Research Article

Assessment of oral stereognostic ability and cognitive status in dental implant patients compared to partially edentulous and fully dentate individuals

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Abstract: Background: The oral stereognostic ability (OSA) examines an individual's oral functioning and determines how patients respond to various dental therapy. Natural tooth loss may result in a reduction in oral perception. Reduced oral perception has been linked to cognitive deterioration in the elderly. The aim of this study was to assess the oral stereognostic ability among dental implant patients in relation to cognition status and compare them with partially edentulous and fully dentate patients. Material and method: The study group included 90 dental implant patients aged 50-60 years old compared with partially edentulous and fully dentate patients. Five different test samples were used to assess the oral stereognostic ability including (cubic, circle, pyramid, star and cross). The criteria for the assessment of oral stereognostic ability were the time required for the patient to recognize the shape of the samples. The cognition status was assessed using the Self-Administered Gero-cognitive Examination (SAGE) test according to which the participants were divided into two groups poor and good. Data were statistically analyzed using SPSS 22, Chicago, Illinois, USA. Results: The mean time is taken to recognize the shape of all samples was less in the fully dentate group followed by the implant group and then the partially edentulous group with a statistically significant difference. Concerning the cognition status, the mean time taken to distinguish the shape of all sample were significantly higher among person with poor than good cognitive status for implant, partially edentulous and fully dentate groups. Conclusion: The results of the current research revealed that loss of natural teeth decreases both cognitive status and oral perception represented by oral stereognosis ability as the oral stereognosis of partially edentulous subjects was significantly poorer than that of fully dentate subjects.

Keywords: dental implant, partially edentulous, fully dentate, oral stereognosis, cognition.

Introduction

Stereognosis, also known as haptic perception or tactile gnosis, is the ability of a person to detect and discern an object's form solely only on tactile feeling, without the aid of a visual or auditory signal. Stereognosis is derived from the Greek terms "stereo" which means "solid" and "gnosis" which means "knowing" [(1)]. Stereognosis aids in determining the effectiveness of the central nervous system's operation [(2)]. Manual stereognosis is the process of interpreting an object put on a person's hand established on their capacity to distinguish and incorporate several sensual modalities deprived of the use of visual assistances. The effectiveness of someone's hand stereognostic capability is dependent on a strong peripheral sensual passageway that receives discriminating touch and proprioceptive evidence, as well as working processing centers in the parietal lobe cortex [(1)].

Oral stereognosis is the neurosensorial capacity of the oral mucous membrane to understand the formula and nature of an item with no vision aid, as initially described [3]. This interpretation of oral perception can be acquired by using stereognostic exams to examine one's oral stereognostic ability (OSA). As a result, stereognostic exams can be used to measure an individual's oral functioning. Over the years, this unusual notion has gotten a lot of attention in various fields of dentistry [4].

The soft tissues of the oral cavity are one of the greatest heavily innervated in the human body. They have a great quantity and diversity of receptors on their external surface, including as mechanoreceptors, proprioceptors, and nociceptors, that work together inside the mouth to convert diverse sensations into brain electro-chemical impulses [5]. Oral stereognosis is based on the detection of tactile sensations by mechanoreceptors in the mouth. They are specialized neurons that transmit electrical impulses to the brain in order to transmit a variety of sensory inputs such as touch, pressure, and proprioception. These mechanoreceptors are densely innervated in oral tissues such as the tongue, cheeks, gingiva, periodontal ligament, and palate. Any sensations in the oral mucosa are mediated by the sensory nerves that supply these mechanoreceptors [6].

Oral stereognosis is inextricably linked to dental health. The loss of teeth, whether partial or complete, affects an individual's oral function. The majority of the cross-sectional studies Included participants with complete natural dentition as controls to determine the effect of dentition on OSA. When compared to complete denture individuals, subjects with natural teeth had considerably superior stereognostic ability owing to the subjects, easiness of free oral investigation of the examination object [7,8]. Afterward, their dentures are removed, and denture users have a weaker response to oral stereognostic tests. Furthermore, after the denture placement, unsatisfied patients with various complaints have greater planes of oral perception compared to contented, pleased patients [9].

In dentate patients, the periodontal receptors and tongue play a critical role in determining stereognostic ability. As a result, a mandibular nerve block on both sides diminishes their effectiveness by roughly 20%. People who have oral habits for example tongue thrusting, which leads to an anterior open bite, have less OSA. In comparison to complete dentures, studies comparing the oral stereognostic ability of patients beforehand and afterward therapy with implant-supported fixed prosthesis demonstrate a considerable reduction in recognition time in addition to mistakenness [10-12].

Patients who have missing all their teeth have poorer oral perception than those who have natural teeth because they lack periodontal receptors [13]. Oral perception rehabilitation is just as crucial as chewing function restoration. Prosthetics and oral perception are intimately linked [14]. The stereognostic levels of the implant-supported prosthesis are similar to those of natural teeth [15]. Perception variances concerning individuals who have natural teeth and those with implant-supported prostheses have been explored by several studies. However, questions about the oral perceptual ability (OPA) and sensitivity of patients treated with implants are still being debated [13,16,17,18]. The input of periodontal mechanoreceptors from the trigeminal nerve and afferent impulses from the masticatory muscle will be reduced when teeth are lost. This is hypothesized to lower the amount of the brain²s pyramidal cells and the hippocampus·s acetylcholine levels, causing memory and learning problems. This could have an impact on hippocampus-dependent cognitive performance [18,19]. Previous researchs have looked into the link between cognition deterioration and the number of teeth taken [20,21]. Once the number of missed teeth and cognition ability were compared, a positive association was found [22]. Furthermore, it was discovered that human non-natural teeth cause a defeat of sensual feedback to the brain owing to the lack of periodontal ligament mechanoreceptor nerves [23].

As far as there is no preceding study regarding this relation, the present study was conducted among a group of implant patients in comparison to partially edentulous and fully dentate groups with different levels of cognitive status to evaluate the differences in oral stereognosis ability between the three groups in addition to the relation with the cognitive status.

Materials and Methods

This study was conducted among implant patients aged 50-60 years old compared with partially edentulous and fully dentate patients matched in age and gender (90 patients in each group) in Babylon Governorate –Iraq (urban only) for (7) months, from 1\7, 2021 to the end of 31\1, 2022. The study sample involved a group of implant patients, they were selected from several Implant Private Clinics. Both genders were involved since they can read and write, as well as patients who are healthy and do not take any systemic medications. Participants gave their written informed consent to participate in this study. The ethical committee accepted the study's protocol in the College of Dentistry, University of Baghdad.

The (Self-Administered Gero-cognitive Examination) (SAGE) test was given to study participants to assess their cognition state [24]. It is a self-administered, short-term, trustworthy, and verified assessment instrument that lowers the time it takes to detect cognitive deficits in people while also being sensitive to changes over time. Self-administered pen and paper, 10-15 minutes. It does not necessitate the use of office workers or equipment, and it may be simply implemented in any healthcare facility. It should be filled devoid of the assistance of others. The Arabic version of the SAGE test was used in this study, and all of the participants were Arabic. The validity and reliability of the Arabic version were confirmed by a previous Iraqi study [25,26,27]. According to this SAGA assessment, the patients were divided into two groups (seriously cognitive impaired compared with normal cognitive) these two groups underwent further analysis for the oral stereognosis test.

In this study, five different test samples were used including (cubic, circle, pyramid, star and cross) with a thickness of around 4 mm, and length of 10 mm as shown in Figure (1) which were made of acrylic resin in the dental laboratory of the College of Dentistry of the Babylon University to conduct oral stereognosis with a set of geometric figures eightfold increased for these samples [28]. The oral stereognosis procedure was as follows: the patient was requested to close the eyes while a haphazardly selected test sample was placed on his or her tongue with tweezers, and the time it took for the patient to respond was measured using a stopwatch. The set of geometric forms for illustration (eightfold increased in volume) was displayed, and the timer was activated. Then the patient was tested to specify which of the samples he or she had in his or her mouth. When the patient decided on the shape of the sample, the stopwatch was stopped. The patient was told not to look at or touch the model with his or her hands and to spit the test sample into the tray. As a result, each sample was placed in the patient's mouth one at a time, and the patient was asked to identify each one's shape. Oral stereognosis was assessed using the time it took for the patient to recognize the shape of the sample [29].

Figure 1: Oral stereognosis samples

Statistical analysis

SPSS (version 22 Chicago, Illinois, USA) was used to examine the data. Descriptive analysis including Independent-Samples T Test method, and ANOVA (one way) were used. Statistical significance was defined as a P-value of less than 0.05.

Results

The total sample included equal numbers of patients in each group (implant, partially edentulous, and fully dentate). The SAGE test was used to evaluate the cognitive status of the whole three groups into good and poor cognitive status. Poor cognitive status was identified in (54.44%, 58.89% and 42.22%) of the three groups respectively, while good cognitive status was recognized in (45.56%, 41.11% and 57.78%) respectively of three groups as shown in Figure 1.

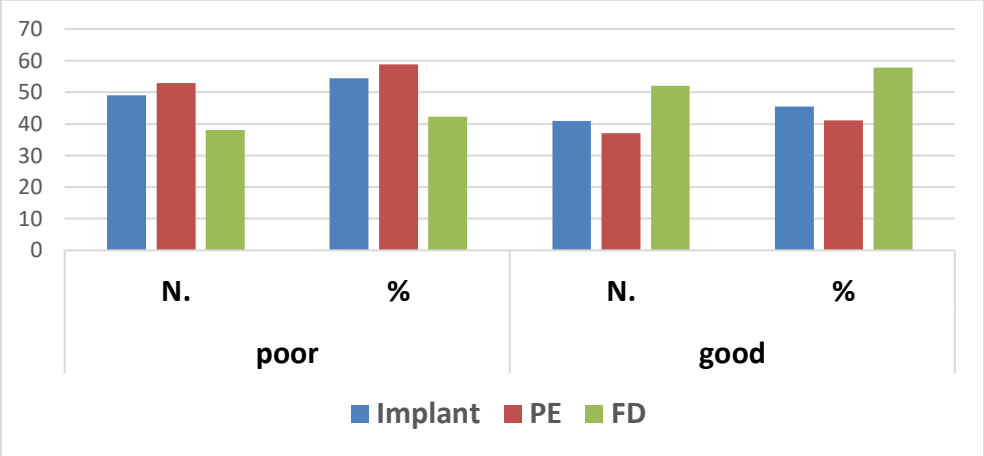

Figure 1: Bar chart of distribution of the sample according to cognitive status.

The oral stereognosis ability for the implant, partially edentulous, and fully dentate groups is illustrated in Table 1. Results revealed that the mean time taken to recognize the shape of all samples was less in the fully dentate group than in the implant group and finally the partially edentulous group, with statistically a significant difference ($p \leq 0.05$).

Table 1. The answer times of oral stereognosis tests for the implant patient compared with the partially edentulous and fully dentate.

Samples	Answer time of oral stereognosis tests (second)						
	Implant		Partially Edentulous		Fully Dentate		
	Mean	±SE	Mean	±SE	Mean	±SE	F
Cubic	7.66	0.09	8.70	0.10	7.00	0.07	90.46*
Circle	6.94	0.08	7.86	0.10	6.27	0.10	68.54*
Pyramid	5.68	0.09	6.76	0.09	4.92	0.10	93.84*
Star	8.25	0.10	9.15	0.13	7.57	0.10	48.11*
Cross	8.97	0.11	10.00	0.14	8.26	0.11	50.73*

* Significant, $p<0.05$

Table 2 shows the oral stereognosis ability by cognitive status among implant patients compared with partially edentulous and fully dentate. Data analysis revealed that the mean time taken to recognize the shape of all sample were significantly higher among person with poor than good cognitive status for the implant, partially edentulous and fully dentate, however among the poorly cognitive group the differences in time for oral stereognosis were found to be significant with the higher value among the partially edentulous group and the same result found concerning a person with good cognitive status.

Table 3. The answer times of oral stereognosis tests for the implant patient compared with the partially edentulous and fully dentate by cognitive status and stereognosis samples.

Samples	Cognition	Answer time of oral stereognosis tests (second)						
		Implant		Partially Edentulous		Fully Dentate		
		Mean	±SE	Mean	±SE	Mean	±SE	F
Cubic	**Poor**	8.02	0.11	9.24	0.08	7.52	0.10	73.839*
	Good	7.24	0.11	7.91	0.12	6.61	0.07	41.429*
	T-test	4.748*		8.902*		7.337*		
Circle	**Poor**	7.30	0.11	8.32	0.12	6.76	0.16	35.165*
	Good	6.51	0.09	7.21	0.09	5.92	0.10	42.435*
	T-test	5.266*		6.474*		4.526*		
Pyramid	**Poor**	6.04	0.11	7.20	0.09	5.60	0.12	55.604*
	Good	5.26	0.11	6.13	0.12	4.42	0.10	57.066*
	T-test	4.750*		6.706*		7.366*		
Star	**Poor**	8.67	0.13	9.60	0.17	8.15	0.15	21.195*
	Good	7.75	0.13	8.51	0.15	7.15	0.09	29.685*
	T-test	4.848*		4.396*		5.804*		
Cross	**Poor**	9.44	0.14	10.60	0.16	8.94	0.16	29.531*
	Good	8.41	0.12	9.13	0.17	7.76	0.11	25.337*
	T-test	5.327*		6.050*		6.140*		

* Significant, $p<0.05$

Discussion

When a tooth is lost, the sensory function of the mouth alters. Stereognosis refers to a sensor's total capabilities rather than a specific collection of mechanoreceptors; therefore, decline of the oral sensory ability may be a significant factor linked to masticatory disorder in the elderly [5,12,16]. The present study showed that the oral stereognosis ability in the fully dentate group was higher than that of the implant and partially edentulous groups of all samples with a statistically significant difference. This outcome was consistent with the findings reported by many previous studies [13,14,30] for the implant and [7,8,31] for partially edentulous and disagreed with the results concluded by others [12,15] for the implant group.

This result might be due to the fact that in dentate patients, the periodontal receptors and tongue play a critical role in determining stereognostic ability. Natural teeth's periodontal ligament provides sensory and motor control feedback to the central nervous system. In contrast, loss of proprioception in implant-supported restorations causes lower tactile sensitivity and less coordinated masticatory muscle activation,

making them more susceptible to occlusal loading and probable failure. The combination of adequate proprioception feedback and motor responses is also critical to a prosthodontic repair or replacement's success or failure. The success or failure of a prosthodontic restoration or replacement is also dependent upon the integration of proper proprioception feedback and motor responses [30,32].

The current study also revealed that the oral stereognosis ability of the implant group was higher than that of the partially edentulous group of all samples with a statistically significant difference. This result was in agreement with the results reported by many previous studies [16,17]. The oral stereognosis ability of edentulous patients with osseointegrated implants (fixed prosthesis, overdenture) showed improvement and was similar to that of totally dentate subjects though the latter did have a slightly higher ability. The hypothesis was that additional receptor groups could compensate for the loss of periodontal ligament receptors in edentulous patients rehabilitated with osseointegrated implant-supported prostheses. Even following tooth loss, the neuromuscular system's adaptability in sustaining subjective interpretative competence appears to be unique [17].

Cognitive impairment is a common problem among the elderly. It is a major cause of disability and care dependence [33]. Concerning the cognitive status, the result of the present study revealed that the oral stereognosis ability for good cognitive status was significantly better than poor cognitive status for all groups. This result was consistent with the results reported by previous studies [33-35].

The explanation for this result might be that because there is a considerable correlation between them in elderly populations, reduced oral perception appears to be a result of peripheral sensory and/or central neurological problems [36]. It has been widely reported that missing teeth cause reductions in most sensory and motor modalities, including oral stereognostic ability and masticatory function. [37-40], occur with aging [31]. Although aging, tooth loss and denture use have all been linked to a loss of oral perception, cognitive decline may be the basis of the problem [34,40,].

There are some limitations inherent in this survey study due to the cross-sectional nature of the data, cannot fully tease apart the causal relationship between cognitive function and oral stereognosis ability. Another limitation is that the SAGE, the single cognitive test available in its forms as self-administered test, only evaluated a segment of the multiple domains that contribute to cognitive ability. Limitation of using the SAGE in a community setting. First, participants must be able to read, write and see to take the exam. Clinical relevance of this study is to educate patients that oral stereognosis helps clarify the link between oral sensory function and cognitive status. Since implant patients may show reduced oral sensation compared with fully dentate individuals, stereognosis testing can support patient understanding of the need for attentive oral hygiene, regular follow-up, and early recognition of cognitive changes that may influence implant care.

Conclusion

Within the limitations of this study, it can be concluded that the oral stereognosis of partially edentulous subjects was significantly poorer than that of dentate subjects. Understanding oral stereognosis in edentulous individuals can help dentists create appropriate prostheses that will allow these patients to execute a variety of oral activities, including not only mastication and chewing, but also swallowing/deglutition, speech, and esthetics. The weakening of cognitive impairment is elaborate in oral perceptions since its preclinical phase.

Conflict of interest

The authors have no conflicts of interest to declare.

Author contributions

AHMJ; study conception and design. AFI; data collection. AHMJ and NA.; Methodology. AHMJ, MOMI, OAB and AFI; statistical analysis and interpretation of results. AFI; original draft manuscript preparation. AHMJ and AFI; Writing & editing. Supervision; AHMJ and OAB. All authors reviewed the results and approved the final version of the manuscript to be published.

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Informed consent

Informed consent was obtained from all individuals (or their guardians) who participated in this study.

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التجسيم الفموي بين مرضى زراعة الأسنان فيما يتعلق بحالة الإدراك

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المستخلص:

الخلفية: تقوم القدرة المجسمة الفموية (OSA) بفحص الأداء الفموي للفرد ، كما تحدد كيفية استجابة المرضى للعلاجات السنية المختلفة. قد يؤدي فقدان الأسنان الطبيعي إلى انخفاض في الإدراك الفموي. تم ربط انخفاض الإدراك الفموي بالتدهور المعرفي لدى كبار السن. الهدف من الدراسة: هو تقييم القدرة المجسمة الفموية بين مرضى زراعة الأسنان فيما يتعلق بحالة الإدراك ومقارنتها مع المرضى الذين يعانون من فقدان الأسنان الجزئي والمرضى مع كامل الأسنان من نفس العمر والجنس. المواد والطرق: شملت عينة الدراسة 90 مريض زراعة اسنان تتراوح أعمارهم بين (50-60) سنة بالمقارنة مع المرضى الذين يعانون من فقدان الأسنان الجزئي والمرضى مع كامل الأسنان. تم استخدام خمس عينات اختبار مختلفة لتقييم القدرة المجسمة الفموية تشمل (مكعب ، دائري ، هرم ، نجمي ، صليب). كانت معايير تقييم القدرة المجسمة الفموية هي الوقت اللازم للمريض للتعرف على شكل العينات. تم تقييم حالة الإدراك باستخدام اختبار (Gero-cognitive Examination (SAGE الذي تم بموجبه تقسيم المشاركين إلى مجموعتين فقيرة وجيدة. تم تحليل البيانات إحصائيًا باستخدام Spss 22 Chicago Illinois USA. النتائج: كان متوسط الوقت المستغرق للتعرف على شكل جميع العينات أقل في المجموعة مع كامل الاسنان تليها مجموعة زراعة الاسنان ثم مجموعة فقدان الأسنان الجزئي مع وجود فرق معنوي إحصائيًا. فيما يتعلق بحالة الإدراك ، كان متوسط الوقت المستغرق للتمييز بين شكل كل العينة أعلى بشكل ملحوظ بين الأشخاص ذوي الحالة المعرفية الفقيرة من الحالة المعرفية الجيدة لمجموعة الزراعة ، مجموعة فقدان الأسنان الجزئي والمجموعة مع كامل الاسنان. الخلاصة: أظهرت نتائج البحث الحالي أن فقدان الأسنان الطبيعية يؤثر على كل من الحالة المعرفية والإدراك الفموي المتمثل في القدرة المجسمة الفموية (OSA).