Influence of mastication and its relationship with Body Mass Index before and after prosthetic rehabilitation in partially edentulous patients

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Recommended Citation  
DOI: 10.55691/2278-344X.1028  
Available at: https://rescon.jssuni.edu.in/ijhas/vol11/iss2/8

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Cover Page Footnote
The study was supported by the Department of Prosthodontics and Crown and Bridge, JSS Dental College and Hospital, JSS Academy of Higher Education & Research, Mysuru, Karnataka, India

This original study is available in International Journal of Health and Allied Sciences: https://rescon.jssuni.edu.in/ijhas/vol11/iss2/8
Original Study

Influence of Mastication and its Relationship with Body Mass Index Before and After Prosthetic Rehabilitation in Partially Edentulous Patients

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Abstract

Background: The main purpose of prosthetic rehabilitation is to enhance the masticatory function by replacing the missing teeth with an artificial substitute, which improves nutrient-rich food intake. There are recent studies which indicate the influence of chewing behavior and energy intake, but little is known about the relationship between chewing on nutritional status.

Objective: This study intended to assess the changes in masticatory efficiency before and after prosthetic rehabilitation and its influence on nutritional status and body weight.

Methods: A total of 40 partially edentulous subjects aged between 45 and 65 years were recruited. Body Mass Index was determined by measuring body weight using a medical grade weighing scale. Height was measured using wall mounted stature meter and Waist circumference was measured with an anthropometric measure tape. Masticatory efficiency was determined using the sieve method with peanuts as test food at baseline, at 3 and 6 months of prosthetic rehabilitation with a removable partial denture.

Results: Sieve test performed for evaluating masticatory efficiency showed an increase in the percentage of smaller particles by 28.3% in non-obese and 32.15% in the obese group. The obese/overweight group showed a decrease in BMI values and non-obese subjects showed no significant change in BMI.

Conclusion: The study concluded that improving masticatory efficiency by prosthodontic rehabilitation can aid in normalizing the nutritional status in certain partially edentulous non-obese and obese individuals.

Keywords: Masticatory efficiency, Body Mass Index, Obese, Non-obese, Prosthodontics rehabilitation

1. Introduction

Mastication is a process of chewing food and breaking them into smaller pieces. It increases the surface area for absorption of nutrient [1,2], aids in swallowing of bolus by ensuring salivation, optimizes gastric draining and it also increases the feeling of satiety [2]. Mastication is affected by poor health status and dental status. Poor dental status like reduced teeth number and limited occlusal contact area impairs the masticatory function leading to inappropriate food choice [2]. Decreased masticatory ability leads to unbalanced food and inadequate nutrient intake, which leads to Malnutrition and weight loss [5].

The intake of food depends on two aspects - dental status and oral health status. Reduced teeth number and limited occlusal contact area lead to inadequate and unbalanced food intake leading to weight loss [1,3,4].

Individuals with compromised dentition usually avoid hard-to-chew foods such as fruits, vegetables, and meat, which are major sources of dietary fiber, vitamins, minerals, and proteins [1,4]. They instead prefer softer, carbohydrate-rich food, high in fat and cholesterol content which might lead to weight gain.

Received 17 December 2022; revised 3 February 2023; accepted 4 February 2023.
Available online 29 March 2023

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https://doi.org/10.55691/2278-344X.1028
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These food habits lead to either unhealthy weight loss or unhealthy weight gain, therefore an improvement in chewing efficiency may be an important prerequisite for adequate nutrition.

It is reported that masticatory efficiency is less in individuals with a smaller number of teeth and this reduction in masticatory efficiency influences nutritional status [1,7].

It is observed that elderly decreased number of teeth with inadequate dietary habits is associated with increased Body Mass Index [1].

Body Mass Index is calculated by weight and height of a person is used to indicator to categorize into normal, overweight, or obese group based on the body weight.

Obesity due to inadequate nutritional intake and malnutrition due to inadequate food intake is becoming a socioeconomic burden to human life [8].

Few studies have also reported an association between obesity and masticatory performance. [1,2,3] The study intended to assess the changes in masticatory efficiency, and its relation with Body Mass Index after Rehabilitation with a Removable Partial Denture.

2. Materials and methods

A total of 40 partially edentulous subjects were recruited for the study, who were grouped into 20 obese/overweight based on BMI values (Fig. 1).

Occlusal units were determined by counting the number of occluding pair (one occluding molar is considered 2 occluding units and one premolar is 1 occluding unit).

The ethical clearance (No-JSS/DCH/IEC/MD-02/2017–18) was obtained from the Institutional Ethical Committee of JSS Dental College and Hospital, a constituent college of the JSS Academy of Higher Education and Research to involve the partially edentulous patients in to the study, the subjects were recruited from the outpatients in the Department of Prosthodontics and Crown & Bridge, JSS Dental College and Hospital, Mysuru, and filtered based on the inclusion criteria.

2.1. Inclusion criteria

Patients aged between 45 and 65 years.
Patients with more than 4 occluding pairs missing.
Complains of inability to chew.
No history of previous denture treatment
No eating disorder, or actively dieting.

2.2. Exclusion criteria

Subjects with known systemic diseases.
Subjects taking immunosuppressive medications, neuromuscular disorder that affects masticatory muscle function,
Pregnant, lactating mothers, BMI
TMJ disorders more than or equal to 18.5, less than 25, and waist circumference less than 80 cms were considered to be in non-obese group. BMI more than or equal to 25 and waist circumference more than or equal to 80 cms were considered to be in overweight/obese group [1,3].

![Fig. 1. Study groups.](image-url)
Body Mass Index was determined by measuring body weight using a digital weight scale (Fig. 2) after 2 h of food intake at every interval. Height was measured using a wall-mounted stature meter in centimeters, the subjects were barefooted during the measurement. Waist circumference was measured with an anthropometric measure tape at the upper margin of the iliac crest midpoint between the coastal margins of the ribs [1]. (Figs. 3–5) Body Mass Index values were calculated by dividing weight in kilograms by the square of the height meters.

\[ \text{BMI} = \frac{\text{Kg}}{\text{m}^2} \]

2.3. Evaluating Masticatory efficiency before Denture treatment

The subjects were asked to rinse their mouth with 0.2% chlorhexidine mouthwash diluted with water. Further, each patient was provided with 5 g of roasted peanut (Fig. 6) and made them to chew on both side of jaws for span of 20 s (Fig. 7) The chewed peanuts was expectorated in to a beaker by rinsing the mouth of subject with distilled water and the collected samples were filtered through 0.15 mm sieve initially and treated with disinfectant (chlorhexidine) in accordance with Centre for Disease Control and Prevention (Fig. 8).

Chewed peanuts were dried in a hot air oven for 1 h at 80 °C and were weighed (Fig. 9). Sieve method of masticatory efficiency evaluation was performed, using No.18, 16, 10, sieves [9].

The sieve No.18, 16, 10 with small, moderate and large diameter respectively were used to sieve the dry peanut particles. The dried samples were first sieved through the No.18 sieve, wherein the smaller particles were filtered, and then the remaining particles were sieved through No.16 sieve. The particles remaining over the No.16 sieve were then sieved through No. 10 sieve. The particles passing through each sieve were collected and weighed in the digital balance. The weight of the particle that passed through the No.18 sieve (smaller particles) and the weight of particles remaining on the No.10 sieve (larger particles) was obtained against the total weight of collected peanuts (Fig. 10).

**PROTOCOL FOR SIEVE METHOD** - If the weight percentage of smaller particles (i.e., passing through No.18 sieve) is more then the masticatory efficiency is better; if the weight percentage of larger

![Fig. 2. Digital weighing scale.](image)

![Fig. 3. Anthropometric measuring tape and stature meter.](image)

![Fig. 4. Measuring body weight using digital weighing scale.](image)
particles is more (i.e., remaining on No 10 sieve), then masticatory efficiency is poor.

The patients were considered for removable partial denture treatment. Primary impression was made, followed by border molding and secondary impression. Denture trial was done followed by insertion of the final Denture. Dentures were inserted in patients’ mouth and post operative instructions were provided.

The denture was inserted with necessary adjustments, and subjects were asked to use them daily, except in the nighttime, and report back if there is any pain or discomfort. A periodic check-up was done. No special instruction on a diet or physical exercise was given during denture insertion.

The same procedure and protocol were followed at intervals of 3 months and 6 months after prosthetic rehabilitation with a removable partial denture. The above-mentioned method to evaluate masticatory efficiency was performed with the dentures. The chewed particles sticking to the removable denture was rinsed with water into the same beaker containing the chewed particles, after which the subjects were asked to rinse their mouth. The difference in the values of masticatory efficiency and Body Mass Index obtained at baseline and after 3 and 6 months of prosthodontics, and rehabilitation was tabulated, compared, and statistically analyzed.
3. Results

3.1. Statistical analysis

Type of Study: Comparative and interventional Study.

Table 1 shows the mean BMI values of all the subjects at 3 different intervals i.e., 1st - before denture insertion, 2nd - 3 months after denture insertion, and 3rd- 6 months after denture insertion.

Statistics in the Non-obese group revealed that the average BMI was less at the 1st interval with a mean of 21.925 than in the 2nd interval with a mean of 21.94 and the 3rd interval with a mean of 21.98. This indicated improvement in BMI after prosthetic rehabilitation as showed a gradual increase in body weight at 2nd and 3rd intervals.

In the obese group, statistics the average BMI was high at 1st interval with a mean of 29.10 than 2nd interval with a mean of 28.60, and 3rd interval with a mean of 28.52. This indicated a decrease in BMI after prosthetic rehabilitation and showed a gradual decrease in body weight at the 2nd and 3rd intervals.

Table 2 shows the results of the ANOVA test for BMI values 1st interval and 2nd interval demonstrate a highly significant difference (p = 0.012) and between 1st interval and 3rd interval demonstrated a highly significant difference (p = 0.007).

No statistically significant difference between the 2nd interval and 3rd interval (p = 0.590).

Table 3 Statistics in the Non-obese group revealed that the average percentage of smaller particles was less at 1st interval with a mean of 11.50 than 2nd interval with a mean of 16.05 and 3rd interval with a mean of 16.95. This indicated an increase in the percentage of small particles after prosthetic rehabilitation, which represents an increase in masticatory efficiency.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-obese</td>
<td>21.925</td>
<td>2.02065</td>
<td>20</td>
</tr>
<tr>
<td>Obese</td>
<td>29.100</td>
<td>3.22343</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>25.5125</td>
<td>4.50015</td>
<td>40</td>
</tr>
<tr>
<td>2nd</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-obese</td>
<td>21.945</td>
<td>1.98348</td>
<td>20</td>
</tr>
<tr>
<td>Obese</td>
<td>28.605</td>
<td>3.33900</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>25.275</td>
<td>4.32682</td>
<td>40</td>
</tr>
<tr>
<td>3rd</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-obese</td>
<td>21.985</td>
<td>2.12461</td>
<td>20</td>
</tr>
<tr>
<td>Obese</td>
<td>28.525</td>
<td>3.22619</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>25.255</td>
<td>4.27047</td>
<td>40</td>
</tr>
</tbody>
</table>
Statistics in the obese group revealed that the average percentage of smaller particles was less at a mean of 13.90 than in the 2nd interval with a mean of 21.65 and the 3rd interval with a mean of 22.40. This indicated an increase in the percentage of small particles after prosthetic rehabilitation, which showed an increase in masticatory efficiency.

Table 4 shows the results of the ANOVA test for the percentage of smaller particles value at different intervals, which demonstrates a highly significant difference (p = 0.000), but no statistically significant difference between the groups at different intervals (p = 0.298).

GRAPH 1 shows no significant difference in mean values of BMI pre-rehabilitation, at 3 and 6 months post prosthodontic rehabilitation in the non-obese group.

In the Obese/overweight group, there is a significant reduction in the mean values of BMI pre-rehabilitation, at 3 and 6 months post-prosthodontic rehabilitation.

GRAPH-2 In both non-obese & obese groups there was a significant increase in the mean values of the percentage of smaller particles passing through No 18 sieve.

GRAPH-3 shows a significant decrease in the mean values of percentage of large particles between pre-rehabilitation, 3 and 6 months in both the groups, this shows an improvement in masticatory efficiency.

4. Discussion

Masticatory efficiency is defined as the effort required in achieving a standardized degree of comminution or number of strokes needed to achieve a certain particle size reduction. The sustainability of nutritional status is elicited by sensory perceptions of food during mastication. [2,10] It is a major determinant of the pleasure that drives us to eat [6]. Loss of teeth leads to impaired function of the masticatory system as masticatory efficiency is related to the number of teeth and occluding surfaces [11,13].

It is observed that prevention of tooth loss and/or prosthodontic replacement of missing teeth may be effective in improving nutrition and reducing the incidence of diet-related chronic diseases [2,7,11].

The purpose of this in vivo study was to assess the changes in masticatory efficiency and BMI of the patients before and after prosthodontic rehabilitation. It is important to assess whether rehabilitating the edentulous spaces with removable partial dentures increases masticatory efficiency and provides benefit to the patient by normalizing the nutritional status.

The result showed a significant increase in masticatory efficiency after prosthetic rehabilitation with an average of 25–38% in both non-obese and overweight/obese group. The results of this study are in concurrent with Alfonso sanchez et al. (2012), where they observed an improvement in chewing efficiency with a removable partial denture (RPD) than without RPD. [10] Size of food particles in the swallowed bolus influences the process of digestion and absorption of nutrients. Coarser particles in the bolus may lead to gastrointestinal disturbance and decreased bioavailability of nutrients, whereas small-sized particles in the food bolus help in easy absorption, they increase the surface area, which aids enzymes to act on it readily. There was an increased percentage of smaller-sized particles by 5.45% in non-obese group and 8.5 % in Overweight/obese group which indicates an increase in masticatory efficiency in both the groups after denture treatment.

BMI is known to independent of age and gender, however in this study age was correlated to BMI, because there may be age related dietary changes in the patients. Age related loss of communication capacity, loss of posterior teeth, lower occlusal force

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### Table 2. ANOVA test.

<table>
<thead>
<tr>
<th>Pair</th>
<th>Paired Differences</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Non-obese</td>
<td>11.500</td>
<td>0.79636</td>
<td>2</td>
<td>0.780 19 .012</td>
</tr>
<tr>
<td>Total</td>
<td>12.7000</td>
<td>13.4080</td>
<td>40</td>
<td>0.548 19 .590</td>
</tr>
<tr>
<td>2nd Non-obese</td>
<td>16.0500</td>
<td>8.40397</td>
<td>2</td>
<td>3.040 19 .007</td>
</tr>
<tr>
<td>Total</td>
<td>21.6500</td>
<td>14.0536</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>3rd Non-obese</td>
<td>18.3000</td>
<td>8.50858</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21.8500</td>
<td>14.0536</td>
<td>20</td>
<td>0.578 19 .007</td>
</tr>
</tbody>
</table>

* Statistically significant.
and salivary flow may alter the food consumed by the individual.

Non-obese group showed slight improvement in BMI but was not statistically significant. Educating them regarding the food habits might have showed a significant improvement, although subjects reported an increased intake of food after denture treatment.

In the obese/overweight group, there was a decrease in the BMI by 1.82% which was statistically significant. The decrease in body weight may be due to increased reported an increase intake of fruits, vegetable and hard to chew foods, these foods are rich in dietary fibre, proteins and vitamins. There was an improvement in the quality of food consumed, increased intake of nutritional food and reduced consumption of soft foods that are devoid of nutrients, and there may be an increase in metabolic rate as the size of particles decreases [12]. It is reported that individuals with higher BMI or obesity chew less and swallow larger particles size food [2]. According to Sanchez et al. (2013), poor masticatory efficiency is associated with increased body fat [1]. Many micro and macro nutrients provide protection against various types of disease but excessive consumption of some nutrients may be

GRAPH-1. Comparison of BMI values between the non-obese and obese group at baseline, after 3 months and 6 months of prosthodontics rehabilitation.

GRAPH-2. Comparison of percentage of smaller particles (passing through No 18 sieve) between the non-obese and obese group at baseline, after 3 months and 6 months of prosthodontics rehabilitation.
harmful to health [7]. Therefore replacement of lost teeth decreases the risk of developing obesity in individuals with loss of more than 4 occluding pairs.

Limitations of the study being BMI doesn’t measure the excess muscle or bone mass and is a vague indicator of adiposity.

Although there may be fluctuations in the body weight which is considered normal. According to the study there may be a correlation between Masticatory efficiency and BMI, considering age, Dietary habits, and Dental and health status. Increasing the masticatory efficiency may help in weight management in obese and overweight subjects by increasing the intake of fruits and vegetables that are rich in dietary fibers and reducing consumption of carbohydrates and a fat-rich soft diet. This may help in normalizing the BMI in obese individuals with fewer teeth.

Further studies can be carried out at different stages for specific age groups taking account of the physical activity, mental health status, socio-economic conditions.

5. Conclusion

Prosthodontic rehabilitation improves masticatory efficiency which can improve the nutritional status in some partially edentulous individuals. There may be an association between Body mass index and masticatory efficiency.

Improving masticatory efficiency by prosthodontic rehabilitation and educating patients on dental health can aid in normalizing the nutritional status and act as an adjunct treatment in the management of obesity.

Financial support

None.

Conflict of interest

Authors declare that there was no conflict of interest.

Acknowledgment

The study was supported by the Department of Prosthodontics and Crown and Bridge, JSS Dental College and Hospital, JSS Academy of Higher Education & Research, Mysuru, Karnataka, India.

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