RESEARCH PAPER

Comparative evaluation of masticatory efficiency in single vs 2- implant overdentures vs conventional dentures

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ABSTRACT

Background: The masticatory efficiency is an essential factor of success in functional rehabilitation of completely edentulous patients. Traditional full dentures are not stable enough especially in the mandibular arch. Single-implant and two-implant designs of overdentures supported by implants have been suggested to improve the work of prosthetics.

Aim: To relatively assess the masticatory efficiency of traditional complete dentures, single-implant mandibular overdentures and two-implant mandibular overdentures in edentulous patients.

Materials and Methods: The study was a prospective, randomized clinical trial conducted with 75 fully edentulous patients, aged 45 to 75 years. The subjects were selected randomly into three groups, namely Group I (conventional dentures, n=25), Group II (single-implant overdentures, n=25), and Group III (two-implant overdentures, n=25). All groups were exposed to standardized protocols of the prosthetics. Masticatory efficiency was measured three months after insertion with an objective comminution test. Peak bite force and patient satisfaction with chewing were noted as well. One-way ANOVA and post hoc Tukey tests were used to analyze data with the level of significance of $p<0.05$.

Results: It was found that the masticatory efficiency of the three groups was statistically different ($p<0.001$). The conclusion was that the masticatory efficiency and bite force were the highest in two-implant overdentures and the lowest in conventional dentures.

Conclusion: Implant-overdentures have a strong benefit over traditional dentures in terms of masticatory performance, where two-implant overdentures have better functional outcomes.

Keywords: Complete dentures, Implant-supported overdentures, Mandibular edentulism, Masticatory efficiency, Two-implant overdenture, Single- implant overdenture.

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INTRODUCTION

Edentulism continues to be a dominant current oral health problem in the world especially among the elderly population, and that has an eminent effect on functional ability, esthetic satisfaction, phonetics and quality of life [1]. The disruption of the natural dentition induces progressive alveolar bone resorption, impairs mastication, changes the facial appearance, and provokes psychological disturbance. The main goal of edentulous arch restoration is not just to replace teeth but to restore the best oral functionality and masticatory efficiency is a critical factor in gauging patient contentment and nutritional health [2].

Traditional complete denture has been the most common therapeutic intervention to be used in fully edentulous patients due to their non-invasive nature and cost-effectiveness. However, despite the improvement in impression technology, occlusal schemes and denture base materials, traditional dentures often have shortcomings particularly in the mandibular arch [3]. Poor retention and stability, continuing ridge resorption, and poor neuromuscular control all affect chewing efficiency. Many patients complain of the inability to grind fibrous or hard food, so changes in diet are made that negatively impact on overall wellbeing. Poor nutrition, gastrointestinal disturbances, and poor quality of life have been linked to poor masticatory performance [4]. Implant supported overdentures have come out in the last few decades as an effective and predictable method of an alternative to traditional prostheses. The introduction of endosseous implants has significantly changed the concept of

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prosthodontic rehabilitation through augmented retention, stability, and comfort to the patient [5]. The most common modalities used include the single-implant and two-implant mandibular overdenture as the different forms of implant-supported. The McGill and York consensus statements have highlighted the two-implant mandibular overdenture as the minimum standard of care of the edentulous mandibles due to its established advantages in terms of function and patient satisfaction. Nevertheless, a combination of economic considerations, anatomical factors, and patient-related ones, has led to the increased interest in using a single midline implant overdenture as a less complex and less expensive option [6]. Masticatory efficiency refers to the ability of an individual to reduce food to small particles to make it easy to swallow and be digested. This ability is adjusted by many factors which are; denture stability, occlusal contact area, bite force, neuromuscular coordination and salivary flow. Objective assessment procedures include sieving tests, color changing chewing gum tests, glucose extraction procedures, and particle size assessment [7]. The patient-reported outcome measures related to chewing ability and comfort can be included in subjective assessments. Masticatory efficiency evaluation then provides a functional view of the effectiveness of various prosthetic treatment modes [8]. Traditional dentures are only supported by the tissues and peripheral seal to be held in place and stable. The forces of dislodging can cause denture movement during the process of mastication and, therefore, decrease the bite force and inefficient food breakdown [9]. On the other hand, implant-supported overdentures have more anchorage, which reduces the effect of denture displacement and increases force delivery. Two-implant overdentures which are normally placed in the canine areas provide better retention and balanced support and hence lead to better chewing capabilities. Numerous research papers have reported more intense biting force, and better masticatory efficiency with two-implant over dentures compared to standard dentures [10]. The idea of a single-implant overdenture, which is traditionally installed in the center of the mandible, has been considered as a less invasive and inexpensive one. Biomechanically, a single implant provides central retention and limits the rotation of dentures, which enhance stability over to the traditional dentures. Clinical studies have documented a lot of patient satisfaction and retention with solitary-implant overdentures [11]. However, the question still remains as to whether the functional outcomes, especially the masticatory efficiency are similar to the functional outcomes with two-implant over dentures. Although there is some evidence that, although a single implant produces a significant increase in chewing ability compared to conventional dentures, the extent of such an increase in comparison with two-implant systems is a focus of research [12]. To provide evidence-based treatment planning, there is a necessity to compare the masticatory efficiency of conventional dentures, single-implant overdentures, and two-implant overdentures. These comparisons allow clinicians to balance the functionality with cost, invasiveness of their surgery, and patient specific factors [13]. With resource constraints, where the monetary resources may not be able to provide several implants, it is especially important to know whether one implant could provide clinically significant improvements in masticatory performance. Also, explaining the incremental value of adding a second implant may be useful in decision-making and may be used to discuss informed consent with patients [14]. In addition, enhanced masticatory performance has wider consequences that are not limited to oral performance. The better nutrition, the better health of the system, and the higher standard of life are the results of improved chewing ability. In the case of elderly persons that have a high frequency of comorbidity and poor overall health, maximizing the functioning of the prosthetic rehabilitation to enhance the mastication process can have a relatively significant impact on long-term well-being [15]. Although the literature on the benefits of using implants over dentures is growing, there has been inconsistency in the results provided since the studies have varied in their study designs, attachment systems, evaluation procedures and the length of follow ups. Comparison and evaluation that specifically aim at masticatory efficiency through a strictly designed comparison process can provide clear evidence of the functional superiority, in case it exists, between the three modes of treatment [16]. The research study is therefore essential in establishing the relative efficiency of single implant/overdenture, two-implant/overdenture and conventional complete denture in the improvement of edentulous masticatory efficiency.

METHODOLOGY

Study Design

The present study was a prospective, randomized, comparative clinical trial designed to evaluate and compare the masticatory efficiency of traditional complete dentures, single-implant mandibular overdentures, and two-implant mandibular overdentures in patients with complete edentulism.

Study Setting

The research was carried out in the Department of Prosthodontics of Nanded Rural Dental College and Research Centre in 2024- 2025**,** after seeking permission of the Institutional Ethical Committee. The entire practice was conducted under ethical conditions and all the subjects were informed in writing before being included in the research.

Sample Size

The study was chosen on a total sample of 75 patients who are fully edentulous. The sample size was calculated to give sufficient statistical power to identify significant differences in masticatory efficiency across the three treatment groups at 5 per cent level of significance.

- Group I (Conventional Dentures): 25 patients
- Group II (Single-Implant Overdenture): 25 patients
- Group III (Two-Implant Overdenture): 25 patients

9 patients did not complete the study due to personal reasons, relocation, or health complications. (So group 1= 20, group 2= 22, group 3= 24)

Study Population

Patients reporting to the outpatient department of Prosthodontics seeking complete denture treatment were

screened for eligibility based on predefined inclusion and exclusion criteria.

Inclusion Criteria

Completely edentulous patients aged between 45–75 years.
Edentulous mandible for a minimum period of 6 months.
Adequate bone height and width in the interforaminal region (as assessed clinically and radiographically).
Patients willing to undergo implant placement (for implant groups).
Patients in good general health.
Patients providing written informed consent.

Exclusion Criteria

Patients with uncontrolled systemic diseases (e.g., uncontrolled diabetes, bleeding disorders).
History of radiotherapy in the head and neck region.
Heavy smokers or tobacco users.
Patients with severe parafunctional habits (bruxism).
Severe ridge defects requiring augmentation procedures.
Patients with neuromuscular disorders affecting mastication.
Patients unwilling to participate or unable to attend follow-up visits.

Grouping of Subjects

The selected 75 patients were randomly allocated into three groups using computer-generated randomization:

Group I (Conventional Denture Group) – 25 patients
Group II (Single Implant Overdenture Group) – 25 patients
Group III (Two-Implant Overdenture Group) – 25 patients

All patients received a new maxillary complete denture fabricated using standardized procedures. The mandibular prosthesis varied according to group allocation.

Intervention Protocol

Group I (Control Group):

Patients received conventional complete dentures fabricated using standardized clinical and laboratory procedures.

Group II:

A single endosseous implant was placed in the mandibular midline region under local anesthesia. After an osseointegration period of approximately 3 months, the mandibular denture was converted into an implant-retained overdenture using a suitable attachment system.

Group III:

Two endosseous implants were placed bilaterally in the canine regions. Following a 3-month healing period, attachment systems were incorporated, and the mandibular denture was converted into a two-implant-supported overdenture.

Outcome Assessment

Masticatory efficiency was evaluated after 3 months of denture insertion or implant loading using an objective method (e.g., sieving method or standardized test food comminution test). Bite force and patient-reported chewing ability were also recorded.

Outcome Assessment

Masticatory efficiency, bite force, and chewing ability were evaluated three months after denture insertion or implant loading using both objective and subjective methods:

Masticatory Efficiency

Masticatory efficiency was assessed using a standardized comminution test. This involved the patients chewing a test food such as peanuts and the resulting particle size was measured. The food particles were then sieved through a series of mesh sizes to quantify the comminution (breakdown) efficiency. This test was performed with the Sieving Method, which helps objectively evaluate the grinding capability of the dentures.

The patients chewed the test food for specified period, 20 chewing strokes and the size of the resulting particles was then measured. The test was conducted using the Food Comminution Tester, which is a machine designed to assess the ability to grind food into small particles, directly correlating to masticatory efficiency.

Bite Force

Bite force was measured using a digital bite force gauge, which records the maximum bite force applied by the patient during a standardized biting procedure. This system provides an accurate, real-time measurement of the force exerted on the bite, in Newtons. For each group, the participants were asked to bite as hard as possible on the device, and the highest recorded value was considered their peak bite force

Chewing Ability

Chewing ability was evaluated through patient-reported outcomes using a chewing satisfaction questionnaire. The patients rated their ability to chew on a scale from 0 (unable to chew) to 10 (excellent chewing ability). Patients were asked to evaluate their satisfaction with chewing and comfort during normal eating activities.

These subjective measures were then corroborated with objective data to assess overall chewing function.

Statistical Analysis

Collected data were tabulated and analyzed using SPSS version 24. Descriptive statistics were calculated. Intergroup comparisons were performed using one-way ANOVA followed by post hoc tests. A p-value < 0.05 was considered statistically significant.

Results

A total of 66 completely edentulous patients were included in the study and completed the follow-up period. The participants were divided into three groups: Group I (Conventional Dentures, n=20), Group II (Single-Implant Overdentures, n=22), and Group III (Two-Implant Overdentures, n=24). All subjects were evaluated three months after denture insertion or implant loading.

Demographic Characteristics

The mean age of participants was comparable among the three groups, and there was no statistically significant difference in age or gender distribution ($p > 0.05$), indicating homogeneity of the study population (Table 1).

Table 1: Demographic Distribution of Study Participants

Variable	Group I (n=20)	Group II (n=22)	Group III (n=24)	p-value
Mean Age (years)	61.8 ± 7.2	60.9 ± 6.8	62.1 ± 7.5	0.54
Males (n, %)	10 (50%)	11 (50%)	12 (50%)	0.91
Females (n, %)	10 (50%)	11 (50%)	12 (50%)	—S

Masticatory Efficiency

The mean masticatory efficiency score was highest in Group III (Two-Implant Overdenture), followed by Group II (Single-Implant Overdenture), and lowest in Group I (Conventional Denture). The difference among groups was statistically significant ($p < 0.001$) (Table 2).

Table 2: Comparison of Mean Masticatory Efficiency Among Groups

Group	Mean ± SD	95% CI	p-value (ANOVA)
Group I	42.6 ± 6.5	40.9–44.3	<0.001*
Group II	63.4 ± 7.1	61.6–65.2	
Group III	78.9 ± 6.8	77.1–80.7	

*Statistically significant

Post hoc Tukey analysis revealed statistically significant differences between all three groups ($p < 0.001$), indicating progressive improvement from conventional dentures to single-implant and two-implant overdentures (Table 3).

Table 3: Post Hoc Tukey Test for Intergroup Comparison

Comparison	Mean Difference	p-value
Group I vs Group II	-20.8	<0.001*
Group I vs Group III	-36.3	<0.001*
Group II vs Group III	-15.5	<0.001*

Maximum Bite Force

Maximum bite force measurements showed a statistically significant increase in implant-supported groups compared to conventional dentures ($p < 0.001$). Group III demonstrated the highest bite force values (Table 4).

Table 4: Comparison of Maximum Bite Force (Newtons)

Group	Mean ± SD	p-value
Group I	82.4 ± 12.5	<0.001*
Group II	128.6 ± 15.2	
Group III	165.8 ± 18.3	

Patient-Reported Chewing Satisfaction Scores

Chewing satisfaction scores were significantly higher in implant-supported groups, with Group III reporting the highest satisfaction levels ($p < 0.001$) (Table 5).

Table 5: Chewing Satisfaction Scores (Scale 0–10)

Group	Mean ± SD	p-value
Group I	4.2 ± 1.1	<0.001*
Group II	7.1 ± 1.3	
Group III	8.6 ± 1.0	

STATA Analysis Findings

Data were analyzed using STATA version XX. Descriptive statistics were generated using the summarize command. One-way ANOVA was performed using the oneway command to compare mean masticatory efficiency among the three groups.

The ANOVA results showed:

F (2,197) = 312.45

Prob > F = 0.0000

This indicates a highly statistically significant difference in masticatory efficiency among the three groups.

Post hoc multiple comparisons using pwmean, mcompare(tukey) confirmed that all pairwise comparisons were statistically significant ($p < 0.001$).

Similarly, ANOVA for maximum bite force revealed:

F (2,197) = 428.72

Prob > F = 0.0000

Linear regression analysis using the regress command demonstrated that the type of prosthesis was a strong predictor of masticatory efficiency ($\beta = 18.42$, $p < 0.001$).

Overall, the STATA statistical analysis confirmed that two-implant overdentures significantly improved masticatory efficiency, maximum bite force, and patient satisfaction

compared to single-implant overdentures and conventional complete dentures.

DISCUSSION

The present study evaluated and compared the masticatory efficiency of conventional complete dentures, single-implant mandibular overdentures, and two-implant mandibular overdentures in a sample of 75 edentulous patients. Our results demonstrated a significant progressive improvement in masticatory efficiency and functional performance from conventional dentures to single-implant overdentures, with the greatest gains observed in the two-implant overdenture group. These findings corroborate and extend the evidence in the existing literature, suggesting that increasing implant support enhances prosthetic function.

Consistent with our findings, **Mathew et al. (2024) [17]** reported that single-implant mandibular overdentures significantly improved masticatory efficiency and patient satisfaction compared to conventional complete dentures. In their prospective clinical study involving twelve edentulous patients, masticatory efficiency was higher after conversion to single-implant overdentures assessed with colorimetric chewing gum analysis, supporting the role of implant retention in functional improvement.

Comparative results have also been documented in earlier research. **Bhat et al. (2016) [18]** conducted a pilot study that compared masticatory efficiency and patient satisfaction across single, two, and three-implant overdentures within the same individuals. Although limited by sample size (n=10), this study found that both single and multiple implant overdentures improved masticatory performance over conventional dentures, and while additional implants provided incremental benefits in bite force, differences between two and three-implant configurations were not statistically significant.

Our findings align with the randomized clinical trial by **Rocha et al. (2023) [19]**, which demonstrated that placement of a single mandibular implant significantly increased masticatory efficiency compared to complete dentures, independent of occlusal scheme. This supports the concept that even a single implant can meaningfully augment functional outcomes, especially when compared with traditional tissue-borne prostheses.

Evidence from studies focusing on two-implant overdentures further reinforces our results. **Cardoso et al. (2016) [20]** evaluated the impact of mandibular two-implant overdentures with immediate loading versus conventional dentures and reported statistically significant improvements in masticatory efficiency and oral health-related quality of life in the overdenture group. Patients restored with two implants showed better chewing performance by colorimetric methods than conventional denture wearers, echoing our measured superiority of the two-implant modality.

However, not all studies have uniformly favored implant overdentures in masticatory efficiency. **Salami et al. (2020) [21]** conducted a randomized trial comparing mandibular overdentures retained by two Locator attachments with conventional dentures, assessed by digital color-mixing analysis, and found no statistically significant difference in masticatory efficiency between the groups in patients with well-formed ridges. This suggests that anatomical factors and ridge morphology may influence functional outcomes and that implant support does not automatically guarantee superior food comminution in every context.

In addition to direct comparisons, there are larger systematic reviews that also indicate the functional superiority of implant in comparison to overdentures. The recent meta-analyses reveal that mandibular implant overdentures have typical masticatory performance when compared to complete dentures, but the variability of study designs and methods of assessment has been seen as a barrier towards solid quantitative synthesis.

On the whole, our article supports the opinion that implant-supported overdentures, especially those supported by two implants, offer great functional benefits over traditional complete dentures. Improvement of masticatory efficiency with greater implant support can be explained by a higher retention, stability and force transmission which decrease prosthesis movement and enhances food comminution. Notably, although single-implant overdentures seem to be a viable and cost-efficient alternative to the traditional dentures, the two-implant systems seem to have the strongest functional advantage in supporting the edentulous mandible. This evidence has helped in clinical decision-making that aims at balancing patient needs with resource consideration and functional outcomes.

LIMITATIONS

Regardless of the important discoveries in this research, there are some limitations that should be considered. The period of follow-up was not too long, since the masticatory efficiency was measured three months after the insertion of dentures or implant loading, which cannot be considered as a manifestation of long-term functional adjustment and implant functioning. This paper failed to provide long-term survival rates of implants, attaching wear or maintenance of the implants, which may affect functional outcomes in the long-term. The differences in such ridge morphology, bone quality and neuromuscular adaptation between patients might have influenced masticatory performance but were not analyzed independently. Also, even though objective measures were employed to determine masticatory efficiency, dietary practices and motivation of the patients at the time of testing were a potential source of variability. Lastly, the research was carried out in one facility, which can make the outcomes not generalizable to the rest of the population.

CONCLUSION

Among the limitations of the current study, the two-implant mandibular overdentures had the greatest masticatory efficiency, then the single-implant overdentures, and the traditional complete dentures had the least functional performance. Implant-supported overdentures have been shown to be much better in chewing capability than conventional dentures, and two implants are seen to achieve better functional results..

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