Comparative Evaluation Of Oral Stereognosis And Masticatory Efficiency In Patients Rehabilitated With Conventional Complete Denture And Implant Supported Overdenture

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KEYWORDS:

Oral Stereognosis ability, Masticatory Efficiency, Implant-Supported Denture, Oral Perception, Complete Denture.

ABSTRACT:

This study explores the role of stereognosis—the tactile ability to identify shapes and objects—in oral function, particularly among individuals without teeth. Alongside this, it examines masticatory efficiency, a crucial factor impacting nutrition and overall quality of life in edentulous patients. The aim was to compare these two parameters in patients rehabilitated with either conventional complete dentures or implant-supported overdentures. Twenty completely edentulous patients were selected and divided equally into two groups. Group 1 received conventional dentures, while Group 2 was provided with implant-supported overdentures. Stereognostic ability was assessed using six uniquely shaped acrylic test forms, and masticatory efficiency was evaluated by measuring the weight reduction of chewing gum after mastication. Assessments were performed at three stages: before insertion, post-insertion, and after six months. Results showed a significant improvement in both stereognostic ability and chewing efficiency in the implant-supported overdenture group compared to the conventional denture group. Patients with implant-supported prostheses demonstrated better object recognition and enhanced chewing function, likely due to improved neuromuscular coordination and denture stability. These findings highlight the functional benefits of implant-supported overdentures in oral rehabilitation and support their wider use for improving quality of life in edentulous patients.

INTRODUCTION

Stereognosis is the ability to perceive an object's shape through touch without visual input. Oral stereognosis, in particular, refers to the oral mucosa's ability to detect and differentiate object shapes within the mouth. Berry and Mahood were the pioneers in developing the oral stereognosis test, which

involved placing unseen objects into a patient's mouth and asking them to identify the shape.[1] The National Institute of Dental Research created a set of 20 shapes and recommended their use for evaluating oral stereognosis.[2] This testing method does not target specific receptors but serves as a general measure of a patient's overall sensory capability.[3]

The periodontal membrane is a key component of oral sensory function, containing an intricate network of nerve fibers and receptors. This system plays a vital role in controlling masticatory forces and identifying foreign objects between the upper and lower teeth.[4] Oral mechanoreceptors play a crucial role in detecting tactile sensations, forming the basis of oral stereognosis These specialized neurons transmit signals related to touch, pressure, and proprioception to the brain through electrical impulses, facilitating various sensory functions.[5]

Complete edentulism impairs mastication, aesthetics, and speech, with conventional dentures often leading to instability and patient dissatisfaction—particularly in the mandible. Implant-supported overdentures offer a more stable and effective alternative, enhancing function and overall oral rehabilitation.[6]

Tooth extraction leads to the loss of periodontal receptors essential for sensory feedback in mastication, resulting in reduced proprioception in complete denture wearers. Implant prostheses, however, may restore some sensory input through osseoperception, improving overall masticatory function.[7]

The null hypothesis of the present study was that there was no difference in stereognostic ability and masticatory efficiency in conventional dentures and implant supported overdentures.

CASE STUDY:

The study was conducted in Department of Prosthodontics and Crown & Bridge, I.T.S Centre for Dental Studies and Research, Ghaziabad to evaluate and compare the oral stereognosis and masticatory efficiency between the conventional complete denture and implant supported overdenture wearers.

Ethical approval with reference number ITSCDSR/IIEC/2022-25/PROSTHO/02. Informed consent was obtained from each subject before enrolling them in the study.

Patients were segregated under two groups:

Group 1: Conventional Denture(n=10).

Group 2: Implant overdenture (n=10).

Inclusion criteria:

1. Completely edentulous patient
2. Class I ridge relation
3. Mandibular arch
4. First time denture wearer

Exclusion criteria:

1. Uncooperative patients
2. Patients with systemic or congenital diseases.
3. Patients with TMJ disorders.
4. Patients with neurological disorders, under the influence of neurological drugs, under intoxications, and having any psychological problems or deleterious habits.

Conventional Denture Group:

Patients who opted for conventional complete dentures underwent standard clinical procedures, including primary and final impressions, master cast fabrication using Type III gypsum, jaw relation recording, teeth arrangement in bilaterally balanced occlusion, and denture fabrication. Stereognostic ability and masticatory efficiency were assessed on the day of denture delivery and again after six months.

Implant-Supported Overdenture Group:

For patients receiving implant-supported overdentures, treatment began following successful osseointegration. Healing abutments were replaced with locator attachments for improved retention. A new mandibular denture was fabricated and relieved in the attachment areas for passive seating. Using a direct chairside pick-up technique with self-cure acrylic resin, the attachments were incorporated intraorally with the patient in centric occlusion. Occlusion was adjusted, and final polishing was done. Patients were instructed on hygiene and scheduled for follow-up visits. Assessments for stereognosis and masticatory efficiency were conducted on the day of insertion and after six months.

Oral Stereognostic Ability Evaluation:

Tests were conducted in three phases—before denture insertion, at insertion, and after six months—using six distinct heat-cured acrylic resin shapes (circle, oval, triangle, square, rectangle, star), each 10 mm in diameter and 5 mm thick. Wax patterns were created using uniform moulds, followed by processing into acrylic forms. Dental floss was attached to each shape to prevent aspiration, and all forms were autoclaved at 121°C, 15 psi for 30 minutes. Larger reference models were made using Type II gypsum. Shapes were introduced randomly on the tongue with participants blindfolded, and identification was done by pointing to the corresponding reference model. A three-point scale was used: 0 (not identified), 1 (incorrect but similar), and 2 (correct), with a maximum score of 12. Standardized shape selection avoided sharp edges, flexible or metallic materials, or unusual forms to prevent discomfort or confusion.[1]

Masticatory Efficiency Evaluation:

Each subject was given pre-weighed chewing gum and instructed to chew for 25 strokes. The chewed gum was rinsed, dried with absorbent paper, and desiccated for 24 hours using calcium chloride. The final weight was recorded, and the percentage weight loss was used to calculate masticatory efficiency. Unchewed control samples were also desiccated to account for baseline moisture loss.[1,8]

RESULTS:

Table 1: Comparison of change in stereognostic ability within each group

Group	Interval	Mean	SD	χ^2 value	p-value
Conventional denture	Before denture insertion	5.20	0.92	18.667	<0.001 *
	After denture insertion	6.00	0.67		
	At 6 months follow-up	8.30	0.82		
Implant overdenture	Before denture insertion	5.30	1.16	19.158	<0.001 *
	After denture insertion	6.50	0.85		
	At 6 months follow-up	9.60	0.97		

Friedman's two-way ANOVA test; * indicates a significant difference at $p \leq 0.05$

Table 1 Compares the change in stereognostic ability at different time points within each group. In each group, the stereognostic ability showed a significant increase till 6-month follow-up.

Table 2: Pairwise comparison of change in stereognostic ability within each group

Pairwise comparison	p-value	p-value
Before denture insertion vs After denture insertion	0.539	0.221
Before denture insertion vs 6 months follow-up	<0.001*	<0.001*
After denture insertion vs 6 months follow-up	0.022*	0.042*

Post hoc Bonferroni test; * indicates a significant difference at p≤0.05

Table 2 presents the pairwise comparison of the change in stereognostic ability at different time points within each group. In each group, there was a non-significant difference in the stereognostic ability before & after denture insertion. However, the stereognostic ability after 6 months was significantly greater than the insertion in each group.

Table 3: Comparison of stereognostic ability between the two groups

Interval	Conventional denture		Implant overdenture		z-value	p-value
	Mean	SD	Mean	SD		
Before denture insertion	5.20	0.92	5.30	1.16	-0.290	0.796
After denture insertion	6.00	0.67	6.50	0.85	-1.397	0.218
At 6 months follow-up	8.30	0.82	9.60	0.97	-2.673	0.009*

Mann Whitney test; * indicates a significant difference at p≤0.05

Table 3, compares the stereognostic ability between the two groups. Before and after denture insertion, the stereognostic ability of the two groups did not differ significantly. However, after 6 months, the stereognostic ability of Implant overdenture group was significantly greater than that in the conventional denture group.

Table 4: Comparison of masticatory efficiency at the time of denture delivery and at 6-month follow-up

Group	Interval	Mean	SD	SEM	Difference	t-value	p-value
Conventional denture	**Immediate**	18.91	1.47	0.47	-7.73	-22.808	<0.001*
	6-month	26.64	1.36	0.43			
Implant overdenture	**Immediate**	24.45	2.62	0.83	28.73	-52.667	<0.001*
	6-month	53.18	2.51	0.79			

Paired t test; * indicates a significant difference at p≤0.05

Table 4, compares the masticatory efficiency at the time of denture delivery and the 6-month follow-up. In each group, the masticatory efficiency (in %) at 6-month follow-up was significantly greater than that at the time of denture delivery.

Table 5: Comparison of masticatory efficiency between two groups

Group	Interval	Mean	SD	SEM	Difference	t-value	p-value
Immediate	**Conventional**	18.91	1.47	0.47	-5.54	-5.831	<0.001*
	Implant overdenture	24.45	2.62	0.83			
6-month	**Conventional**	26.64	1.36	0.43	-26.54	-29.43	<0.001*
	Implant overdenture	53.18	2.51	0.79			

Independent t test; * indicates a significant difference at p≤0.05

Table 5, compares the masticatory efficiency between the two groups. At the time of denture delivery, the masticatory efficiency (in %) of the Implant overdenture group was significantly greater than that in the conventional denture group. Similarly, at 6-month follow-up, the masticatory efficiency (in %)

of the Implant overdenture group was significantly greater than that in the conventional denture group.

DISCUSSIONS:

In the present study, test forms for oral stereognosis testing were fabricated using heat-cured acrylic. To maintain hygiene and prevent cross-contamination, new samples were fabricated for each patient and sterilized by autoclaving at 121°C. To eliminate the risk of accidental ingestion, floss was attached to each sample. Additionally, patients were instructed to keep their eyes closed before the placement of the sample in the mouth to prevent visual identification and ensure an unbiased assessment of shape recognition. Various studies[1,9-13] have used acrylic based test forms to fabricate test forms because of the same reason. Jacobs et al.[14] in the review article discussed various methodologies employed in assessing oral stereognosis, highlighting that the design and material of test pieces significantly influence the outcomes. They noted that many studies have utilized acrylic materials to fabricate standardized test samples for evaluating oral stereognostic ability. The use of heat-cured acrylic resin is common due to its durability and ease of manipulation, allowing for the creation of precise shapes necessary for accurate assessment. These acrylic samples are typically customized for each participant to ensure proper fit and to prevent cross-contamination, they are often sterilized before use. Additionally, attaching dental floss to each sample is a precautionary measure to prevent accidental ingestion during testing. Participants are usually instructed to keep their eyes closed during the placement of the samples in the oral cavity to eliminate visual cues, ensuring that the assessment strictly measures tactile recognition abilities. However other materials like raw carrots[15] and metal alloys[14] are also used.

In the present study, chewing gum was used to evaluate masticatory efficiency since they provide a repeatable and simple objective test of chewing. The development of the method is based on the weight loss of sugars from chewing gums, which may indicate the chewing efficiency of an individual.[1,8]

In the present study the locator attachments were used for the implant overdenture wearers. Locator attachments are widely preferred in implant-retained overdentures due to their low profile, ease of insertion, and self-aligning feature, which compensates for implant angulation discrepancies up to 40 degrees.[13] Their retention capacity is adjustable using different nylon inserts, allowing for customization based on patient needs. Studies have demonstrated that locators provide high patient satisfaction and prosthesis stability, contributing to improved oral function and quality of life.[14] A systematic review reported a 97% survival rate for locator attachments after a mean follow-up period of three years, making them a reliable option for long-term prosthetic rehabilitation.[15] However, locator attachments are not without disadvantages. Their nylon inserts tend to wear out over time, requiring periodic replacement, which increases maintenance efforts and costs.[16] Additionally, studies have shown that locator attachments are associated with higher prosthetic complications, such as retention loss and attachment fractures, compared to other systems.[17] Marginal bone loss around implants has been found to be comparable to other attachment systems, with a mean bone loss of approximately 1.2 mm after five years.[18] Several alternative attachment systems are also commonly used in implant-retained overdentures. Ball attachments, for instance, provide good retention and ease of use but are associated with higher wear rates and a greater need for relining procedures.[19] A study comparing locator and ball attachments found that while both systems provided satisfactory retention, locator attachments exhibited lower rates of peri-implant inflammation and better long-term stability.[20] Bar-clip attachments are another option, offering excellent retention and stress distribution across multiple implants, though they require more inter-arch space and have higher fabrication costs.[21] Magnetic attachments, while beneficial for patients with limited dexterity, demonstrate lower retention and higher susceptibility to orrosion, making them less favourable for long-term use.[22] In conclusion, locator attachments remain a popular choice due to their adaptability and ease of use, but they require ongoing maintenance. Other attachment systems, such as ball, bar-clip, and magnetic attachments, each have their advantages and limitations, making the choice of attachment highly dependent on individual patient factors and clinical requirements.

The present study evaluated the impact of conventional dentures and implant-supported overdentures on masticatory efficiency and stereognostic ability over a six-month period. The results indicate that implant-supported overdentures significantly improve both masticatory function and oral stereognostic

ability compared to conventional dentures.

Masticatory efficiency was significantly higher in the implant overdenture group at both the time of denture delivery and the six-month follow-up. The mean masticatory efficiency (%) of the conventional denture group increased from 18.91% at delivery to 26.64% at six months, whereas the implant overdenture group showed a more substantial increase from 24.46% to 53.18%. These findings align with studies by Fontijn-Tekamp et al. [26] and Geertman et al. [27], which demonstrated that implant-supported prostheses enhance chewing performance due to improved retention and stability. The increased efficiency in the implant overdenture group is likely attributable to the superior stability of the prosthesis, allowing for more effective food comminution and bolus formation.

The findings revealed notable enhancements in stereognostic ability over time in both groups, with the implant overdenture group demonstrating a more substantial improvement. The mean stereognostic ability score in the conventional denture group improved from 5.20 before insertion to 8.30 at six months, while the implant overdenture group improved from 5.30 to 9.60 over the same period. These findings support the work of Matsuo et al. ,[28] who found that oral stereognostic ability improves with enhanced prosthesis stability and retention, factors that are inherently superior in implant-supported overdentures.

Statistical analyses further confirmed these trends. The paired t-tests demonstrated significant intra-group improvements in masticatory efficiency at six months, with p-values <0.001 for both groups. Similarly, stereognostic ability showed statistically significant differences at six months, as evidenced by the Friedman's two-way ANOVA test results. However, the implant overdenture group exhibited significantly greater improvements compared to the conventional denture group ($p = 0.009$), emphasizing the clinical advantage of implant-retained prostheses.

The findings of this study suggest that implant-supported overdentures provide superior functional outcomes compared to conventional dentures. Improved masticatory efficiency enhances overall nutrition and digestion, while better stereognostic ability contributes to greater oral sensory perception and prosthesis control. These factors collectively improve patient satisfaction and quality of life, as reported by Thomason et al.[29] and Feine et al.[30]

The present study highlights the significant advantages of implant-supported overdentures in enhancing masticatory efficiency and oral stereognostic ability compared to conventional dentures. Clinically, these findings reinforce the preference for implant-retained prostheses as an effective rehabilitation option for edentulous patients, providing improved stability, better chewing function, and enhanced sensory perception. The superior retention and functional benefits of implant overdentures contribute to greater patient satisfaction, potentially leading to better nutritional intake and overall oral health. However, while these findings underscore the benefits of implant-supported prostheses, they also emphasize the need for individualized patient assessment, as factors such as neuromuscular coordination, cognitive function, and adaptation periods may influence treatment success.

Despite promising results, this study has limitations. The small sample size limits generalizability, and the six-month follow-up may not fully reflect long-term outcomes such as prosthesis wear or peri-implant bone loss. Future studies should include larger, multi-center cohorts with extended follow-ups to assess durability, stability, and cost-effectiveness. Additionally, incorporating patient-reported outcome measures (PROMs) would provide a more comprehensive understanding of comfort, adaptation, and social impact.

Looking ahead, there is significant potential to enhance implant-supported overdenture research. Future investigations should aim to optimize prosthetic designs to improve masticatory performance and nutritional outcomes, using tools like pressure-mapping sensors and electromyography to evaluate bite force and muscle activity. In terms of stereognostic ability, further research should explore its influence on neuromuscular coordination and prosthesis control, potentially integrating neuroimaging and sensory testing.

The advent of digital dentistry, including CAD/CAM and 3D printing, offers promising solutions for creating precise, patient-specific prostheses. Exploring alternative attachment systems, occlusal schemes, and materials may further improve retention, sensory function, and long-term success. Interdisciplinary research combining prosthodontics, neurology, and material science could lead to more personalized, functional, and patient-centered rehabilitation approaches.

CONCLUSIONS:

Within the limitation of the study the following conclusions were drawn:

1.) The stereognostic ability of Implant overdenture wearers was found more than the conventional complete denture wearers. There was statistically significantly difference($p<0.05$) between Implant overdenture wearers as compared to the conventional complete denture wearers.
2.) The masticatory efficiency was found more in implant overdenture wearers than the conventional complete denture wearers. There was statistically significant difference ($p<0.001$) between the masticatory efficiency in Implant overdenture wearers as compared to the conventional complete denture wearers.

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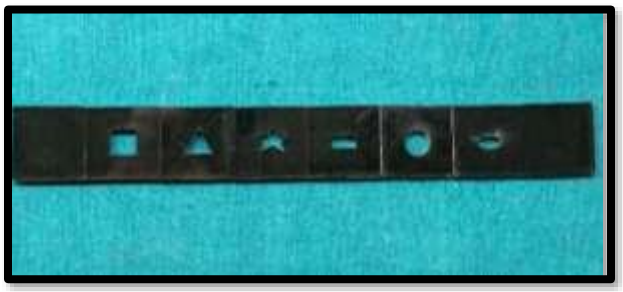

Figure-1 : Moulds for fabrication of test forms used in the study

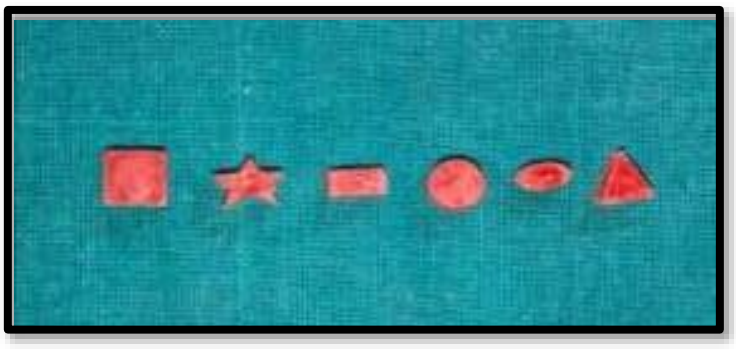

Figure2 : Wax pattern obtained

Figure-3 : Plaster Test forms fabricated for the study

Figure 4: Subject is introduced to test form

Figure 5: Subject identifying the test forms

Figure 6: Weighing Machine