Research Article

Water Sorption of Thermoplastic and Conventionally Heat Cured Hollow Maxillary Obturator

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Abstract
Objectives: The aim of this study was to assess and compare water sorption of thermoplastic versus conventional heat cured maxillary hollow obturator**. Material and Methods**: Ten heat cured maxillary hollow obturators (control group) were constructed and ten thermoplastic maxillary hollow obturators (test group) were constructed. Specimens were polished and dried in a desiccator until a constant mass was reached. Specimens were then immersed in distilled water at 37°C for seven days and weighed. the specimens were dried again until equilibrium was reached. Differences between the mean values in the two groups were analyzed using Student's t-test. **Results:** the water sorption mean value of control group was 3.44 (0.28) and mean value of test group was 1.35 (0.21). Acrylic group showed statistically significantly higher mean water sorption than Flex group. **Conclusions:** The thermoplastic obturators group showed lower water sorption rates than conventional heat cured resin obturator group**.** Thus, thermoplastic obturators are considered a viable treatment option for hemi maxillectomy cases slightly favorable than heat cured acrylic resin obturators regarding the ability of water sorption

Key words: Water Sorption, obturator, heat cured Acrylic resin, Thermoplastic resin

Introduction
Congenital or acquired tissue defects of the palate and/or contiguous structures need special prosthesis for proper sealing. The Glossary of Prosthodontic Terms defines an obturator as “a maxillofacial prosthesis used to close a congenital or acquired tissue opening, primarily of the hard palate and/or contiguous alveolar/ soft tissue structures.”(1)

There are many methods available to fabricate open or closed hollow bulb obturator. The reduced weight of both types of prostheses makes them more readily acceptable to the patients.(2)

The open hollow bulb obturator is easier to fabricate and adjust; thus, it is constructed more frequently than the closed hollow obturator.

The flexible thermoplastic material is chosen for construction of maxillary obturator because of its softness, easily engage to undercuts.(3)

Water sorption of a material indicates adsorption and absorption of water when in service. The water absorbed by the acrylic resin can act as a plasticizer and cause softening, discoloration and loss of mechanical properties of acrylic resin such as hardness, transverse strength and fatigue limit. However, water sorption causes three-dimensional expansion, and can affect the dimensional stability of acrylic resin.(4)

So, this study aimed to study the water sorption of a thermoplastic PMMA resin obturator in comparison with a heat-polymerized PMMA acrylic resin obturator.

Materials and Methods
The research proposal approved from the Research Ethics Committee (REC) of faculty of dentistry, Minia university.
Master cast was poured into improved stone from primary impression was obtained from patient with class I palatal defect.

Duplication of master casts:
The master cast was duplicated using silicone duplicating material, to obtain twenty rubber molds. To get twenty extra hard stone casts.

Construction of the maxillary heat cured acrylic hollow obturators:

The stone cast was waxed up, Artificial stone was mixed and placed in the base part of the flask.

The stone was allowed to set. Firmly the lid of the flask was closed, gentle tapping on it to ensure complete filling of the flask. The stone was allowed to sit before wax elimination. After wax elimination packing was done.

After packing and curing deflasking was done to retrieve casts to undergo finishing and polishing.

Construction of heat cured acrylic resin lid:

Waxed-up lid was put in the flask then the flask was put in wax elimination unit. Packing of heat-cured acrylic resin into the flask was done as mentioned in the bulb part of obturator. The lid part was then retrieved and finished and polished and assembled to bulb part using cold cured acrylic resin mix.

Construction of maxillary thermoplastic resin hollow obturators:

The same steps were done in heat cured acrylic obturators except that: The waxed-up cast was sprued by using pink wax and put in special flask for thermoplastic resin.

After packing and curing, deflasking was done to finish and polish obturators.

Construction of thermoformed resin lid:

Same steps were done as heat cured acrylic lid except, Flasking of the waxed-up lid was made in special flask for thermoformed resin

Then lid was assembled to bulb part using cold cured acrylic resin mix.

Samples grouping:

Group (1) control group: Consists of ten heat cured maxillary hollow obturators.

Group (2) test group: Consists of ten thermo-plastic maxillary hollow obturators.

Water sorption test:

Ten maxillary hollow obturators for each group were prepared as follows: ten acrylic resin maxillary hollow obturator as control group and ten thermoformed resin maxillary hollow obturator as test group Specimens were subjected to a drying process in order to achieve a constant weight. So, they were kept in a vacuum desiccator and daily weighed on a digital analytical balance until the difference between sequential weight measurements were less than 0.5 mg.

After obtaining the constant mass, specimens were stored in distilled water at 37°C for seven days, specimens removed from water and wiped with clean dry piece of cloth until being free from visible moisture.

To calculate the water sorption specimens passed again by the above drying process. The water sorption percentages were calculated using the following equations:

% Sorption = 100 x (m2 – m3)/m1

where: m2 is the mass (mg) of the specimen after immersion in water; m3 is the mass (mg) of the specimen after the second drying; and m1 is the mass (mg) of the specimen after the first drying.

Statistical Analysis

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). Water sorption data showed normal (parametric) distribution.

Parametric data were presented as mean and standard deviation (SD) values.

For parametric data; Student's t-test was used to compare between the two groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

Results

Water sorption %

Acrylic group showed statistically significantly higher mean water sorption than Flex group (P-value <0.001, Effect size = 8.491).

Table: Mean, standard deviation (SD) values and results of Student's t-test for comparison between water sorption % in the two groups

Acrylic (n = 10)	Flex (n = 10)	*P*-value	*Effect size (d)*
3.44 (0.28)	1.35 (0.21)	<0.001*	8.491

**: Significant at $P \leq 0.05$*

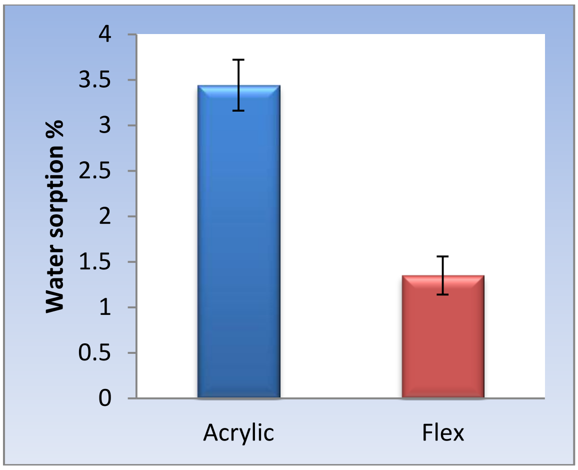

Fig.: Bar chart representing mean and standard deviation values for water sorption % in the two groups

Discussion

In the evaluation of water sorption and solubility, the Kazanji and Watkinson technique (1998) is more representative (data in percent) and has less variable (surface area, results in mg/cm2) in the calculations[5]

In this study, we used the technique recommended by Kazanji and Watkinson (1998).

Water sorption presumably occurs among macromolecules، which are forced slightly apart. This separation causes molecular mobility. Inherent stress created during heat curing of the acrylic resin can be relieved, with resulting intermolecular relaxation and possible changes in the shape of the denture.

The water sorption rate of materials affects their color stability as well as their physical properties. Acrylic resins absorb water for a prolonged length of time because of the polar property of the resin molecules, whereby the extent of water sorption is determined in proportion to the resin components with high polarity, which form hydrogen bonds with water molecules.

Based on the results of the present study, the null hypothesis was refuted. A statistically significant difference in water sorption ($P < 0.001$) was observed between the thermoformed obturators group and the conventional heat cured acrylic resin obturator group.

High water sorption may be due to cross-linking agents, plasticizers, unreacted monomers, initiators or soluble materials.[6]

The water sorption findings in our study were consistent to those reported by Pfeiffer et al. They stated that the water sorption in thermoplastic group was significantly lower than that of the PMMA control group.[7]

Also, Hemmati et al., stated that the water sorption of thermoplastic group was lower than the conventional heat cured acrylic resin[8]

Also, Takabayashi stated that there were significant differences in the water sorption of six thermoplastic resins and a conventional PMMA, except for one polyamide resin (Lucitone) that had higher water sorption(9)

Different results were found in this study compared to Wesam E Badr, et al., showed non-significant higher values of water sorption than conventional heat cure and this may be attributed to Polyamide-group denture base resins are subjected to water sorption between molecular chains due to the hydrophilicity of the many amide bonds that form the main chains of the resins, resulting in high water sorption rates.(10)

Conclusions

Within the limitations of this in vitro study, it can be concluded that the thermoplastic obturators group showed lower water sorption rates than conventional heat cured resin obturator group.

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