under the supervision of the college and the university ethical committee of a recognized medical university in North India. All studies conducted are standardized by adhering to the principles of ethics recommended in Helsinki Declaration. The sample studied was purely North indian population who were the regular out patient department (OPD) patients. All participants gave a written consent after being briefed about beneficience and the individuals confidentiality.

***Study design:*** This comparative, experimental clinical study was started in the first quarter of year 2017 and completed in the second quarter of year 2018. The study was accomplished in different stages. In the first stage a sample of 120 subjects were selected according to certain study criteria. The second stage involved fabrication of test specimens for the study and construction of standardized complete denture prosthesis for the completely edentulous subjects.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 12250 - 12259
Received 05 March 2021; Accepted 01 April 2021.

The third stage included testing and data collection. Study design used both qualitiative and quantitative approach to accomplish objectives.

***Sample selection and grouping:*** The subjects participating in the study belonged to two age ranges: 20 – 30 years (n=20) and 60 -70 years (n=100) [20 Dentulous (D) and 80 Edentulous (E)]. General criteria for all subjects included no history of any congenital or systemic disease (including dementia, depression or chronic drug use), no history of sensory impairment (visual, hearing, tactile or chemosensory), tongue impairment (congenital or aquired), no history of drug/alcohol use. Patients with philosphical mental attitude and cooperative nature were prioritized. Dentulous subjects were chosen fulfilling the criteria for age (20-30 years and 60-70 years), full complement of permanent natural dentition with Class 1 molar and canine relations, no history of any occlusal, temperomandibular joint or musculoskeltal disorders, no history of orthodontic treatment and no history of trauma and endodontic treatment. Edentulous subjects had to fulfill the criteria for age (60-70), no history of difficult extraction of natural teeth, no history of traumatic loss of teeth, well formed completely edentulous residual alveolar ridges (RAR) and were first time denture wearers. For fulfilling the requirement of efficiency, representativeness, reliability and flexibility the sample size was calculated to be 40 patients in GpA and 80 in GpB. The subjects were divided into two main groups, namely Group (Gp) A (D) and Gp B (E). Each group was further divided into subgroups. In GpA, 20 subjects were divided into GpA1 (20-30 years) and GpA2 (60-70 years) depending upon the age. GpB had four subgroups: Gp B1 (no prosthesis - control group), Gp B2 (single maxillary denture), Gp B3 (single mandibular denture) and Gp B4 (both dentures). Differences in OHP and RT were obtained by comparing Gp A2 with Gp A1 (both dentulous) and by comparing subgroups of B with Gp A2 (same age) and between various subgroup of that group.

***Preparing of the test specimens:*** Six different shapes (circle, ellipse, square, rectangle, triangle and semicircle) in two different sizes (large - 12x12x3 mm, Small 8x8x2 mm) were prepared for the study. The specimens were carved, finished and polished from hard wax (Bego,Wilhelm-Herbst, Germany), following which they were used to form a mold. Using the compression molding technique, [16] the final test specimens were obtained in heat cure denture base resin (Dentine, Major, Moncalieri, Italy). A small hole (1mm) was drilled in all specimens so as to hold a piece of thread (prevent accidental swallowing by the subject). All specimens were stored in normal water at room temperature.

Construction of complete denture prosthesis: The complete denture treatment for the subjects in Gp B was standardized in terms of total number of appointment (12/14 appointments), clinical and laboratory procedures, prosthesis design, laboratory assistants and processing methods. All patients were treated by postgraduates under a supervision of a two member team of experienced prosthodontists (>8 years). Each prosthesis upon completion were evaluated by a separate team of experienced prosthodontist (double blind) for prosthetic quality. Dissatisfactory prosthesis were rejected and not included in the study. Patients were given instructions regarding the use and maintenance of CD prosthesis.

***Testing of the specimens:*** Random ordered specimen testing by the patients was done one month after the patients last complaint during follow up was corrected. This was done to assure patients complete adaptation to the prosthesis. Testing was performed in an isolated clinical setting (sound proof) where there were minimum distracters. Instructions regarding the identification of test specimens were given to the subjects without carrying any practice trial. This included showing a picture of all test specimens to each subject before commencing the test. After analyzing the shape of each test specimen with the tongue, the subjects had to point out the

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 12250 - 12259
Received 05 March 2021; Accepted 01 April 2021.

corresponding shape on a corresponding chart. Test pieces were sterilized by placing test pieces in 2% glutaraldehyde (Cidex) for 15 minutes. A prevalidated scale (3 point) was used for determining oral haptic perception (OHP) score. [17] The six different shape forms were grouped into three pairs based on similarity of shape and were scored as 0 (Incorrect identification of shape), 2 (Incorrect identification of shape within the same group) and 4 (Correct identification of shape). [17] RT was set as the time between the subjects initiation of perception upon a signal from the observer and the subject's judgement at the completion of perception. The possible range of OHP scores would be 0 (none correct) to 48 (all correct), thus higher scores meant better OHP. For RT, the time was calculated in milliseconds with less time taken meaning better RT.

**Data Analysis**

Collected data for each individuals OHP score and RT was reviewed, studied and coded following which the entire data was analyzed using the statistical package of social science (SPSS-25.0) software. Within both groups and subgroups, mean values, standard deviation (or median with interquartile range) was calculated for both OHP score and RT. Unpaired "t" test was used to compare the means between study groups and one way ANOVA (F-test) judged the significance of the different values among each groups. Significance of differences between various groups and subgroups was considered at various levels of p values that included the range of $P<0.05$, $P<0.01$ and $P<0.001$.

**Results**

The OHP score of completely dentulous patients in Gp A1 (20-30 yrs) was higher (m=46.05) than the patient in Gp A2 (60-70 yrs) (m=42.2). There was also more than four times increase in the RT between the two groups suggesting that both OHP score and RT is influenced by age. When difference were compared between the two subgroups of completely dentulous patients, both OHP score and RT were statistically significant at predetermined respective values **(Table 1)**. Within the same age (60 -70 yrs), the OHP score was observed to decline from 42.2 to 24.9 when the transition takes place from dentulous to edentulous state while the RT increased from 277.45 to 372.4 with complete edentulism. The OHP score was observed to increase when a person wore single maxillary complete denture (m=35.03) and both maxillary and mandibular denture (m=33.7) while with mandibular denture there was not much increase in OHP score (m=27.95). The differences between Gp B1 (No denture), Gp B2 (maxillary denture), Gp B3 (Mandibular denture) and Gp B4 (both dentures) to that of Gp A2 (completely dentulous, same age) all showed statistically significant values at different levels of significance **(Table 1)**. Within the edentulous group there was statistically significant differences in OHP scores between Gp B2 (Maxillary denture), Gp B4 (Mandibular denture) to that of Gp B1 (No denture). The results show that the RT was more in patients of all the subgroups of Gp B (E) when compared to the Gp A2 (D). However the differences for RT were only statistically significant for Gp B1 (m=372.4) with Gp A2 (m=277.4) and that of Gp B4 (both dentures) with Gp A2 (D) **(Table 1).** Among all the specimens tested, the elliptical (37%) specimens were found to be identified more readily as compared to other specimens irrespective of the size **(Graph 1)**.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 12250 - 12259
Received 05 March 2021; Accepted 01 April 2021.

**Table 1: Comparison of oral haptic perception (OHP) score and response time (RT) between studied groups along with their relative significance (between and within groups)**

| | **Completely Dentulous (Group A)** | | **Completely Edentulous (Group B)** | | | |
|---|---|---|---|---|---|---|
| Parameters | Gp A1 20-30 yrs (n=20) | Gp A2 60-70 yrs (n=20) | Gp B1 Completely edentulous (n=20) | Gp B2 Maxillary denture (n=20) | Gp B3 Mandibular denture (n=20) | Gp B4 Both dentures (n=20) |
| | | | | | | |
| OHP score | 46.05 ± 1.67 ** | 42.2 ± 1.12 ^^, ###, +++, ¥¥¥ | 24.95 ± 1.23 *** | 35.03 ± 1.76 ***, ## | 27.95 ± 1.78 *** | 33.7 ± 1.08 **, ### |
| RT | 66.65 ± 1.88*** | 277.45 ± 1.76 ^^^, ## | 372.4 ± 1.92 | 351.5 ± 1.67 | 363.25 ± 1.87 | 292.8 ± 1.76 * |

n = number of patients , SD = Standard Deviation , OHP = oral haptic perception , RRT = reflex response time

Data expressed as Mean ± SD comparison of data between various groups as compared by one- way ANOVA.

Signs for significance:

^ Comparison with Gp A1

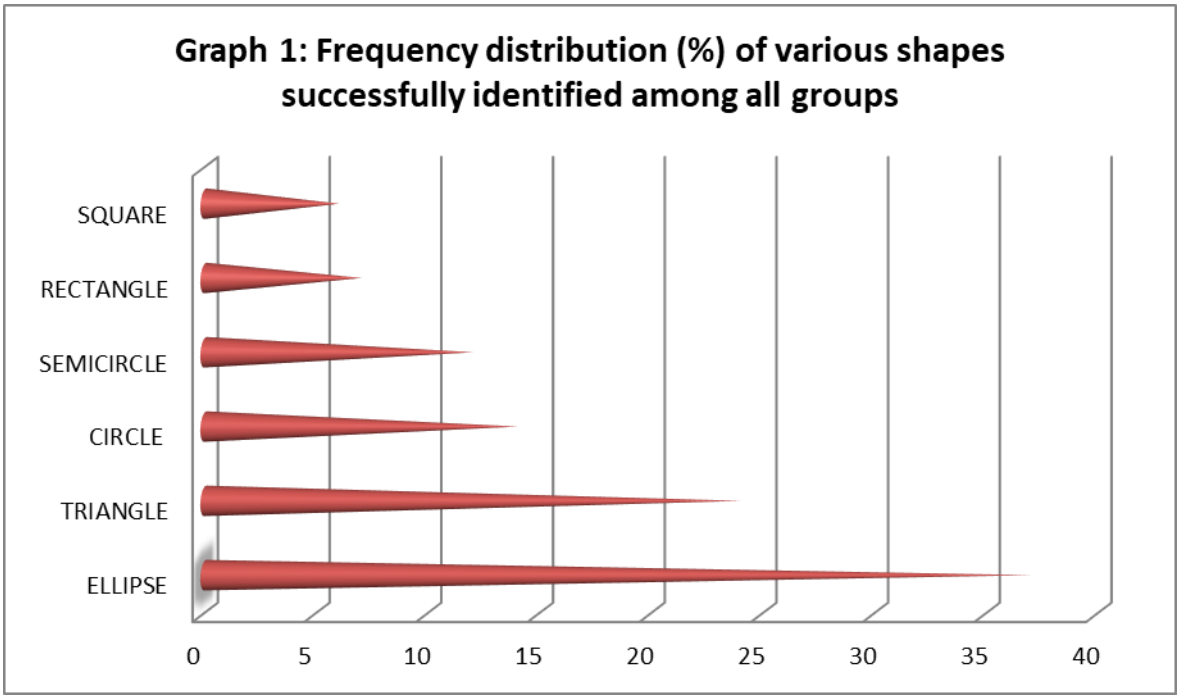
* Comparision with Gp A2

# Comparison with Gp B1

+ Comparison with group B2,

¥ Comparison with group B4

Level of significance: *P<0.05, **P<0.01, ***P<0.001, ### P < 0.001, +++ P < 0.001, ¥¥¥ P<0.001, ^^ P<0.01, ^^^ P<0.001



Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 12250 - 12259
Received 05 March 2021; Accepted 01 April 2021.

## Discussions

This clinical study was performed on a group of 120 patients with dentulous patients acting as control and edentulous patients acting as test group. The chief finding of the study are that the OHP decreased with age [46.05(20-30 yrs) vs 42.2 (60-70 yrs)] and if teeth were lost [42.2 (D) vs 24.95 (edentulous) as a result of which the RT was found to increase as one ages [66.6 (20-30 yrs) vs 277.45 (60-70 yrs) and if one looses teeth [277.45 (D) vs 372.4 (CE)]. Both parameters showed variable differences that were statistically significant. Wearing of a complete denture prosthesis improves the OHP [35.03- maxillary dentures, 33.7- both dentures] as compared to remaining edentulous (24.95).

Aging and OHP: Age defines time and almost all living organisms deteriorate structurally and functionally with time. Sensory proprioception of oral structures plays a major role in prosthesis adaptation besides aiding many other oral diagnostic/therapeutic procedures in medical/dental sciences. Various clinical applications include acceptance of orthodontic brackets, wires, elastic bands, surgical wires for maxillofacial fractures and/or medical diagnostic procedures like endoscopy, gastroscopy etc. Significant age changes in sensory mechanism are loss of neurons and cellular interconnection, cerebral ischemia, dementia, depressive illnesses, decreased rate of replacement of epithelial cells, decreased cell volume, density and decreased degree of mucosal keratinisation [18-20]. Besides these changes, aging also brings oral mucosal thinning, loss of elasticity and stippling, loss of papillae [21] and altered / deteriorated taste perception [22]. Changes in oral sensory function start taking place at a young age [23] and are affected by medical and dental conditions [24]. Results of this study confirm higher OSA score in younger dentulous individuals (Gp A1) than older dentulous individuals (Gp A2) which are in accordance with various other studies [3],[7],[12],[13],[17],[23]. While our study was chiefly directed to evaluate the influence of prosthesis in old age, the younger group was mandatory to determine the age changes for OHP. The impact of age on OHP has been explained in relation to many factors. Motor skills of the tongue and its masticatory performance decrease with increasing age. The sensory inputs that are synthesized in the cortex needs to be compared with previous sensory memories in order to permit identification of shapes. Since memory and cognition decline with age in healthy people, [26] the resulting declining of OHP is understandable. Chief site for the detection of a food particle or bolus is not between the teeth, but on the oral mucous membrane [3], [27] and oral perception of size is a result of combination of sensory inputs from the tongue and palate [(5],[28]. Results also indicate that young dentulous subjects responded more quickly to identify test pieces than older subjects as oral sensory receptors decrease with age and spatial acuity of the tongue also decreases with age. A study by Ikebe et al, however found higher oral sterognostic scores in older dentate individuals and complete denture wearers than in younger dentate subjects [29].

Among the various shapes, elliptical specimens were readily identified by the tongue (both small and large) as compared to square which were most difficult. These findings are in agreement with few studies [7], [13], while others have reported the circle to be identified readily by subjects[3],[23]. These findings are important considerations while designing a prosthesis, appliance or components of a medical diagnostic aid.

OHP and tooth loss: The OHP score within the completely edentulous group (Gp B) demonstrated highest OHP scores in Gp (B2) (Maxillary denture) followed by Gp B4 (33.7) and Gp B3 (27.9) with completely edentulous showing the least OHP score. All four subgroups within group B (B1,B2,B3 and B4) had statistically significant differences when compared with

the OHP score of Gp A2 (D). Within Gp B, significant differences were found for Gp B2, Gp B4 against the means score of Gp B1. These results suggest that tooth loss affects OHP score and wearing of a maxillary denture or both dentures improves ones OHP, although maxillary denture has a bigger role to play in restoring the OHP. While some authors have credited the tongue being more responsible for OHP, [3] others have attributed more importance to the receptors of the palate [30]. Tongue's role in sensing the shape of the object seems to be more important than input of palatal receptors. Placement of dentures may confine tongue within normal space which in turn aids tongue in determining objects shape. The denture provides the surface against which it can manipulate the outer boundaries of the object leading to recognizing the shape. These results have been reported in other studies also [30], [31]. Patients with a higher OHP score defines them as clinically sensitive, which renders these subjects to be less tolerant of minor errors in dental prosthesis. Such patients have been reported to come with more post insertion problems and consequently less satisfied with treatment during follow up[32]. Alrefaly et al [13] has even related the mean stereognostic score with their subjective performance in relation to retention and stability, mastication and speech with complete dentures.
RT is an indirect measure of the status of OHP. Our study shows, that the RT increased with age and loss of teeth. However, the difference between two variables was not found to be statistically significant except for the Gp B4 when compared to Gp A2. This is in agreement with various other studies who have found increased time taken in older patients that subsequently decreased with repetitions [17], [33].

## Conclusion

This study concludes that oral haptic perception of an individual diminishes with age and loss of permanent natural teeth. Determination of OHP score before any diagnostic /therapeutic oral procedures can indicate the difficulties that will be encountered for that particular patient. Oral perception of objects definitely improved if one wears a complete denture prosthesis. Since the study is aimed to determine the relevance of diagnostic and therapeutic procedures and treatment, all clinicians should ascertain their patients not to use their dentures or teeth to determine various shapes during routine oral functions.

## Limitations and Future Studies

The present study is based on an experimental, case control study done on a cross sectional sample. Although such study designs have inherent flaws in drawing the cause and effect relation between a dependent and independent variable, all efforts to minimize the effect of confounding variables has been attempted in this study. Further studies are recommended to see if the positive influence of OHP remains same after use of prosthesis for a long time. With passage of time, there are internal changes in the denture foundation that alters functioning process of dentures. Dentures may become loose and unstable. Whether, any impact on OHP is present needs to be studied.

**Acknowledgement**
The authors would like to acknowledge the efforts of the post graduate students, academic and technical staff of the department of prosthodontics for their valued contribution at various levels during the conductance of the study.

**Author Contributions:** KM, SM, and V Conceptualization; KM, SM, methodology; SJ, SM, software; KM,VS, validation; SM, VS, formal analysis;KM,VS, investigation;VS,SJ,KM, data acquisition and curation;KM,SJ, writing, review and editing; KM, VS, SM, supervision; VS, project administration; KM, VS, Ethical approval and informed consent; All authors had access to the data at all times of the study and all authors have read and agreed to the submitted version of the manuscript

## References

[1] Yekutiel, M., Jariwala, M., & Stretch, P. (2008). Sensory deficit in the hands of children with cerebral palsy: a new look at assessment and prevalence. *Developmental Medicine & Child Neurology*, 36(7), 619–624. https://doi.org/10.1111/j.1469-8749.1994.tb11899.x.
[2] Klever, L., Voudouris, D., Fiehler, K., & Billino, J. (2019). Age effects on sensorimotor predictions: What drives increased tactile suppression during reaching? *Journal of Vision*, 19(9), 9. https://doi.org/10.1167/19.9.9
[3] Ikebe, K., Amemiya, M., Morii, K., Matsuda, K., Furuya-Yoshinaka, M., & Nokubi, T. (2007). Comparison of oral stereognosis in relation to age and the use of complete dentures. *Journal of Oral Rehabilitation*, 34(5), 345–350. https://doi.org/10.1111/j.1365-2842.2007.01687.x
[4] Mioche, L., Bourdiol, P., & Peyron, M. A. (2004). Influence of age on mastication: effects on eating behaviour. *Nutrition Research Reviews*, 17(1), 43–54. https://doi.org/10.1079/nrr200375
[5] Engelen, L., van der Bilt, A., & Bosman, F. (2004). Relationship between Oral Sensitivity and Masticatory Performance. *Journal of Dental Research*, 83(5), 388–392. https://doi.org/10.1177/154405910408300507
[6] Kilcast, D., & Fillion, L. (2001). Understanding consumer requirements for fruit and vegetable texture. *Nutrition & Food Science*, 31(5), 221–225. https://doi.org/10.1108/00346650110396574
[7] Meenakshi, S., Gujjari, A. K., Thippeswamy, H. N., & Raghunath, N. (2013). Evaluation of Oral Stereognostic Ability After Rehabilitating Patients with Complete Dentures: In Vivo Study. *The Journal of Indian Prosthodontic Society*, 14(4), 363–368. https://doi.org/10.1007/s13191-013-0333-z
[8] Van Der BILT, A. (2011). Assessment of mastication with implications for oral rehabilitation: a review. *Journal of Oral Rehabilitation*, 38(10), 754–780. https://doi.org/10.1111/j.1365-2842.2010.02197.x
[9] Slagter, A. P., Olthoff, L. W., Bosnian, F., & Steen, W. H. (1992). Masticatory ability, denture quality, and oral conditions in edentulous subjects. *The Journal of Prosthetic Dentistry*, 68(2), 299–307. https://doi.org/10.1016/0022-3913(92)90334-7
[10] Elgestad Stjernfeldt, P., Sjögren, P., Wårdh, I., & Boström, A. M. (2019). Systematic review of measurement properties of methods for objectively assessing masticatory performance. *Clinical and Experimental Dental Research*, 5(1), 76–104. https://doi.org/10.1002/cre2.154

[11] Ikbal, L. K., Kerem, K., Ravza, E., Damla, U., Ahmet, A., Bülent, K., & Stephan, E. (2017). Evaluation of Oral Stereognosis in Relation to Tactile Ability and Patient Satisfaction. *Journal of Oral Implantology*, 43(6), 468–475. https://doi.org/10.1563/aaid-joi-d-17-00130
[12] Amarasena, J., Jayasinghe, V., Amarasena, N., & Yamada, Y. (2010). Oral Stereognostic Ability during Adaptation to New Dentures in Experienced and Non-experienced Complete Denture Wearers. *Journal of Oral Biosciences*, 52(2), 181–186. https://doi.org/10.1016/s1349-0079(10)80048-9
[13] Alrefaly, M.Q., Sherfuddin, H., Abdulla, M.A.(1996). Oral stereognosis in predicting denture success. *Saudi Dent Jour* ; 8(3):126-130
[14] Fillion, L., Kilcast, D. (2001). Towards a measurement of oral tactile sensitivity and masticatory performance: Development of texture tests. *LFRA Research report* ; 781.
[15] Kaiba, Y., Hirano, S., Hayakawa, I. (2006). Palatal coverage disturbance in masticatory function. *J Med Dent Sci* ; 53:1-6.
[16] Morrow, R.,M., Rudd, K.D., Eissman, H.F.1980. Dental Laboratory Procedures: Complete Dentures. Vol. 1. St. Louis: The C.V. Mosby Co; p. 291
[17] Smith, P.W., McCord, J.F. (2002) Oral stereognostic ability in edentulous and dentate individuals. *Eur J Prosthodont Restor Dent* ;10:53–56.
[18] Masoro, E.J. (1996) Physiology of aging. In: Holm-Pedersen P, Loe H, Textbook of geriatric dentistry. Second edition;:38–53.
[19] Klineberg, I., Murry, G. (1999) Osseoperception: Sensory function and proprioception. *Adv Dent Jour* ; 13:120 -129.
[20] Bilt, A.V. (2002). Human oral function: a review. *Braz J Oral Sci* ; 1:7-18
[21] Aldrees, A.M. (2010). Oral and perioral physiological changes with aging. *Pakistan Oral & Dental Jour* ; 30(1):26-30.
[22] Mioche, L., Bourdiol, P., Peyron, M.A. (2004). Influence of age on mastication: effects on eating behaviour. *Nutrition Research Review* ; 17:43-54.
[23] Kawagishi, S., Kou, F., Yoshino, K., Amano, N. (2007). The stereognostic ability of the tongue in young adults. *Jour Kyasu Dent Society* ; 61:16-22
[24] Catalannoto, F.A., Moss, J.L. (1973). Manual and oral stereognosis in children with cleft palate, gonadal dysgenesis, pseudohypoparathyroidism, oral facial digital syndrome and kallaman's syndrome. *Arch Oral Biol* ; 18:1227-1232
[25] Koshino, H., Hirai, T., Ishijima, T., Ikeda, Y. (1997). Tongue motor skills and masticatory performance in adult dentates, elderly dentates and complete denture wearers. *J Prosthet Dent* ; 77:147-152.
[26] Prinz, J.F., Lucas, P.W. (1995). Swallow thresholds in human mastication. *Arch Oral Biol.* ; 40:401–403
[27] De Wijk, R.A., Engelen, L., Prinz, J. (2003). The role of intra-oral manipulation in the perception of sensory attributes. *Appetite* ; 40: 1–7.
[28] Ingervall, B., Schmoker, R.M. (1990). Effect of surgical reduction of the tongue on oral stereognosis, oral motor ability and the rest position of tongue and mandible. *Am J Orthod Dentofac Orthop* ; 97:58-65.
[29] Ikebe, K., Amemiya, M., Morii, K., Matsuda, K., Furuya‐Yoshinaka, M., Nokubi, T. (2007). Comparison of oral stereognosis in relation to age and the use of complete dentures. *J Oral Rehabil* ;34:345‐50.
[30] Batisse, C., Bonnet, G., Eschevins, C., Hennequin, M., Nicolas, E. (2017). The influence of oral health on patients' food perception: a systematic review. *J Oral Rehabil*; 44: 996-1003.

[31] Mantecchini, G., Bassi, F., Pera, P., Preti, G. (1998). Oral stereognosis in edentulous subjects rehabilitated with complete removable dentures. *Jour of Oral Rehab*; 25:185-189.
[32] Rossetti, P.H., Bonachela, W.C., Nunes, L.M. (2004). Oral stereognosis related to the use of complete denture: A literature review. *Int J Oral Med Sci* ;2:57‐60.
[33] Landt, H., Fransson, B., Alin, L. (1979). Oral recognition of forms and oral muscular coordination ability. A longitudinal study in young adults. *J Oral Rehabil* ; 6: 279-290.