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RESEARCH ARTICLE

TO EVALUATE AND COMPARE EFFECT OF DIFFERENT THICKNESS OF HEAT CURED POLYMETHYL METHACRYLATE DENTURE BASE RESINS STORED IN DISTIL WATER AND ARTIFICIAL SALIVA AT DIFFERENT TIME INTERVALS ON SORPTION AND LINEAR DIMENSIONAL CHANGE – AN IN-VITRO STUDY

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ABSTRACT

To evaluate & compare effect of different thicknesses of heat cure polymethyl methacrylate denture base resin at different time intervals in distilled water, artificial saliva and its combination on sorption and linear dimensional change.- An in- vitro study. **Materials & Method:** This was an invitro study where a total of 176 samples of heat cured polymethyl methacrylate were made. 44 samples each of 1mm and 2mm rectangular slab and 44 samples of each 1 mm and 2mm circular discs were made. 11 samples were allocated to each group of 1mm and 2 mm samples and immersed in artificial saliva and distil water for 30 and 90 days. The rectangular slabs were used to test the linear dimensional change and the circular discs were used to test for sorption according to ADA specification number 12. **Results:** Unpaired T test was used to evaluate the values obtained in the study. It was observed that the linear dimensional change seen was statistically significant after immersing the 1mm ($p = 0.013$) and 2mm ($p = 0.019$) samples for 30 days in artificial saliva and distil water. No statistically significant change was seen in sorption over 30 and 90 days. **Conclusion:** The greatest change in linear dimensional change was observed after 30 days in artificial saliva and distil water. No significant changes were seen thereafter in linear dimensional change or sorption. **Clinical significance:** The thickness of the denture base material is an important factor for successful prosthesis. If the denture base is thin, it may fracture, may not tolerate occlusal forces. If it is thick it will be heavy to load the tissues, may absorb more liquid & shows linear dimensional changes & may not fit the tissues & disturbs the occlusion. Inspite of such an important factor thickness of the denture base is often neglected.

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INTRODUCTION

Complete denture prosthesis replaces the missing natural teeth along with the structures of maxilla & mandible (Glossary of Prosthodontic terms). The denture base in turn derives support from contact with underlying oral tissues, teeth or implants. Missing teeth affects to majority of the people and treatment for this is their replacement by artificial substitutes, such as prosthesis.While restoring such cases with prosthesis there may be concern related to strength & design of the prosthesis to meet the oral function (Craig, 2002). The denture base material should have properties like biocompatibility, durability, strength (Kurtulmus, 2010). After its introduction, acrylic resins have been used to construct various removable prosthesis like complete dentures & treatment partial dentures. Acrylic resins provide ease of handling, adequate thermal conductivity, and less than adequate permeability to oral fluids but there will be resultant polymerization shrinkage. Dimensional stability problem with acrylic resin may get compensated by water sorption by the prosthesis, resilientgingival mucosa. There is inadequate information about sorption, linear dimension changes for acrylic resin materials (Darbar, 1994). Therefore, the present in- vitro study was plan to

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evaluate and compare the effect of different thicknesses of heat cured polymethyl methacrylate denture base resin stored in distill water & artificial saliva at different time intervals on sorption & linear dimensional change.

MATERIALS AND METHODS

Heat activated polymethyl methacrylate denture base resin was used in the study. All specimens were fabricated as per standard protocol.

Sorption

A total of 88 specimens were fabricated in heat activated Polymethyl methacrylate using the conventional flasking and compression molding technique. The master specimen (Figure 1) was a stainless steel disc with a dimension of 5 mm diameter X 1 or 2 mm thickness. Forty four specimens of each one and two millimeter thick discs were made (Figure 2). After deflasking the samples were finished and dried in desiccator at 37°C for 24 hours. Individual sample was then maintained in same dessicator at atmospheric temperature for 60 minutes and measured with a weighing machine having a precision of 0.1 mg. The eighty eight samples were divided equally into 8 groups (n = 11). 11 samples each of 1mm and 2mm were immersed in artificial saliva and distil water for 30 and 90 days respectively. All samples were taken out of the artificial saliva and distil water, damped with a cloth napkin, air dried for 15s, and measured on weighing machine (Figure 3). Sorption was calculated as (Table 1 and 2): Sorption [μg/cm^2] = [mass after immersion (μg)-dry mass (μg)] /Surface area (cm^2).

Table 1. Mean values of the samples in each group to test for sorption (n = 11)

Group	Medium	1 mm disc	Group	2 mm disc
9	Distil water 30 days	0.74373	13	1.25209
10	Artificial saliva 30 days	0.37091	14	-0.32464
11	Distil water 90 days	0.51000	15	-1.57118
12	Artificial saliva 90 days	0.04627	16	0.60273

Table 2. Standard Deviation of the samples in each group to test for sorption (n = 11)

Group	Medium	1 mm disc	Group	2 mm disc
9	Distil water 30 days	0.89255	13	1.31771
10	Artificial saliva 30 days	0.68768	14	2.66312
11	Distil water 90 days	1.04519	15	4.08742
12	Artificial saliva 90 days	1.55476	16	0.63773

Table 3. Comparison between the groups and calculation of the t and p value for sorption

Group	Mean difference	t	P value
9&10	.372818	1.097	0.286
11&12	.463727	0.821	0.421
13&14	1.576727	1.760	0.094
15&16	-2.173909	-2.1739	0.97

Table 4. Mean values of the samples in each group to test for linear dimensional change (n = 11)

Group	Medium	1 mm slab	Group	2 mm slab
1	Distil water 30 days	0.42218	5	0.43009
2	Artificial saliva 30 days	0.34673	6	0.30855
3	Distil water 90 days	0.34968	7	0.36573
4	Artificial saliva 90 days	0.31418	8	0.32055

Table 5. Standard Deviation values of the samples in each group to test for linear dimensional change (n = 11)

Group	Medium	1 mm slab	Group	2 mm slab
1	Distil water 30 days	0.057841	5	0.141313
2	Artificial saliva 30 days	0.071829	6	0.071559
3	Distil water 90 days	0.058216	7	0.062224
4	Artificial saliva 90 days	0.067752	8	0.091016

Table 6. Comparison between the groups and calculation of the t and p value for linear dimensional change

Group	Mean difference	t	P value
1&2	0.075455	2.714	0.013
3&4	0.035455	1.316	0.203
5&6	0.121545	2.545	0.019
7&8	0.045182	1.3590	0.189

Linear Dimensional Change

A total of 88 specimens were fabricated in heat activated Polymethyl methacrylate using the conventional flasking and compression molding technique. The master specimen (Figure 1) was a stainless steel rectangular slab with a dimension of 65mm X 10mm and 1 or 2 mm thickness. Forty four specimens of each one and two millimeter thick rectangular slab were made (Figure 4). After deflasking the samples, they were finished and the dimensions were measured using a digital vernier caliper with a 0.01mm precision (Figure 5). The eighty eight samples were divided equally into 8 groups (n = 11). 11 samples each of 1mm and 2mm were immersed in artificial saliva and distil water for 30 and 90 days respectively. Each measurement was taken three times and mean was taken to minimize errors (Table 4 and 5).

RESULTS

The unpaired-t test was applied (Table 3 and 6) in this study to compare 1mm & 2mm thick samples immersed in artificial saliva and distil water for 30 and 90 days. It was observed that statistically significant change had occurred in the linear dimensions of the 1 mm and 2 mm rectangular slab after immersing them in artificial saliva and distil water. Higher change was seen in the 1mm slab after immersing it in distil water for 30 days and 2mm slab after immersing it in distil water for 90 days. Comparison between other groups did not give any statistically significant result.

DISCUSSION

Many studies had proved that resins may absorbliquidin which it is stored. According to Arima*et al* the molecular structure of the acrylic versus molecular structure of waterinfluences sorption property of acrylic (Arima, 1996). Polar property for the resin molecules is responsible for the absorption of liquid through the process of diffusion (Skinner, 1943). This helps the denture base to adapt to the underlying residual ridge tissue and help in retention of the denture (Anthony, 1962 and Campbell, 1956). Period required for sample saturation or drying is derogatory and varies as per the acrylisation technique employed and the content of storing liquid. Specification given by the American Dental Association recommend that the change in the mass of the polymer shall not exceed 0.8mg/cm^2 of the original mass duringstoring in water for 7 days at 37+/- 1 degree Celsius (Council on Dental Materials and Devices,

1975). According to a study done by Rizzatti-Barbosa *et al.* fluctuation in temperature affect amount of sorption as the pressure increases that of surrounding (Rizzatti-Barbosa, 2001). Factorsthat affects sorptionare coefficient of water diffusion and inside-outside water concentration of the sample (Braden, 1964). The macromolecules of Poly (Methyl-methacrylate) are very large and complex molecules with a heterogeneous conformation withabruptvoids and biased interstices, also vary as per their constitution (Phillips, 1993), The mechanism of sorption originates from spreading of liquid molecules inside polymer macromolecules. The entry of liquid molecules inside the polymerized mass creates little expansion of the polymerized mass& alsoliquid molecules interfere with the entanglement of polymer chains acting as plasticizers (Anusavice, 1996). Mechanical properties of acrylic resin are affected by the heat and water sorption due to the changes in polymer chains which in turn soften the denture while as few researchesprovedan incrementalrise in surface hardness of acrylic resins immersion in liquid. Soluble content present in acrylic resins are initiators, plasticizers, and free monomer. Any observed loss of weight of acrylic is the amount of the sample's solubility. Therefore, the water sorption and solubility are the critical problems that affect the durability (Phillips, 1991). Due to volumetric changes, the resin is subjected to internal stresses which can create crack leading to denture fracture. An advantage of water sorption is that polymerization shrinkage is to some extent compensated for. However, prolonged use could create an affinity for water, resulting in a long-term plasticizing effect on the resin material.

This reduces its transverse strength; hardness and fatigue limit (Dixon, 1991 and Fujii, 1989). In the present study, the method recommended by the ISO for measuring water sorption was used. The water sorption was determined according to an increase in mass per unit volume. According to a study done by Saini *et al* least sorption value (12.75 μg/mm^3) for self-cure resin in artificial saliva and highest sorption value (27.25 μg/mm^3) for heat-cure resin in distilled water + denture cleanser (Saini, 2016). They found that artificial saliva solution is a better storage medium than distilled water and denture cleansing solution for both heat-cure and self-cure acrylic resins (Saini, 2016). Denture base resins arewidely used as denture base material because of properties like color stability, polishability and easy fabrication procedurebut still dimensional stability is highly questionable. During prosthesis fabrication stresses get released after deflasking leading to varying amount of shrinkage (Anthony, 1962). Not many studies have been done to analyze the linear dimensional change. The results of this study show that the linear dimensional change occurring over a period of 30 and 90 days was statistically insignificant.

Conclusion

Within the limits of the study, the following conclusions could be drawn:

- Highest change in linear dimension is seen after 30 days. There is an increase in the dimensions.
- Though there is an increase in sorption of the material after 30 days but it is not statistically significant.
- After 90 days neither sorption nor linear dimension changes are affected to an extent that they become statistically significant.
- Higher changes are seen when samples are immersed in distil water than when kept in artificial saliva.

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