



## Choice of Occlusal Schemes in Complete Denture Prosthesis based on Comparative Analysis of Masticatory Performance with Each Occlusal Design – *An In-Vitro Study.*

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### KEYWORDS

occlusal scheme, balanced occlusion, non-balanced occlusion, masticatory performance, chewing efficiency

### ABSTRACT:

**Background:** To compare the masticatory performance in complete denture with three different occlusal schemes and assess the masticatory performance.

**Aim:** Loss of chewing ability is the biggest challenge encountered by complete denture wearers. The aim of the study is to restore masticatory function, aesthetics, phonetics as well as preservation of alveolar ridge. According to some authors the occlusal scheme plays an important role for restoring lost functions in complete denture wearers. This study aims at searching the preferable occlusion scheme for a particular edentulous patient. The initial period of adaptation of dentures with different occlusal schemes need to be observed and evaluated.

### Materials and methods

18 patients of age group between 55 to 70 years with same eligible criteria were selected for the study. They were given three sets of complete denture of different occlusal schemes. The masticatory performance test was performed using sieving method. The obtained data was statistically analysed and conclusion was drawn.

### Conclusion

No specific occlusal scheme can fulfill all the criteria of an ideal occlusal scheme. Each scheme has both advantages and disadvantages. Masticatory performance is found out to be almost same for all the occlusal schemes. Hence the choice of occlusal scheme should be done according to the customised need for the particular patient. Preference of operator also plays an important role in this regard. An initial phase of 8 to 10 weeks is essential for adaptation of the denture so that the patient can chew efficiently and comfortably.

### 1. Introduction

The prime goal of rehabilitation of edentulous mouth with complete denture is restoring mastication, aesthetics, phonetics and psychological well-being. The digestive process starts with mastication of food. The food is crushed and ground on the occlusal table in between upper and lower teeth. The reduction of food particle size help in swallowing by forming a bolus.<sup>1</sup> Usually it is done in 10 to 40 masticatory cycles. The Masticatory efficiency is dictated by the number of masticatory cycles to make certain particle size.<sup>2</sup>

It is proved by several studies that there is notable reduction of chewing ability with the complete denture in comparison to natural teeth.<sup>3</sup> Chewing efficiency of denture wearers is less than 1/6th of a person with natural teeth. Prosthesis with artificial teeth can generate force that is 15% of the force generated with natural teeth. There are several factors which influence the masticatory efficiency of complete denture. Artificial teeth are arranged in one unit, supported by thin and sensitive mucosa over bone. The mucosa thus becomes



pinched in between two hard structures, denture base and underlying bone. Moreover the tactile sensations is lost and activity of orofacial musculature is reduced. Reduction of basal area, impaired neuromuscular coordination are inevitable for long term edentulous condition. All these factors are responsible for reduction of masticatory efficiency with complete denture.

Apart from the psychological factor, there are some mechanical factors that influence the masticatory performance in different individuals. These factors should thoroughly be studied so that we can improve the chewing efficiency by controlling some of the factors. From the mechanical point of view, the most controversial factors is the type of posterior occlusal form and occlusal arrangement of the artificial teeth. For many years, prosthodontics have been intrigued by the relation of occlusion and posterior toothform, both natural and artificial with the masticatory load and efficiency. In 1909, the twentieth century anatomical bicuspid and molar was introduced which was developed from Gysi's study on mandibular movement and occlusion.<sup>6</sup> In 1922, Sears described an early version of activity but in 1929, Hall introduced zero-degree teeth.<sup>7,8</sup> Previously, prosthodontists were busy to create complex adjustable articulators and techniques to produce high-quality dentures. But maximum dental surgeons find it challenging to provide time and effort required for the complicated process. Introduction of zero-degree teeth and mechanical analysis of occlusion by Devan along with introduction of adjustable articulator made this challenge easy. Complicated jaw relation records were no longer considered necessary by majority of the prosthodontists.<sup>9,10</sup> The type of posterior occlusal form and the occlusal arrangements are two factors that have caused controversy for many years. In this study we attempt to evaluate the efficiency of mastication with different occlusal schemes frequently used in fabrication of complete denture.

## 2. Materials and methods

18 patients of age group between 55 years and 70 years took part in the study. They were divided into two groups – Group 1 for new complete denture wearers (Total 10 patients) and group 2 for old complete denture wearers (Total 8 patients).

Excluding criterias were

1. Very old patient (over 75 years)
2. Poor neuromuscular coordination
3. Almost flat ridge (Atwood's classification IV and V)

The study was carried out at North Bengal Dental College and Hospital, West Bengal in the year 2023. All the patients were informed about the investigation procedure and written consent form were signed. Institutional permission was also granted. Each patient was given three set of complete denture with three different occlusal schemes (anatomic balanced, atomic non-balanced, and nonanatomic non-balanced occlusion). Duplicate dentures with different occlusal schemes were used. Masticatory efficiency was evaluated after 2 weeks, 6 weeks, 10 weeks, 14 weeks, 18 weeks after delivery of the dentures. There are various recognised methods of investigating masticatory efficiency like electromyography and masticatory performance, sieving method and masticatory performance, biopak system and masticatory performance, hand-held occlusal force meter and masticatory performance, dental prescale system and masticatory performance.<sup>11</sup>

In this study we used sieving method which was developed by Manley et al and modified by Kapur at.<sup>12,13</sup> Sieving method is a commonly used procedure to assess masticatory function based on the size distribution of the test food while peanuts have been depicted as the most reliable test food and was selected as test food for this study. It is relatively hard, natural, available and swallowable. Previous documentation of use of peanut as test food for masticatory efficiency is noted in the article by Susil Kar.<sup>12</sup> (Fig 1)



Fig 1: Peanut was selected as test food for this study



Each individual was given 3 g of peanut, to be chewed by 20 chewing strokes each time. This is performed 3 times by wearing three types of complete denture for each individual. After chewing the peanut in 20 cycles, the patient was instructed to spit the chewed material thoroughly into a large beaker by rinsing mouth with water. (Fig: 2) Now the collected material in the beaker were poured over a specifically standardised mesh sieve (Fig: 3) . The collected filtrate and residues were poured into a graduated test tube of 15 cc (Fig:2) and centrifuged in a centrifugal machine at 1500RPM for three minutes (Fig: 4). Now the sediments in each test tube (both filtrate and residue) were recorded.



Fig 2: Beaker and Test Tubes for the purpose of measuring.

This procedure was performed at a four weeks interval. The dentures were delivered at first and adjustment was done after 48 hours and the patients were adapt with the new denture for two weeks. From the second week, we started evaluating the masticatory performance. The reading thus obtained was evaluated and used for statistical analysis.



Fig: 3 Specifically standardised mesh sieve



Fig:4 centrifugal machine

### 3. Statistical analysis

Percentage of chewing ability is calculated by

Annotation	p value
ns	Non significant
*	< 0.05
**	< 0.01
***	< 0.001

Formula ,Table & Graph

**Table 1:** Significance of statistics

Treat ment group	Den ture wear ers	2 Week s	6 Week s	10 Week s	14 Wee ks	18 Week s
ABO	Ne w	1.61 ± 0.23	1.85 ± 0.18	2.11 ± 0.20	2.16 ± 0.18	2.20 ± 0.16
	Old	1.68 ± 0.28	2.00 ± 0.28	2.08 ± 0.26	2.12 ± 0.24	2.16 ± 0.19
ANB O	Ne w	1.54 ± 0.24	1.79 ± 0.20	1.97 ± 0.21	2.06 ± 0.20	2.12 ± 0.20
	Old	1.64 ± 0.25	1.92 ± 0.32	2.05 ± 0.27	2.15 ± 0.25	2.30 ± 0.20



NAN BO	Ne w	1.58 ± 0.23	1.85 ± 0.22	2.07 ± 0.24	2.23 ± 0.19	2.32 ± 0.19
	Old	1.67 ± 0.26	1.97 ± 0.27	2.08 ± 0.25	2.15 ± 0.23	2.22 ± 0.17

**Table 2:** Descriptive statistics of results: Mean residual weight for anatomic balanced, mean residual weight for anatomic non-balanced Mean residual weight for non-anatomy non-balanced, mean seived weights for anatomic balanced, mean seived weight for anatomic non- balanced, mean seived weight for non anatomic non-balanced were noted and descriptive statistics were obtained.

New denture wearers

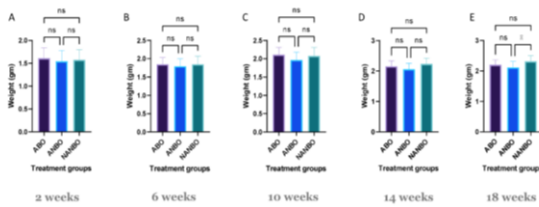


Figure 1: Comparison among different treatment groups of the new denture wearers at different time points. A-D: No significant difference was observed among the groups. E: Only a significant difference was observed between ANBO and NANBO groups ( $p < 0.05$ ). All data are presented as Mean  $\pm$  S.D.

Old denture wearers

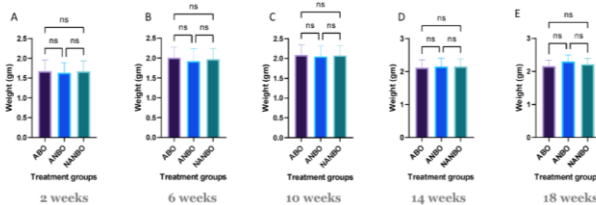
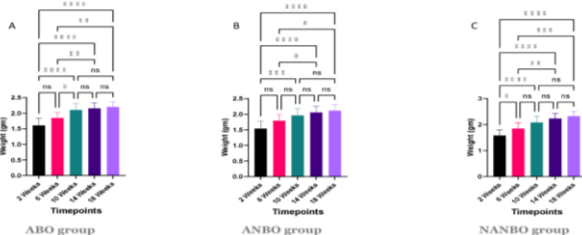


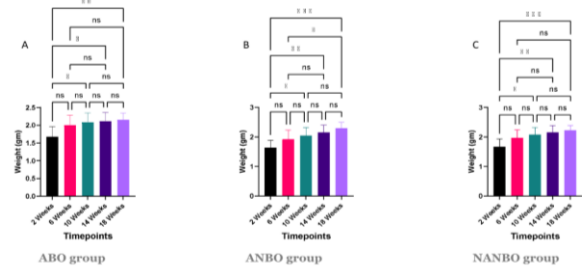
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New denture wearers



**Figure 3:** Comparison among different time points of the new denture wearers of different treatment groups.

Old denture wearers



**Figure 4:** Comparison among different time points of the old denture wearers of different treatment groups.

ABO group

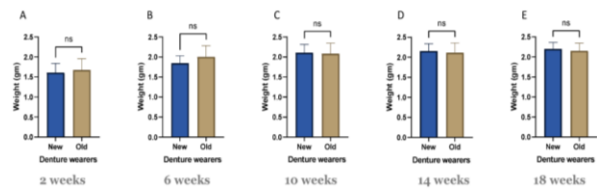


Figure 5: Comparison between masticatory efficiency of different denture wearers of the ABO group at different time points. Fig 5A-E: No significant difference was observed among the groups. All data are presented as Mean  $\pm$  S.D.

ANBO group

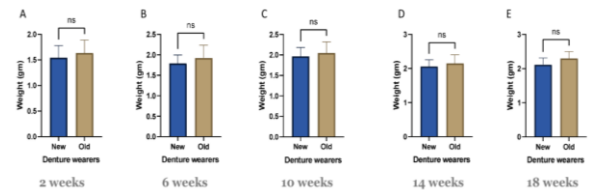


Figure 6: Comparison between masticatory efficiency of different denture wearers of the ANBO group at different time points. Fig 6A-E: No significant difference was observed among the groups. All data are presented as Mean  $\pm$  S.D.

NANBO group

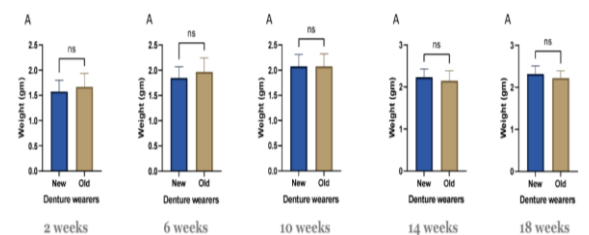


Figure 7: Comparison between masticatory efficiency of different denture wearers of the NANBO group at different time points. Fig 7A-E: No significant difference was observed among the groups. All data are presented as Mean  $\pm$  S.D.



#### 4. Results

1. In case of new denture wearers, comparison among different treatment groups of the new denture wearers at different time points shows no significant difference was observed among the groups till 14 weeks. Only a significant difference was observed between **ANBO and NANBO groups** ( $p < 0.05$ ). (Fig:1)
2. In case of old denture wearers, comparison among different treatment groups of the old denture wearers at different time points shows no significant difference among the three groups. (Fig 2).
3. In new denture wearers, the **ABO group** at 2 weeks, the **weight of the residual peanut** is lower than 10 weeks, 14 weeks, and 18 weeks dentures ( $p < 0.0001$ )(Fig 3a), In the **ANBO group** at 2 weeks, the **weight of the residual peanut** is lower than 14 weeks, and 18 weeks dentures ( $p < 0.05$ )(Fig 3b), In the **NANBO group** at 2 weeks, the **weight of the residual peanut** is lower than 6 weeks ( $p < 0.05$ ), 10 weeks, 14 weeks, and 18 weeks dentures ( $p < 0.0001$ ) (Fig 3c).
4. In old denture wearers, the **ABO group** at 2 weeks, the **weight of residual peanut** is lower than 10 weeks, 14 weeks ( $p < 0.01$ ), and 18 weeks dentures ( $p < 0.001$ )(Fig 4a), In the **ANBO group** at 2 weeks, the **weight of the residual peanut** is lower than 14 weeks, and 18 weeks dentures ( $p < 0.05$ )(Fig 4b), In the **NANBO group** at 2 weeks, the **weight of the residual peanut** is lower than 6 weeks ( $p < 0.05$ ), 10 weeks, 14 weeks, and 18 weeks dentures ( $p < 0.0001$ )(Fig 4c).
5. Comparison between masticatory efficiency of new and old denture wearers of the **ABO group** at different time point shows no significant difference among the two groups. (Fig 5)
6. Comparison between masticatory efficiency of new and old denture wearers of the **ANBO group** at different time point shows no significant difference among the two groups.(Fig 6)
7. Comparison between masticatory efficiency of new and old denture wearers of the **NANBO group** at different time point shows no significant difference among the two groups.(Fig 7)

- Masticatory Efficiency is same for anatomic balanced (Anatomic balanced) and non-balanced teeth (Anatomic non balanced teeth) but initial acceptance is better for balanced occlusion.
- A significant difference was observed between **ANBO (Anatomic non-balanced) and NANBO groups (Non Anatomic Non-balanced balanced)** ( $p < 0.05$ ) and but initial acceptance is poor.
- Chewing efficiencies reach peak level after 2 and 1/2 months (10 weeks) in all the three occlusal schemes.
- Experienced patients (Old denture wearers) reached the peak level faster than non experienced patients (New denture wearers).

#### 5. Discussion

The main goal of this research was to evaluate the masticatory efficiency of complete denture wearers with commonly used occlusal scheme. Masticatory performance measurement provides essential information that enables the assessment of health and function of the masticatory system.<sup>11</sup> Thompson was the pioneer in studying the chewing efficiency of anatomic and non-anatomic tooth form.<sup>12</sup> He found high cusp teeth to be more efficient, but subsequently investigators reported conflicting results.<sup>14</sup> Trapozzano concluded that the sharpness of the occluding surface but not necessarily sharpness of the cusps of the posterior teeth can improve the chewing efficiency.<sup>12</sup> Advocates of the non-anatomic form have claimed that the absence of cusp minimizes lateral stress and thereby preserves the supporting bone but Payne showed that more lateral movements was generated in chewing with flat teeth.<sup>15,16</sup> The study of Brewer and co-workers showed that patients could not differentiate between duplicate dentures with different occlusal forms and Bascom found that the degree of soreness does not vary significantly from with any occlusal form.<sup>17,18</sup>

In 50 years of controversy surrounding the superiority of tooth form and occlusal scheme, no evidence was found that one form is particularly more efficient, comfortable and adaptable to tissue changes than the other. No occlusal forms are imperfect but prognostic result can be



obtained based on the neuro-muscular co-ordination and adaptive capability.<sup>19</sup> Simplicity in technique and instrumentation certainly provide large advantage to the use of non-anatomic tooth form. It is an accepted fact that non-anatomic teeth are suitable for crossbite and abnormal jaw relation due to less generation of lateral movement. Generally, anatomic teeth are more acceptable in esthetic zone and phonetics. There is also a lesser obstacle in the anterior teeth region due to no generation of lateral forces. From the study it is evident that old denture wearers adapt better in the initial phase than the new denture wearers as they are already experienced in controlling the mandibular movement with denture. Perceived chewing ability has been considered to provide valuable information, though subjective methods in general are relatively simple to implement.<sup>20</sup> The subjective assessment of masticatory ability has been reported to be conclusive compared to the masticatory performance reported via objective methods.<sup>21,22</sup>

The initial masticatory efficiency of experienced denture wearers are more than the new denture wearers. Neuromuscular control of the oro-facial musculature plays an important role in such situation, though after a sustained period of wearing the dental prosthesis (about 10 weeks), the masticatory performance becomes almost same for both the old and new denture wearers. Results of this study shows that the peak level of chewing efficiency is attained after initial adaptation with the denture. In this phase the patient can realise the limitation of conventional complete denture and uses it accordingly. Moreover the surrounding tissues also get trained spontaneously for proper controlling of the denture. Thus after adaptation phase, the patient can chew food confidently and efficiently.

## Conclusion

From this study we have come to the conclusion:

1. Type of occlusal scheme is not a major factor for masticatory efficiency.
2. Chewing ability increases gradually to reach the highest level after initial adaptation with the denture (average 10 weeks). Neuromuscular control of the oro-facial musculature plays an important role here.

3. Old denture wearers reach the peak level faster than the new denture wearers due to previous experience of oral rehabilitation.
4. Occlusal scheme should be chosen according to the patients need and the operator's choice. If simplicity of technique is of prime importance, the non-anatomic form with monoplane occlusion should be chosen. Especially it is used in patients with class II and class III jaw relation, un-coordinated jaw movement and resorbed ridge.
5. If the patient is concerned about esthetics, the tooth form and arrangement may be customised when indicated for providing best interest to the patient.

## Limitation of the study

In this study only the commonly used occlusal schemes are selected. Lingualised occlusion and balanced non-anatomic occlusion are not considered here. Moreover the sample size is small. So extensive study is needed for proper conclusion.

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