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ORIGINAL ARTICLE

A comparative Study of the Masticatory Efficiency in Complete Dentures Using Acrylic and Metal Occlusal Posterior Teeth—Photocolorimetric Analysis

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Abstract Masticatory efficiency is always compromised in complete denture patients. The denture teeth with compromised occlusal anatomy and material further compound the inherent limitations of complete dentures. To compare the masticatory efficiency of patients with complete denture using acrylic and metal occlusal posterior teeth. Ten edentulous patients with well-formed ridges were selected. Complete dentures using acrylic and metal occlusal posterior teeth were fabricated. The masticatory efficiency was calculated using photo colorimeter. Complete dentures with 20° acrylic resin posterior teeth were fabricated for ten edentulous patients and masticatory efficiency was measured using raw beetroot as test food on a photocolorimeter after 10, 15, 20 strokes. The acrylic resin posterior teeth were replaced with metal occlusal posterior teeth on the same denture base. The masticatory efficiency was measured by the same method. The mean average percentage of masticatory efficiency with acrylic resin teeth and metal occlusal teeth were first calculated and statistical analysis was done using students unpaired t test. The average masticatory efficiency with acrylic teeth was 46.46% and metal occlusal teeth was 65.62, 't' = 5.38. The difference between the mean average masticatory performance percentage with acrylic teeth and metal occlusal teeth was significant at 1% i.e. $P < 0.01$. Within the limitation of this study the average percentage value of masticatory efficiency improves considerably when metal occlusal teeth replace normal acrylic teeth without any alteration in position or relation.

Keywords Masticatory efficiency · Photocolorimeter · Complete denture

Introduction

Today, material and technological progress in dentistry has helped us to rehabilitate the dentally crippled patients more satisfactorily.

In the prosthetic rehabilitation of edentulous patients, achieving acceptable masticatory function is one of the salient objectives as it is the basis for proper digestion and absorption of nutrients. The denture teeth with compromised occlusal anatomy and material can compound the inherent limitations of complete dentures.

The complete denture with only esthetic norms fulfilled, is only a partial attempt at restoration without fulfilling functional requirements. Teeth material, cuspal angulations play an important role in achieving optimum masticatory efficiency. Several studies evaluating this aspect using different cuspal inclines [1–6] and material of teeth [7–11] have been carried out in past.

The purpose of this study was to compare and evaluate the masticatory efficiency of 20° acrylic teeth and 20° metal occlusal posterior teeth. A photo colorimetric analysis using raw beetroot as test food was carried out to evaluate the masticatory efficiency of the two types of teeth.

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Methodology

This study was carried out with ten edentulous subjects in age group of 45–70 years with well-formed ridges and sufficient interocclusal distance.

Fabrication of Conventional Complete Denture

Conventional complete denture were fabricated for all 10 patients in heat cured Polymethyl-methacrylate (Heat Cure-DPI) (Fig. 1) using 20° semi-anatomic cross-linked acrylic resin teeth (Ivoclar) (Fig. 2).

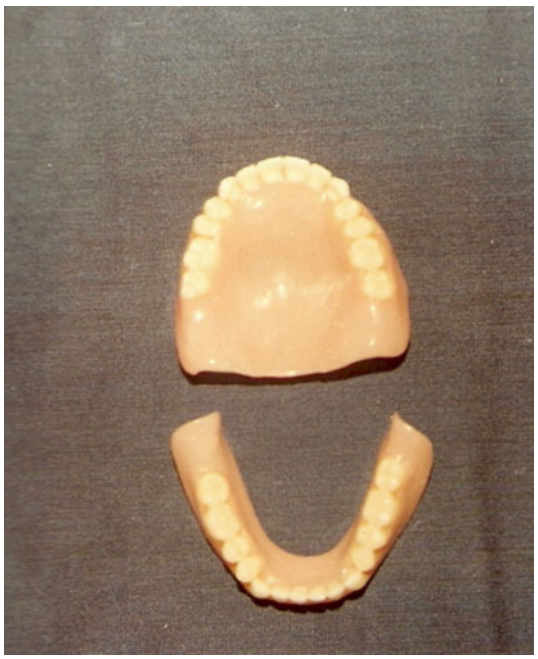

Fig. 1 Complete dentures with 20° semianatomic acrylic teeth

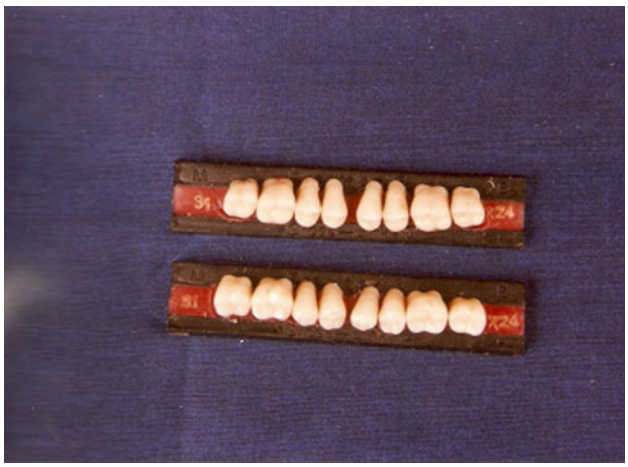

Fig. 2 20° semi anatomic acrylic posterior teeth

After placement of the dentures, for first 24 h patient was instructed to wear dentures throughout the day except during meals to get adjusted. Next 2–7 days the subject was asked to chew with dentures. 7 days following the denture insertion, test for masticatory efficiency was carried out.

Masticatory Efficiency Test

The masticatory efficiency test for acrylic resin teeth was done by Photo colorimetric method as suggested by Kayser and Hoeven [12].

The test food used in this study was raw beetroot. The method measures the naturally occurring dye present in raw beetroot. This dye is released when vegetable is chewed and can be determined spectrophotometrically at 530 nm (Fig. 3).

The increase in surface area of a food bolus following the chewing process can be measured using a test food containing a dye.

To get standardized maximum Extinct i.e. E^{max}, a randomly selected sample of raw beet root weighing 3 g was ground in grinder for 90 s This sample was diluted by adding 10 ml of distilled water and filtered. The filtrate was studied under photo colorimeter and this was considered to be E^{max} or 100%. All the chewed samples were compared to E^{max}. To standardize the conditions, value of E^{max} for beetroot used in the study was determined separately for each patient.

The subject was instructed to chew a piece of raw beetroot weighing approximately 3 g for 10, 15 & 20 strokes respectively. After chewing, all the particles and saliva produced during the process was expectorated in a graduated cylinder.

The samples were transferred into the test tubes to these samples 10 ml of distilled water was added. These samples were then vortexed on vortexmeter (Cyclometer) for 2 min.

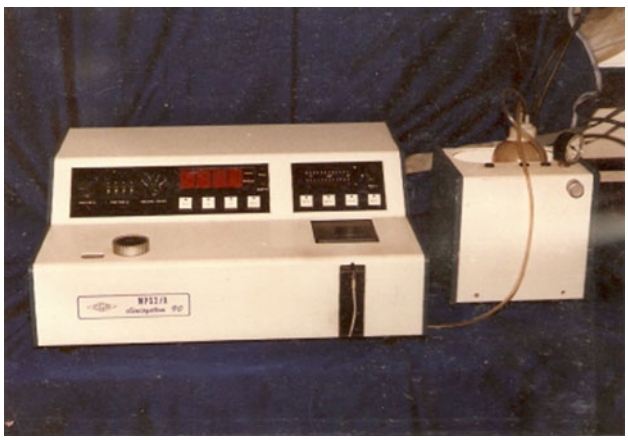

Fig. 3 Photocolorimeter (MPS2/A Clinisystem)

The vortexed solutions were filtered with Whatmann filter paper. The control for photo colorimeter method was obtained by using test tube with distilled water and viewed under photo colorimeter at 530 nm.). The reading recorded with distilled water was taken as 100%. After the photo colorimeter reading for distilled water is recorded, these filtrates were viewed on photo colorimeter at 530 nm. From the readings obtained percentage value was recorded from the chart available.

Fabrication of Metal Occlusal Teeth

For fabrication of metal occlusal teeth, two layers of wax were used to cover the occlusal and incisal surface of the denture with acrylic resin teeth. Then it was embedded in plaster. After the plaster was set wax was removed and impression of occlusal surface of teeth and their arch form was obtained in putty silicone (Silaplast, Detex Company) impression material, which was placed in the space previously occupied by the wax spacer. Light body impression material was used to get the details of posterior teeth (Fig. 4). Blue inlay wax (Biowax) was poured on occlusal surface of the impression up to 1 mm thickness. The pattern of, each quadrant was sprued and cast in Nickel–Chromium alloy with a provision made in the form of loop for attachment of metal to the resin. The casting was finished and polished [13] (Fig. 5).

Replacing the Acrylic Teeth with Metal Occlusal Teeth

The dentures with 20° acrylic teeth were mounted in centric occlusion on an articulator with a facility of reorientation rings. The lower ring was detached and with the incisal pin in position the upper jig (plaster and impression combination) was mounted on the lower part of the articulator so that the upper teeth aligned properly in the occlusal jig and the pin is in the position. (Fig. 6).

Fig. 4 Plaster jig with elastomeric impression material

Fig. 5 Metal occlusal posterior teeth

Now the posterior teeth from upper denture were ground off. Metal occlusals fabricated were then positioned in the plaster jig (plaster and impression combination) and attached to upper denture base with self-cure resin**.** [13] (Fig. 7).

The same procedure was repeated for replacing the acrylic posterior teeth with metal occlusal posterior teeth in the lower denture. After finishing, the upper and lower denture were mounted back on the articulator and checked for any occlusal discrepancy. One week following the use of denture with metal occlusal posteriors, masticatory efficiency test was performed in the same manner as acrylic resin teeth.

Observation and Results

Results of the investigation carried out in this study have been based on the colour intensity of the dye released from

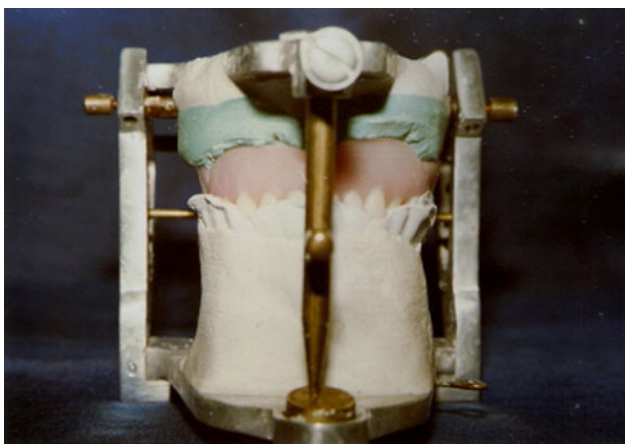

Fig. 6 Plaster jig for replacing acrylic teeth with metal occlusal teeth

Fig. 7 Complete dentures with metal occlusal posterior teeth

the sample of raw beetroot when the vegetable is chewed. This colour intensity was studied on the photocolorimeter for optical colour intensity.

Three readings were taken for 10, 15 and 20 strokes with acrylic and metal occlusal teeth respectively The average of the three strokes was taken as mean reading (Tables 1, 2). Average masticatory efficiency percentage was calculated by dividing the mean masticatory efficiency value of each patient with E^{max} or standard maximum extinct of dye that can be released from the beetroot.

A hypothesis of null (HO) was assumed that there is no significant difference between the masticatory efficiency with acrylic and metal occlusal posterior teeth.

Tabulated value of 't' at 99% level of significance, $t_{0.01}$ for N1 + N2 − 2 degree of freedom was recorded from the statistical table of 't'. If the calculated value of 't' is the greater than the tabulated $t_{0.01}$ the difference between the two mean efficiency is set to be significant at 1% level of significance, otherwise the data is set to be consistent with the null hypothesis (Table 3).

Table 1 The percentage of the masticatory efficiency of complete denture with 20° acrylic teeth

S. No	E^{max}.Std	10 Strokes	15 Strokes	20 Strokes	Average	Percentage
1	1.523	0.377	0.41	0.611	0.466	30.59
2	1.187	0.0757	0.444	0.842	0.448	37.73
3	1.602	0.53	0.937	1.097	0.854	53.34
4	0.502	0.1675	0.2328	0.31	0.236	47.16
5	1.097	0.2183	0.611	0.921	0.583	53.18
6	0.502	0.252	0.257	0.309	0.272	54.31
7	1	0.42	0.56	0.612	0.5306	53.06
8	1.202	0.1253	0.523	0.915	0.521	43.34
9	1.028	0.35	0.453	0.752	0.5138	50.42
10	1.52	0.456	0.565	0.825	0.615	41.48
						464.61

Mean average percentage of masticatory efficiency with acrylic teeth = 464.61/10 i.e. 46.46%

Table 2 The percentage of masticatory efficiency of complete denture with 20° metal occlusal teeth

S. No	E^{max}.Std	10 Strokes	15 Strokes	20 Strokes	Average	Percentage
1	1.187	0.733	0.872	0.925	0.843	71.04
2	0.502	0.1192	0.319	0.352	0.2634	52.47
3	0.952	0.625	0.753	0.797	0.725	76.15
4	1.296	0.675	0.796	0.975	0.815	62.91
5	1.195	0.622	0.785	0.988	0.815	67.5
6	0.856	0.467	0.645	0.776	0.629	73.52
7	0.85	0.575	0.895	0.978	0.816	70.95
8	1.18	0.345	0.753	0.95	0.682	57.85
9	1.356	0.635	0.824	0.912	0.79	58.28
10	1.252	0.685	0.782	0.996	0.821	65.57
						656.24

Discussion

This study was carried out to compare the masticatory efficiency in complete denture patients with 20° semi anatomic acrylic teeth and 20° semi anatomic metal occlusal teeth.

Innumerable methods are described for fabrication of metal occlusal teeth since 1942. JohnVincent [14] introduced metal inserts in resin posterior, he used gold solder wires, which were later replaced by stainless steel. Hardy [15], Wallace [16], Rita Brandberg [11] used metal occlusals of various designs to improve the masticatory efficiency. Difficulty in the availability of indigenously made metal occlusal posterior teeth is the main reason that prompted us for the fabrication of metal occlusal posterior teeth for this study. Studies in the past have shown that the average cuspal incline of 20° is more effective and acceptable for complete denture patients; hence it was decided to use 20° teeth in the study [3, 4, 8].

Brandberg and Horst [11] in 1986 used duplicate dentures with metal occlusal teeth for comparison of masticatory efficiency. In this study the metal occlusals were replaced on the same denture base so as to standardize the factors of retention and stability of the denture base, which may influence the efficiency in mastication. Care was taken to standardize the method and minimize any error. All factors being constant, difference in the masticatory efficiency was therefore the result of difference in material used for posterior teeth in the denture.

Photocolorimetric method was used in this study to evaluate the masticatory efficiency as proposed by Kayser

Table 3 Statistical data Test of significance: students unpaired 't' test

S. No	Parameter	Value
1	Average percentage value of masticatory efficiency with acrylic teeth	46.46%
2	Average percentage value of masticatroy efficiency with metal occlusal teeth	65.62%
3	Standard deviation for acrylic teeth (S.D.1)	8.127
4	Standard deviation for metal occlusal teeth (SD2)	7.812
5	't'	5.38
6	Significance level	1%
7	Degree of freedom	18
8	Inference	$P < 0.01$ (significant)

and Hoeven [12] in 1977. This method is based on the principle that increase in surface area of food bolus following the chewing process can be measured using test food which contains natural dye (e.g. carrot, Beet root). This dye can be determined spectrophotometrically at 530 nm. This technique gained precedence over the other available methods as it required minimum material and instrumentation, moreover the technique was simple and less time consuming, as compared to the fractional sieve. There are no synthetic additives or chemical reagents used in determining colour intensity. It depends on the natural dye present in the test food for colorimetric analysis.

Hence the method is more adaptable and can be done in any laboratory and the results were found to be consistent.

Though several tests on masticatory efficiency have used carrot as test food material [12, 17–20], but a pilot study conducted in consultation with Department of Biochemistry to compare the intensity of colour produced by raw carrot and raw beetroot showed consistent colour intensity with beetroots

Beetroots show an individual variation in dye concentration; therefore for every patient a randomly selected sample of beetroot was pulverized in a grinder for 90 s. The dye released, was studied at 530 nm. The result obtained was considered as E^{max} or maximum extinct of dye from the beetroot. All the samples chewed by the patients in the study were compared to this E^{max} reading in terms of relative percentage.

The result of this study shows that average masticatory efficiency with acrylic teeth is 46.46% whereas efficiency with metal occlusal teeth is 65.62. The student 't' for unpaired sample was calculated as 't' = 5.38. Therefore statistical analysis shows that the difference between the mean average masticatory performance percentage with acrylic teeth and that with metal occlusal teeth was significant at 1% i.e. P less than 0.01.

The better masticatory efficiency of metal occlusal teeth may be due to better crushing power of metal occlusal teeth over the normal acrylic teeth. The other advantage of using metal occlusal teeth is its wear resistance. Studies in the past have shown loss of chewing efficiency of 339 using acrylic teeth [7].

Conclusion

This study gives an indication that metal occlusal teeth can be used judiciously in patients with good foundation to increase the masticatory efficiency. But before these teeth can be used routinely in clinical practice, there is a need for careful evaluation on the effect of forces exerted by metal occlusal teeth on underlying foundation. Longitudinal studies can bring to light the resorption pattern of alveolar bone, which would give us an understanding about the use and limitations of such metal occlusal tooth forms. Function and preservation of the underlying tissues are two inseparable parts of oral health care.

Conflict of interest None.

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