Comparison the tensile strength of heat cure and visible light cure acrylic resin denture base

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ABSTRACT

Background: Visible light cured acrylic resin denture materials are one of the developed polymeric acrylic denture base and are manufactured in the form of sheets and rapes, and also in powder and liquid system, they can be adapted for various dental uses and provides rapid service at low cost. This study aimed to compare the tensile strength of heat cured acrylic resin and visible light cured acrylic resin.

Materials and Methods: Twenty samples of acrylic denture base materials were prepared, ten samples of heat cured acrylic denture base materials and ten samples of visible light cured acrylic denture base material. After curing of both groups, the materials were subjected to tensile strength test with the use of Instron universal testing machine.

Results: The results of the present study showed a high significant difference comparing between the two groups; heat cured acrylic denture base material showed a high significant tensile strength than the visible light cured acrylic denture base material.

Conclusion: heat cured acrylic denture base resin showed superiority in the tensile strength values than the visible light cured acrylic denture base material.

Key words: heat cures acrylic, visible light cure acrylic, tensile strength.

INTRODUCTION

The general upgrading of resin in dentistry regarding their physical and mechanical properties render the use of resin based restorative materials to rise exponentially, as dental clinician are always looking for the ideal restorative dental material, also dental community in its search for better, less expensive, easier to handle materials, is often quick to adapt a rising technology for new and different purposes. (1)

The development and continued evolution of photo polymerizable dental materials represents a significant practical advance for dentistry. Photo polymerization had become an integral component in the practice of dentistry since the commercialization of this technology in the late 1960s. (2)

Later, in 1980 the visible light activated system was introduced and dominates the world market and has proved its efficiency and acceptance through its rapid evolution. Initially, visible light curing materials were used to restore only anterior teeth and to seal pits and fissure. With time the use and application of these materials has been expanded with a large variety of materials including cavity liners, die materials, provisional crown and bridge materials, surgical cements, orthodontic resins and adhesive system with composite resins for posterior and anterior restorations, In 1983, anew visible light cured resin technology was developed for use in removable prosthodontic. (3)

In 1984, visible light – cured base resins became available to profession and marketed under the trade name " triad " which was suitable for many prosthodontic applications, removable, fixed and maxilla facial prosthesis. (4)

Since then the use of these materials has increased with new products being used for the relining and repair of dentures. (5,6,7) The light output of light curing units is designed to promote an intensity great enough to cure the deeper parts of the body of the resin, the conversion from soft to solid material relies on the ability of the light to access and initiate the curing in all parts of the restorative material, so high intensity light results in deep polymerization of the material to a depth of (6mm).the cure of visible light cure resin material is most effectively initiated by light in the wave length range 450-500 nm. (8)

Tensile strength is the resistance of the material to a tensile or stretching force. (9) The elongation, in combination with ultimate strength is an indication of the toughness of the plastic. The larger the area under the stress; the tougher the material, while a material with less elongation will be brittle. (10) This study aimed to compare the tensile strength of heat cured acrylic resin and visible light cured acrylic resin.

MATERIALS AND METHODS

Specimens grouping

Twenty specimens were prepared, light cured acrylic denture base resin (Palatray, RXL, Germany) and heat cured acrylic denture base resin (Vertex Netherland) and divided into (10)
specimens for each of the following group: heat cured, and light cured acrylic resin.

**Metal pattern preparation**

The metal pattern was constructed with dimensions of [65mm, 10mm, 2.5mm] length, width, depth, respectively according to ADA specification (11).

**Figure 1: materials used in the study**

**Figure 2: showing the metal pattern**

**Mold preparation**

The lower portion of dental flask was filled with dental stone (Zeta, Italy) mixed according to manufacture instruction; metal block was coated with stone mix to avoid air trapping during insertion the metal block into the stone mix after coating with separating medium. When stone set, both the stone and metal patterns were coated with separating medium (Vertex, Netherland), the upper half of the flask was then placed on top of the lower portion and filled with stone. Stone was allowed to harden for 60 minutes before the flask was opened. The metal patterns were invested for each sample to be prepared. The flask was then opened and metal patterns were removed from the mould carefully.

**Flasking**

Pink heat cured acrylic resin was mixed according to manufactures instructions (powder/liquid ratio is 3/1). The acrylic resin dough was packed in the mould which had been treated with separating medium. The two halves of the flask were closed together and placed under the hydraulic press. The pressure was slowly applied to allow even flow of dough throughout the mould space. The pressure was released. The flask was opened and the over flowed material (flash), surrounding the mould space was removed with wax knife.

A second trial closure was preformed; the stone surface was again coated with the separating media. The two halves of the flask were finally closed until an intimate contact had been established, and it was left under the press (1500 psi) for 5 minutes before clamping was done. Then the flask was placed in a flask clamp maintaining undisturbed pressure during processing (12).

**Curing and cooling**

Curing was carried out by placing the clamped flask in a thermostatically controlled water bath and processed by long curing cycle is established by heating at 74°C for 8 hours in water bath. After completing the curing process, the flask was allowed to cool slowly at room temperature for 30 minutes followed by complete cooling of the flask with tap water for 15 minutes before deflasking. The acrylic patterns were then removed from the stone mould.

**Preparation of test specimens of light cured acrylic denture base resin mold preparation**

Stone mold was prepared following the same method used for conventional denture base acrylic. Metal block was used with dimensions of (65mm X 10mm X 2.5mm) length, width, and depth according to the ADA specification (11). The metal is placed on a flat glass plate, separating medium is applied. Stone slurry was prepared by mixing correct water/powder ratio and it was poured onto the metal block. A second glass plate was placed over the stone mix, so the stone was sandwiched between the two glass plate. After setting of the stone, the glass plates were removed and metal block was removed, layer of separating medium was applied on the mould cavity and all set stone surface.

**Packing**

Light cured sheet was taken out of its light proof packing and positioned into the stone mold. The material was adapted well in the mold using finger pressure, excess material was removed by cutting with sharp wax knife and then the top surface of the stone mold was flattened with a glass plate.
Curing
The material was polymerized in the light curing unit (Engen, Germany) for 5 minutes according to manufacturers instruction. Then the material was then removed from the mold, inverted and exposed to the light cured unite again immediately for additional (5minutes) to ensure complete polymerization, so the total time of curing is 10 minutes. \(^{(13)}\)

Figure 3: Showing the light cure device

Finishing and polishing
All flashes of acrylic were removed with an acrylic bur to get a smooth surface. The acrylic bur should be used followed by (120) grain size sandpaper to remove any remaining small scratches with continuous water cooling. Polishing was accomplished by using bristle brush and pumice with Lathe polishing machine. A glossy surface was obtained with wool brush and polishing soap on dental Lathe using low speed (1500 rpm) and the specimens were continuously cooled with water to avoid overheating, which may lead to distortion of the specimens, then the final measurements of the specimens were obtained using the vernier. After finishing and polishing, the specimens were measured again to ensure exact measurement.

Mechanical tensile strength test
Test equipment and procedure
The tensile strength was tested using Instron testing machine with grips suitable for holding the test specimens. Each specimen was set at across head speed of 0.5 mm/min. chart speed. The load cell was measured by a tensile load cell, with a maximum capacity of 200 kg. Each Specimen was loaded until fracture, and the load of fracture was recorded from the Instron graph reader in kilograms (kg) which were converted into Newton (N).

The values of tensile strength were calculated for each sample according to the following formula:

\[
TS = \frac{F}{A}
\]

Where:
- \(TS\) = Tensile strength (N/m\(^2\)) (then converted to MPa)
- \(F\) = force at failure (N)
- \(A\) = Area of cross section at failure (m\(^2\))

RESULTS
I- Descriptive statistics:
Mean (M) and Standard Deviation (SD) are presented in Table 1. The hot cured acrylic showed higher tensile strength values than visible light activated acrylic.

Table 1: showing the mean, standard deviation for both group expressed in MPa

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (hot cured)</td>
<td>51.2</td>
<td>0.341</td>
</tr>
<tr>
<td>Group 2 (visible light</td>
<td>16.7</td>
<td>0.636</td>
</tr>
</tbody>
</table>

Figure 5: Graphical representation of means by bar chart

II- Inferential statistics
In Table -2, student t – test compared between tensile strength values of hot cured acrylic and visible light cured acrylic and this table revealed that there is a high significant difference when comparing between the two groups, and the hot cured acrylic produced higher tensile strength values than visible light cured acrylic.

Table 2: student t – test comparing between the two groups

<table>
<thead>
<tr>
<th>Group 1 (hot cured)</th>
<th>Group 2 (visible light cured)</th>
<th>T – value</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.2</td>
<td>16.7</td>
<td>27.41</td>
</tr>
</tbody>
</table>

HS highly significant at P – value < 0.01

DISCUSSION
Visible light cured acrylic denture base material had been used in this study because it has many applications such as the fabrication of complete and partial dentures, relining material, transitional prosthesis, provisional splints, denture
repairs and orthodontic appliances, record bases, special trays and obturators.\(^{(14)}\)

One of the mechanical properties of dental material is tensile strength. It had been chosen in this study because the material is much weaker in tension than in compression, which may contribute to failure of the material in service.\(^{(15)}\)

In the present study, two types of acrylic resin denture base were used: the traditional hot cured acrylic resin and the visible light cured acrylic resin denture base material, and the tensile strength of both materials was compared. The results of the present study showed a high significant difference when comparing between the two groups, since hot cured acrylic resin produced a high tensile strength values than the visible light cure acrylic resin. This is in agreement with Dar-Odeh et al \(^{(17)}\) who stated that the visible light cured acrylic resin material tends to be more brittle than heat cured acrylic resin. This is in agreement with Elian \(^{(18)}\) who found that this reduction is due to the composite nature of the visible light cured acrylic resin, it is completely different polymer from other acrylic resin, so this leads to such reduction in tensile strength. According to the knowledge of the authors, there are no previous studies disagree with the results of the present study.

CONCLUSION

It can be concluded from this study that heat cured acrylic denture base resin showed superiority in the tensile strength values than the visible light cured acrylic denture base material.

REFERENCES


Restorative Dentistry