



Evaluation of Transverse strength, Impact strength and Hardness of Thermosense denture base material and compare the result with heat cure acrylic denture base material (in vitro study)

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Abstract

Background: Thermosense material is the innovative virtually unbreakable, new monomer free rigid denture base material easy and quick to polish and available in 10 colors, suitable to patients unable to accept denture made from materials that could result in allergic reactions or other sensitivity problems. This type is suitable for full and partial denture and can be used for rebase and relined jobs. Also suitable for overdenture on implant and for repair.

Material and methods: sixty samples were prepared and divided into two main groups according to the type of material that used (thermosense denture base material and heat cure acrylic denture base material). Each main group was subdivided into three subgroups according to the type of test that was used (Hardness, impact strength, and transverse strength). Data were analyzed by one-way analysis of t-test.

Results: for this study the result for three tests; hardness, transverse strength and impact strength show high significant difference.

Conclusion: This study showed Thermosense denture base material had higher impact strength than Heat cure acrylic denture base material but this material had higher transverse strength and hardness than Thermosense denture base material.

Keywords: Heat cure acrylic denture base material, thermosense denture base material, hardness, impact strength, transverse strength.

Introduction

Loss of teeth can be defined as a common problem that most of patients subjected to it due to many causes, may be due to dental disease, subjected to trauma or pathological causes. This problem had big effect psychologically and lead to disturb the aesthetic, phonetics and disturb the functional occlusion ⁽¹⁾.

Solve of these problems done by replacement of missing teeth by fabrication of denture. Many types of materials were used to fabricate

denture base; the most widely and commonly material used is polymethyl methacrylate (PMMA) denture base material, it's not the ideal material ⁽²⁾ although its esthetically satisfied, low cost, biocompatible and adequate strength, easy to apply but its not fulfilling the ideal mechanical properties ^(3,4) such as poor strength (weak flexural and low fatigue resistance, low abrasive resistance, its brittleness which lead to fracture, difficult to insert in undercut area and

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allergy to methylmethacrylate monomer⁽⁵⁾ .which is try to increased by several approaches^(3,4).

Also there is another type of material which represented as a new denture base material called anylon - derived denture base material , this material is an excellent alternative to use not because it provide excellent aesthetics and comfort to patient but because of flexibility in partial edentulous patient and adapted to contact movement^(1, 6).

This study represented another type of denture base material which is called thermosense denture base material that can be defined as unbreakable free monomer rigid denture base material based on a compound mixture of polyimide and pigments let to create a thinner denture which can be fitted in patient mouth perfectly and comfortably.

Material and Methods

Total samples in this study were prepared are sixty that divided for two main groups according to the type of material that used in this study (heat cure acrylic and thermosense denture base material). Then each main group subdivided to three subgroups according to the tests that measured which include Hardness 20 specimens (10 constructed from conventional heat cure acrylic and 10 constructed from thermosense denture base material), second subgroup for Impact strength also 20 specimens (10 constructed from thermosense and 10 from heat cure acrylic denture base material) and the last subgroup for Transverse strength which are 20 specimens (10 from thermosense and 10 from heat cure acrylic denture base material).

Preparation of sample:

First to prepare the plastic pattern that constructed by cutting plastic plate in to desired shape and dimension

that's done by laser cutting machine, three plastic patterns were prepared for this study according to tests that measured. First for hardness test with dimension (65mm*— 10mm *2.5-+0.1mm)⁽⁷⁾, second pattern prepared for Impact strength with dimensions (80mm*10mm*4mm)(ISO 179, 2000) and the last pattern were prepared for Transverse strength with dimensions(65mm*10mm* 2.5-+ 0.1 mm)⁽⁷⁾.

Preparation of Heat cure acrylic denture base material samples:

coating the sample with separating medium is the first step then dry and coated the lower part of metal flask with it and filled with dental stone that mixed according to manufacturers instructions then insert the sample in the stone (one- half of its depth)and leave it to set .After complete stone setting, coated its surface with separating medium and leave it to dry also coated the upper part of dental metal flask with separating medium and put on the top of lower part of metal flask then start to mix 2nd layer of dental stone and filled upper part of dental metal flask then vibrated to reduce air bubbles .After setting of stone open the flask and remove the plastic pattern then put separating medium again in both surface and start to mix heat cure acrylic according to manufacturers instructions, when heat cure acrylic reach to dough stage pack it in to the stone mold and cured according to manufacturers instructions. Now the 2nd step after curing do deflasking and the samples were removed then do finishing and polishing to samples. Last step put samples in distilled water at 37c for 48 hours. They are ready to measured

Preparation of Thermosense denture base material samples:

For this type of denture base material it follow the same techniques of flasking that's done for heat cure acrylic with few different in the steps.

For this type of material there is a special flask used for injection technique consist of two parts upper half and lower half ; about the upper half there is a hole at the top from which pouring of 2nd layer of stone was put . The lower half fixed to upper half of the flask by 4 screws which should be tighten well in use. now a separating medium used to coat the lower half of the flask and dental stone was mixed and poured in it then the plastic sample inserted one half of it in stone and leave it to set, after setting of stone coated its surface with separating medium and allow it to dry then wax sprues were used here put 2 types of sprues major sprue with diameter 6-8mm and minor sprue with diameter 2-4mm in diameter that attached to sample. after good sealing of sprues put now the upper half of flask and fixed to lower half by tighted the 4 screws well then start to mix the 2nd layer of dental stone and pour it through the hole on upper half of flask and leave it to set. Now reach to step of wax elimination that's done by using boiling water then leave it to cool at room temperature. After that open the flask and remove the plastic sample and wash the stone mold with boiling water to get rid of all remnant of wax and leave it to cool to room temperature again. Then coated the surface of two dental stone mold with vertex thermo flow separating medium and allow it to enter to the holes that prepared in mold by wax sprues and leave it to dry then put the upper half of flask fixed on lower half by screws.

Procedure of Thermosense denture base material injection:

Vertex thermo ject 22 is the injection machine that used to construct the thermosense denture base material.

first step started by preheating of cylinder of machine to 290c in 8 minutes only, then the cartridge of

thermosense material was inserted in the cylinder and put the flask in its position in machine then press the bottom to start injection procedure under 6.5 bar pressure at 290c for 18 minutes, after finishing of program cooling was done for 1 minute and remove the flask from machine and leave it to cool at room temperature. After it's cool open the flask and remove the specimens and start to remove all sprues by cutting. The last step to finish and polish the specimens with thermosilicon polisher.

Mechanical test:

Three tests used in this study include Impact strength ,Hardness and Transverse strength.

For the Impact strength:

20 specimens prepared also (10 from heat cure acrylic and 10 from thermosense) with dimensions mentioned before (ISO 179 ,2000) put all specimens in distilled water at 37 c for 48 hours before start testing⁽⁷⁾. Measurements of this test done by putting the specimen horizontally in impact testing devise which supported at each end then stuck by pendulum which swing freely with 2 joules for heat cure acrylic denture base material and then change deformation till 30 joules then reading calculated in kilojoules/ square meter as this equation:

$$E/b.d*10^3 \text{ (ISO, 2000)}$$

E: the impact energy in joules

b: width of specimen in millimeter

d: depth of specimen in millimeter

2nd test is surface hardness test:

20 specimens used (10 as control made from heat cure acrylic and 10 from thermosense) with a dimensions that mentioned before ⁽⁷⁾, stored in distilled water at 37c for 48 hours before start testing.

For this test use instrument called durometer hardness tester that consist from spring -loaded indenter (0.8 mm in diameter which is tapers to a

cylinder of 1.6 mm) this indenter attach to digital scale graduated from 0-100 units. Procedure of measuring hardness done by pressing down on the indenter firmly and quickly to record the reading by selecting three points of specimen (one on the center and other on each end) then collected the mean of these three reading.

Last test in this study is transverse strength test:

also prepare 20 specimens (10 from heat cure acrylic and 10 from thermosense denture base material) with dimensions mentioned before, put all specimens in distilled water at 37°C for 48 hours before start to test⁽⁷⁾. For this test use Instron Universal testing machine (WDW-200E) by putting each specimen on the bending fixture which consist of two parallel supports (50 mm apart), there is a rod placed on center between these two parallel supports which responsible for making the deflection in the specimens until undergo fracture. The full scale was 50kg and load applied with across head speed of 1mm/ min. when thermosense specimens tested they undergo deflection until the specimen take U shape. This test was calculated by using this equation:

$$S = 3PI / 2 bd^2$$

where:

S = Transverse strength (N / mm²)

P = is the peak load (load of fracture), but for thermosense denture base material it's the maximum load recorded from load-deflection (N)

I = distance between support s (mm)

b = width of specimen (mm)

d = depth of specimen (thickness) (mm).

Results

Statistical analysis was done and the result obtained from measured data were classified according to the

following groups:

-Group A: control (heat cure acrylic)

-Group B: thermosense denture base material.

About the first test (impact strength) the results showed group B had higher impact strength mean value (197.29) also one way analysis of (t-test) indicated highly significant difference among the studied groups ($P < 0.01$) as shown in table(1).

For the 2nd test (hardness surface) the results showed that group A had the higher mean value (86.71) one way analysis of (t-test) indicated a highly significant difference among the studied groups ($P < 0.01$) as shown in table(1).

Last test (transverse strength) use one way analysis of (t-test) indicated a high significant difference among the studied groups ($P < 0.01$), group A had higher mean value (132.36) as shown in table(1).

Discussion

Denture bases are constructed from many types of materials, this study was compare between two different denture base materials (Heat cure acrylic and Thermosense denture base material) in mechanical properties, which include transverse strength, impact strength and hardness that showed high significant difference in these three properties.

For the first test impact strength which is an important property of denture base material, The results showed also high significant difference between these two type of denture base materials, these results may be due to the difference in polymerization techniques for there denture base materials which play an important role in influence the impact strength of denture base material, about heat cure acrylic which break as a result of fatigue failure in the mouth or impact

failure outside the mouth, porosity and residual monomer decrease the impact strength.

Exothermic polymerization reaction increase when temperature increase at 100.8 c (3213.4 F), methyl methacrylate boils and create porosities in resin ⁽⁸⁾. Heat can't be directly produced in denture base material inside mold, but it produced indirectly by heating up of water, while for thermosense denture base material use the pressure polymerization which is easy and require 6.5 bar pressure at 290c for 18 minutes.

2nd test in this study is hardness which is very important in dentistry and define as a resistance of permanent surface indentation or penetration ^(2, 9).

As a results that showed for this study hardness test show high significant difference between thermosense and heat cure acrylic denture base material, heat cure acrylic is harder than thermosense denture base material this is due to the high degree of crystallinity and large crystals with wide interstitial matrix between crystals in thremosense denture base material which make it less resistance to indenter penetration in comparison with heat cure acrylic ⁽¹⁰⁾.

The last test in this study is transverse strength which is the most closely represent the type of loading which applied to denture inside the mouth ⁽¹¹⁾, the result of this test showed high significant difference between thermosense denture base material and heat cure acrylic denture base material (heat cure acrylic higher than thermosense denture base material) these results may be due to the difference in structural formula (chemical composition) of there two type of denture base materials, thermosense is a polyamide which is not only monomer and acrylic free but also virtually unbreakable which

comprises the largest engineering plastics which are suitable for a wide range of application, also its more flexible (low flexural modulus) than PMMA. So its agree with the studies that said the thermoplastics is more flexible than heat cure acrylic denture base polymers. ^(7,12)

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Table 1: Mean distribution and t- test for surface hardness , impact strength and transverse strength in heat cure acrylic and Thermosense denture base material

| Variables | Groups | Descriptive Statistics | | | | | | Groups difference | | |
|---------------------|-------------|------------------------|--------|------|------|--------|--------|-------------------|------|------------|
| | | N | Mean | S.D. | S.E. | Min. | Max. | t-test | d.f. | p-value |
| Impact strength | Control | 10 | 9.35 | 0.65 | 0.21 | 8.40 | 10.66 | -60.256 | 18 | 0.000 (HS) |
| | Thermosense | 10 | 197.29 | 9.84 | 3.11 | 181.73 | 209.02 | | | |
| Hardness | Control | 10 | 86.71 | 2.79 | 0.88 | 83.00 | 90.30 | 6.968 | 18 | 0.000 (HS) |
| | Thermosense | 10 | 78.61 | 0.77 | 0.24 | 77.50 | 79.60 | | | |
| Transverse strength | Control | 10 | 132.36 | 7.11 | 2.25 | 122.40 | 141.60 | 7.534 | 18 | 0.000 (HS) |
| | Thermosense | 10 | 111.56 | 5.06 | 1.60 | 102.00 | 117.60 | | | |