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ABSTRACT:

INTRODUCTION : Denture cleaning helps in maintaining oral hygiene and prevents cross contamination. Cleaning of dentures can be done by mechanical, chemical or combination of both methods. Brushing of denture with dentifrices will help in plaque removal however; additive abrasives may lead to surface roughness. Thus, selection of abrasive plays a vital role on acrylic denture. Thorough literature search showed no study comparing abrasiveness of commercially available denture paste (Stim Clanden) and calcium carbonate containing toothpaste (Emoform R) on PMMA.

MATERIALS AND METHOD : Heat polymerised acrylic resin (n=12) including three groups: Brushing with plain water (T1), Brushing with denture cleaning paste (T2) and Brushing with desensitizing agent (T3). Brushing was performed using electronic toothbrush with soft bristles for 300 minutes, representing 6 months of brushing. Weight was measured initially and after the trial period. Surface roughness was measured using profilometer pre and post brushing.

RESULTS : The observations were analysed using Anova and Post hoc tukey tests. Statistically significant differences (<0.05) were obtained for surface roughness and weight loss amongst three groups.

CONCLUSION : Emoform-R (calcium carbonate containing paste) showed less weight loss and surface roughness of PMMA when compared to Stim clanden(denture cleaning paste).

KEYWORDS: Denture cleaning paste, Calcium carbonate-containing paste, Surface roughness, Weight loss, Heat-polymerized PMMA resin

INTRODUCTION

Cleaning dentures is crucial for preserving both the prosthesis and oral health¹, therefore it's necessary to select a cleanser that is both effective and doesn't negatively impact the characteristics of the denture base resin over time.

There are two forms of denture cleaners: pastes and immersion types. Toothpaste and denture cleaning paste share many of the same ingredients. There are many different potential impacts on the denture surface due to the intricate makeup of cleaning pastes, which includes abrasives, humectants, detergents, and flavouring. The primary determinants of abrasiveness are particle size, particle hardness, and the rate and force at which the particles move over the substrate.

Users of dentures must practise good denture hygiene, in part because doing so encourages the

clearance of biofilm, helps control oral illnesses, lengthens the lifespan of the prosthesis, and promotes patient wellness. Using a toothbrush, dentifrice, and water to mechanically remove debris is a common method for cleaning dentures². This method has the benefit of being easy, affordable, and efficient at getting rid of organic deposits and stains³. A disadvantage of using acrylic resin incorrectly is that it may be difficult to use, especially for patients with motor coordination issues^{4,5}.

Humectants, detergents, flavours, thickeners, colours, and an abrasive agent are the main ingredients of dentifrices for dentures. In the formulation, surfactants and suitable antimicrobials can also be utilised⁶. Potential ingredients for these formulations include fluorosurfactants, which lower surface tension

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Lalan Et. At. Comparative Evaluation Of Effect Of A Denture Cleaning Paste And Calcium Carbonate Containing Paste On Surface Roughness And Weight Loss On Heat Polymerised Pmma Resin: An In Vitro Study

comparable to conventional surfactants but offer better wetting, foaming, emulsifying, and detergency⁷.

These intricate parts have a wide range of potential effects that might be seen on the denture surface. For instance, abrasion can improve biofilm retention⁸. The degree of surface abrasion brought on by brushing your teeth is influenced by the dentifrice you use, the stiffness of your toothbrush bristles, how you brush your teeth, how often you brush, and how hard the base material is for your dentures⁸. The degree of abrasion is significant and affected by a variety of abrasive qualities, including chemical composition, crystalline structure, friability, solubility, concentration, hardness, size and shape of the particles, and compatibility with other dentifrice ingredients⁹⁻¹⁰.

| MATERIAL MOHS | HARDNESS NUMBER |
|----------------------|------------------------|
| Enamel | 3.0 |
| Dentin | 2.0-2.5 |
| Hydrated silica | 2.5-5.0 |
| Calcium carbonate | 3.0 |

Table 1: Mohs Hardness Number

Mohs hardness of enamel, dentine and common abrasives used in dentifrices.

Mohs hardness number closer to dentin signifies that the abrasiveness of that following agent is less than that of the one with higher value which signifies the higher abrasivity (Table 1).

Hydrated Silica has a density of 2.65 g/cm³ and a molecular weight (Mw) of 60.08 g/mol. is a substance that is included in many toothpastes that are easily accessible on the market as an abrasive or thickening ingredient. Hydrated Silica is an ingredient in the widely accessible denture

cleaning paste (Clanden). Compared to the silica found in conventional toothpastes, hydrated silica is thought to be less abrasive¹¹.

CaCO₃, which has a melting point of 1,517°F (825°C) and a specific gravity of 2.71 g/cm³, is a popular abrasive that is added to toothpaste to assist remove external stains that have been deposited on tooth surfaces. Calcium carbonate can deposit in the dentinal tubules, obstruct them, and minimise dentine hypersensitivity in addition to its abrasive impact. Emoform-R is thus a widely accessible calcium carbonate paste that is reasonably priced. Along with sodium chloride, which has a comparable mohs hardness rating (2.5)¹² to calcium carbonate, Emoform-R also contains sorbitol and humectant, both of which are found in normal toothpastes.

The research proposal states that calcium-containing paste will reduce the weight loss and surface abrasion of heat-polymerized PMMA resin.

The null hypothesis states that, after brushing with pastes containing calcium carbonate and denture cleaning agents for six months, there would be no difference in the surface roughness and weight loss of heat-polymerized PMMA resin.

The purpose of the current study was to compare and contrast the efficiency of denture cleaning pastes containing calcium carbonate and hydrated silica on surface roughness and weight loss on heat-polymerized PMMA resin over a simulated six-month period of use.

MATERIALS AND METHODOLOGY

An in vitro study was conducted after obtaining approval from the institutional ethical committee with approval number of Sumandeep ethical committee (SVIEC/ON/DENT/SRP/22069)

Sample description : Based upon the results of study by **Pisani et al**¹³ with 5% alpha error, 80% power of the study and a clinically significant difference of 2 units, the required sample in each group is 12.

SPECIMEN PREPARATION:

With denture base acrylic resin (Trevelon) and circular wax patterns measuring 20 mm in diameter and 3 mm in thickness (in accordance with ADA Specification No. 12), 12 samples per group (Fig 1) will be produced for surface roughness and weight loss¹⁴. According to manufacturer recommendations, heat cure resin shall be blended and packaged in stainless steel moulds.

CURING:

The heat-polymerized samples will be processed for 9 hours at 74 oC (long curing cycle) in a heat-curing unit before being bench-cooled for 1 hour and deflasking. After deflasking, the specimens will be polished with decreasingly abrasive sandpaper and stones for abrading acrylic resin. For polishing in a bench lathe, pumice slurry, white, black and felt-tip brushes will be utilised. All specimens will be kept in distilled water at 37°C for 24 hours after final polishing with a flannel wheel and polishing paste in order to remove any remaining monomers¹⁵.

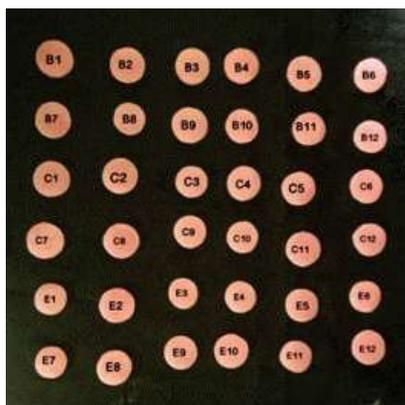


Figure 1: Heat polymerised PMMA samples

BRUSHING TEST:

To perform the brushing test in line with ISO/DTS 145692 standards for wear testing¹⁶, a teeth brushing machine will be used. Three specimens could be brushed at once using the equipment at a 356 rpm speed. The load of brushing teeth was standardised at 200 g, and the distance travelled by the brush is equivalent to 3.8 cm.

At Praj Laboratory, the mechanical tooth brushing must be done according to established standards.

When making paste suspensions for brushing, 60 g of paste and 60 ml of distilled water were combined in a 1:1 ratio (mixing until the suspension was homogeneous). The control group received brushing and distilled water at 23°C.

After the samples have been submerged in distilled water and a consistent mass has been obtained, baseline values will be recorded. The brushing test (Fig 2) was performed on the samples in each group for 300 minutes (106.8 cycles)¹⁷, which is equal to six months of a healthy patient's typical brushing behaviour. The specimens in each group must be taken out of the suspension after 300 minutes of brushing, rinsed, dried with a paper towel, and weighed.



Figure 2

SURFACE ROUGHNESS EVALUATION:

In order to assess surface roughness of PMMA without endangering the surfaces, PROFILOMETER will be used. Three lines with a

1 mm distance will be recorded as the analyzer's stylus is moved across the specimen's surface (Fig 3). Three lines' mean roughness (Ra) will be calculated. It is necessary to compute the average difference between the specimens' initial and final surface roughness after 300 minutes of brushing, which replicates six months of use.



Figure 3: Surface roughness evaluation using profilometer

WEIGHT LOSS EVALUATION

The weight of all samples in each of the group shall be weighed pre and post brushing in a calibrated weighing machine and evaluated for the weight loss (Figure 4)



Figure 4: Evaluation of weight of each sample

RESULTS

The following results were obtained for the weight loss and surface roughness that changed after brushing with three agents, namely, distilled water (T1), denture cleansing paste (T2) and carbonate consisting paste (T3) (Table 2,4)

| | Distilled water | Denture cleansing paste | Calcium consisting paste |
|----------------|-----------------|-------------------------|--------------------------|
| N | 12 | 12 | 12 |
| ΣX | 0.056 | 0.089 | 0.061 |
| Mean | 0.0047 | 0.0074 | 0.0051 |
| Std. deviation | 0.0015 | 0.0014 | 0.0012 |

Table 2 Summary of change in weight in three groups

| Pairwise comparisons | HSD _{0.05} = 0.0014 | | Q _{0.05} = 3.4702 |
|----------------------|------------------------------|------|----------------------------|
| | HSD _{0.01} = 0.0018 | | Q _{0.01} = 4.4227 |
| T1:T2 | M1=0.00 | 0.00 | Q= 6.80 p= (.00009) |
| | M2=0.01 | | |
| T1:T3 | M1=0.00 | 0.00 | Q= 1.01 p= (.75820) |
| | M3=0.01 | | |
| T2:T3 | M2=0.01 | 0.00 | Q= 5.79 p= (.00074) |
| | M3=0.01 | | |

Table 3: Post hoc tukey test for inter group comparison for weight loss

| | Distilled water | Denture cleansing paste | Calcium carbonate consisting paste |
|----------------|-----------------|-------------------------|------------------------------------|
| N | 12 | 12 | 12 |
| ΣX | 1.22 | 4.51 | 0.98 |
| Mean | 0.1017 | 0.3758 | 0.0817 |
| Std. deviation | 0.0554 | 0.1237 | 0.0417 |

Table 4: Summary of change in surface roughness in three groups

| Pairwise comparisons | | HSD _{.05} = 0.0014 | Q _{.05} =3.4702 |
|----------------------|----------|-----------------------------|--------------------------|
| | | HSD _{.01} =0.0018 | Q _{.01} =4.4227 |
| T1:T2 | M1= 0.10 | 0.27 | Q= 11.60 |

| | | | |
|-------|----------|------|-------------|
| | M2=0.38 | | p= (.00000) |
| T1:T3 | M1=0.10 | 0.02 | Q= 0.85 |
| | M3=0.08 | | p= (.82197) |
| T2:T3 | M2= 0.38 | 0.29 | Q= 12.44 |
| | M3= 0.08 | | p= (.00000) |

Table 5: Post hoc tukey test for inter group comparison for change in surface roughness

The results of the one-way ANOVA test revealed significant differences in weight loss and surface roughness among the different dentifrice groups. The f-ratio values obtained were 13.91867 for weight loss and 48.36113 for surface roughness, with corresponding p-values of 0.000041 and < 0.00001 , respectively. These results indicate that there are significant variations in the mean weight loss and surface roughness values between the dentifrice groups.

Furthermore, the post hoc Tukey's HSD test was conducted to perform pairwise comparisons within the ANOVA data. The results of the Tukey's HSD (Table 3,5) test identified significant differences between Test group 1 (Distilled water) and Test group 2 (Denture cleansing paste), as well as between Test group 2 (Denture cleansing paste) and Test group 3 (Calcium carbonate-containing paste).

DISCUSSION

The aim of this in vitro study was to evaluate the effects of different denture cleaning agents on weight loss and surface roughness of denture base acrylic resin. Three agents were compared: distilled water, denture cleansing paste, and a calcium carbonate-containing paste. The results revealed significant differences in both weight loss and surface roughness among the groups.

Weight loss is an important parameter to assess the integrity and durability of denture materials. In this study, the denture cleansing paste group exhibited the highest weight loss, followed by the distilled water group, while the calcium carbonate-containing paste group showed the least weight loss. These findings indicate that the denture cleansing paste may have a more abrasive effect on the denture base resin, leading to greater

material loss. On the other hand, the calcium carbonate-containing paste demonstrated a protective effect, resulting in minimal weight loss. This can be attributed to the mild abrasive properties of calcium carbonate, which allows for effective cleaning without causing excessive damage to the denture material.

Surface roughness is another crucial factor as it influences the esthetics of dentures and can affect plaque accumulation and cleaning efficiency. The results showed that the denture cleansing paste group had the highest surface roughness, followed by the distilled water group, while the calcium carbonate-containing paste group exhibited the lowest surface roughness. The higher surface roughness in the denture cleansing paste group indicates a more aggressive action on the denture surface, potentially causing micro-irregularities and facilitating plaque accumulation. In contrast, the calcium carbonate-containing paste demonstrated superior performance in maintaining a smoother denture surface.

The findings of this study support the notion that the choice of denture cleaning agent can significantly impact the weight loss and surface roughness of denture base acrylic resin. The use of a calcium carbonate-containing paste appears to offer a favorable balance between effective cleaning and minimal abrasion, leading to reduced weight loss and smoother denture surfaces. These outcomes are particularly relevant for long-term denture wearers as they contribute to the overall longevity and esthetics of the dentures.

It is important to note that the results of this study are based on an in vitro setting and may not entirely reflect the clinical conditions. Future research should aim to validate these findings

through clinical trials involving denture wearers to ascertain the practical implications. Furthermore, investigating the long-term effects of different denture cleaning agents on other denture properties, such as color stability and mechanical strength, would provide a more comprehensive understanding of their impact on denture performance.

In conclusion, the present study highlights the significance of selecting an appropriate denture cleaning agent to maintain the integrity and esthetics of denture base acrylic resin. The use of a calcium carbonate-containing paste demonstrated superior performance in terms of reduced weight loss and smoother denture surfaces. These findings contribute to the knowledge base concerning denture hygiene and can guide clinicians and patients in making informed decisions regarding denture cleaning methods to optimize the longevity and aesthetics of dentures.

CONCLUSION

In summary, this in vitro study aimed to evaluate the effects of different denture cleaning agents on weight loss and surface roughness of denture base acrylic resin. The results demonstrated that the use of a calcium carbonate-containing paste resulted in significantly less weight loss and smoother denture surfaces compared to a denture cleansing paste and distilled water. These findings emphasize the importance of selecting an appropriate denture cleaning agent to maintain the integrity and esthetics of denture materials. The use of a calcium carbonate-containing paste offers a favorable balance between effective cleaning and minimal abrasion, contributing to the longevity and esthetics of dentures. However, further research, including clinical trials, is needed

to validate these findings and explore the long-term effects of different denture cleaning agents on other denture properties. These results provide valuable insights for clinicians and patients in making informed decisions about denture hygiene and cleaning methods.

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Lalan Et. At. Comparative Evaluation Of Effect Of A Denture Cleaning Paste And Calcium Carbonate Containing Paste On Surface Roughness And Weight Loss On Heat Polymerised Pmma Resin: An In Vitro Study

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