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The Effect of Aging on Surface Hardness of Provisional Crown and Bridge Material

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Abstract
Background: Mechanical characteristics are necessary for temporary treatments. that enable them to hold use within the oral cavity. Surface hardness is an accurate indication of wear and deterioration resistance.
Aim: To evaluate and compare the surface Hardness of 2 types of composite material (Harvard- temp and Charm-temp). The specimens were tested in dry conditions and after 2 week of aging in artificial saliva. Material and Methods: Whole of 32 specimens of dimensions 64mm×10mm×2.5mm divided in two groups according the type of material (Harvard- temp or Charm- temp). Each group of material have (16) specimens. These specimens (16) divided in two group: control group (8 specimens) in dry conditions and aging group (8 specimens) 2 week stored in artificial saliva. ElCO meter Shore (D) device was used to indicate the values hardness of specimens before and after aging in artificial saliva. Results: After comparing the results, a significant difference in the surface hardness of dry and aging condition of Harvard – temp (P<0.05). However, there is a non-significant effect noticed for dry and aging condition of Charm- temp groups (P>0.05). comparison between Harvard – temp and Charm- temp in dry or aging condition revealed for dry condition high significant P<0.001 and significant difference P<0.05 for aging at artificial saliva. Conclusion: the surface hardness after aging in artificial saliva of Charm-temp not effect. But Harvard-temp showed significant reduction in surface hardness after aging for 2 weeks in artificial saliva. Comparing between the two materials in dry and aging condition showed difference between two conditions.

Introduction:

Temporarily fixed restorations have a key factor in the progress of definitive reconstructions. Before final restorations are placed, Temporary restorations should meet biological, mechanical, or esthetic standards These restorations can preserve pulp and periodontal tissues, supply occlusal operation and stabilization, and provide the appearance [1]. Since the term temporary means "temporarily," provisional restorations are often used for a transitional period; they can last a few of days and also some months, depending on the preparation [2]. Temporary restoration materials are categorized into two classes depending on the chemical structure: those based on mono methacrylates or acrylic resins, such as polymethyl methacrylate (PMMA) and poly ethyl/butyl methacrylate (PEMA); as well as those focused on di methacrylates or bis-acrylate/composite resins, also including bisphenol A-glycidyl di methacrylate (Bis-GMA) and urethane dimethyl acrylate (UDMA) [3]. Usually, no interim content exists that follows the optimum conditions in all cases. Clinicians usually Select a product on the basis of its simple to use, value, as well looks. It would be helpful to know which materials have a more durable Temporary reconstruction where strength is a primary concern. The medium influences the mechanical properties of a provisional substance [4]. Temporary products are used in a number of ways. Short term prostheses may be done intraorally are known as direct restoration, indirect reconstruction by using patient's cast, or restoration – direct – indirect Finally, time between the tooth preparation and the final replacement cementation generally lasts range from a little day to weeks and even months [5]. Temporary restorations can be classified based on the following methods:

1. Fabrication ways.
2. The kind of product that was used.
3. Period of application.
4. Techniques for fabrication [6].

Multiple things may affect the deterioration of dental composites reproductions throughout the oral cavity, so chemical degradation must happen in places that are not subjected to abrasion and compression. Errors in the physical and mechanical properties including its dental composite reconstruction can be caused by Water, saliva drinks, and food [7]. They act as a functional and esthetic trial which is acceptable to both doctors and patients. It also acts as a template for the construction of the final prosthesis for the specialist. The clinician must evaluate many considerations when choosing a product for just a simple crown or long bridge Temporary restoration, including flexural strength, surface hardness, wear resistance, dimensional stability, polymerization shrinkage [8]. The rate of resistance to applied stress with an indenter on a substance is seen by its hardness, which is its resistance to plastic deformation. Density is therefore equal to surface hardness. It improves the abrasion and surface corrosion resistance of dense materials. Surface hardness can soften according to the type of fluids so that occlusal harmony and vertical dimension will change, depending on the occlusal forces and wear on the surface [9]. The most common way to determine hardness to be calculate an indentation's depth or area made through a particular shape with a certain force applied indenter from a specified period of time, Brinell, Rockwell, Vickers, shore (A), (D), and Knoop are some of the more popular standard test techniques for expressing material hardness. Each of these processes is categorized into many scales based on the applied force and indenter shape [10]. Due to this consternation and the need to discover and foresee the probable causes of this disparity, an attempt was made to analyze and compare the Hardness of these different types of composite material, Harvard-temp and Charm-temp, both in dry state and after two weeks of aging in artificial saliva.

Materials and Procedures

Composite based temporary materials supplied as a cartridge with dispensing gun and mixing tips fig. (1.A, B), were investigated as two available commercial

interim crown and bridge materials: show in the Table (1):

Specimens Grouping

A Total 32 specimens were prepared and labeled with a number that described the sort of material and the sequence in which they were made. All specimens were measured for accurate dimensions (64mm×10mm×2.5mm) by using vernire caliper(VC).

The total number 32 of specimens were divided in two group according the type of material (Harvard-temp) and (Charm-temp).

Each group of material had (16) specimens this (16) specimens will divided in two group:

1- Group A (control): dry conditions (8) specimens.

2- Group B (aging): 2week aging in artificial saliva (8) specimens.

Preparation of Custom Made Metal Mold

Custom metal mold was fabricated A rectangular mold with five rectangles of dimensions is used to make specimens. 64mm×10mm×2.5mm to gently remove the specimens, open on one side using adjustable screws on the ends and cover from the mold Fig. (1.c).

Specimen Preparation

With the aid of a brush, Petroleum Jelly was applied to the inside surface of the mold. For The substance was injected directly into the groove using a dispensing cannon in the composites. The material was expressed into the mold with the mixing tip of the cartridge held at one end and the auto mix dispenser moved gently to the other end to avoid the incorporation of air bubbles when dispensing the substance in the mold and cover from metal. A weight of a10 kg was applied load to extrude any excess material and to provide smooth surfaces. The material was allowed to set. The adjustment screws were released once the material had been set. The specimens were taken out of the mold and the excess was cut [11].

Preparation The Artificial Saliva (AS)

Artificial saliva with the following composition was made for the neutral solution (PH 7.0): 100mL Na_2HPO_4 (2.4 m M), 100mL of KH_2PO_4 (2.5mM), 100mL of Na cl (1.0mM), 100mL of $KHCO_3$ (1.50mM), 100mL of $CaCl_2$ (1.5mM), 100mL of $MgCl_2$ (0.15mM), and 6mL of citric acid (0.002mM) [12] Fig.(2,3,4).

Hardness Test

In this research the hardness test is performed by using Dour meter(DM) hardness device, type (Shore-D) scales according to (ASTMD2240), and standard specimen for hardness test fig. (5), Each scale results in a value between (0 and 100) hardness numbers, with higher values indicating a harder material. The specimen is placed beneath the indenter area with a weight applied equal to (50 N) and a depressing time of measuring equal to (15sec). Each specimen was tested five times in various positions at the same time. Each specimen had to be tested in the Centre not on the edge, and the average result was calculated [13].

Statistical Methods

IBM SPSS statistical program Version 24 used for doing the statistical analysis of the current study and Microsoft Excel 2010 for graphics presentation. The usual statistical methods were used in order to assess and analyze the results; these include: Descriptive statistics (mean, standard deviation, Minimum, Maximum) And Inferential statistics (Student test (t-test).

Results:

Descriptive statistics of surface hardness which include the minimum, maximum, mean and standard deviation for Harvard-temp and Charm-temp of the two groups dry and aging in artificial saliva fig. (6), the highest mean value observed in Harvard-temp groups.

Comparison between two groups dry and aging in artificial saliva of Harvard- temp using Paired t-test for the surface hardness demonstrated that there was a statistically significant difference P-value P<0.05

Table (2). Comparative study between two groups dry and aging in artificial saliva of Charm -temp using Paired t-test for the surface roughness showed no- significant difference P-value P>0.05 Table (2). Comparison between the Harvard –temp and Charm- temp for the Surface Hardness revealed High significant P<0.001 in dry, Significant P<0.05 aging in artificial saliva Table (3).

Discussion

Hardness is a property of solid objects that represents surface resistance to scraping, breaking, tear, indentation, pressure, and durability when a hard point is added to it, as well as a measure of surface hardness. The Dour meter hardness test is one of several techniques for determining the hardness of polymers and rubbers. There are many dour meter levels required [13]. Harder products should be used so they are more resistant to wear. This lowers the risk of perforation and helps to keep the structural strength of these restorations for a longer period [14]. The results of present study revealed that aging of Harvard-temp in artificial saliva significantly reduced the surface hardness P –value < 0.05. The causative factor for that result is that Harvard-temp is composite based The degree of the damage is determined by the penetrability of the fluid materials (artificial saliva) and good adhesion between the organic matrix and provisional product fillers. Dietary solvents can penetrate the organic polymeric network of composite resin, allowing the filler and matrix phases to separate and swell [15]. However, the Charm-temp not affected by two weeks aging in artificial saliva No- Significant P-value > 0.05. The scientific explanation for this result related to composition of Charm-temp, Since the urethane linkages inside the polymer matrix are stable. Urethane composite resins have been found to be superior in previous research. Low molecular weight urethane di meth acrylates polymers have close or just a little sorption of water than Bis-GMA polymers [16]. In addition, Barium glass inorganic fillers to strengthen composite resin and minimize shrinkage and thermal expansion during the curing process[17]. The hardness of the test specimens reduced during seven days of preparation for artificial saliva, but there's no statistically difference between hardness of the test materials in both conditions (in dry environment) (after conditioning in artificial saliva) [1]. When hardness were measured in artificial saliva, these interim components displayed a substantial reduction **P<0.05** when applied to the control condition [15]. When comparing both materials in dry condition and after aging for two weeks in artificial saliva showed significant difference due to differences in material composition and their reaction to aging in artificial saliva.

Conclusion:

Within the limitations of this study: -
1- It was concluded that Surface hardness was different according to the type of prosthetic provisional restoration materials
2-Harvard-temp significantly affected by aging for two weeks in artificial saliva.
3- Charm-temp surface hardness not affected by aging for two weeks in artificial saliva.
4- Harvard-temp provisional material significantly harder than Charm-temp both in dry condition and after aging for two weeks in artificial saliva.
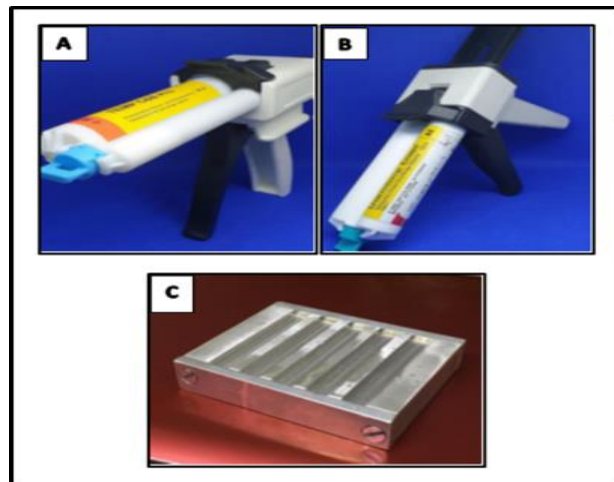
Acknowledgement

Fig. (1) (A)-dispensing gun used for mixing and dispensing of Harvard temp C& b pro
(B)-dispensing gun used for mixing and dispensing of Charm temp
(C)fabricated Custom metal rectangle mold with five holes measuring 64mm or 10mm by 2.5mm
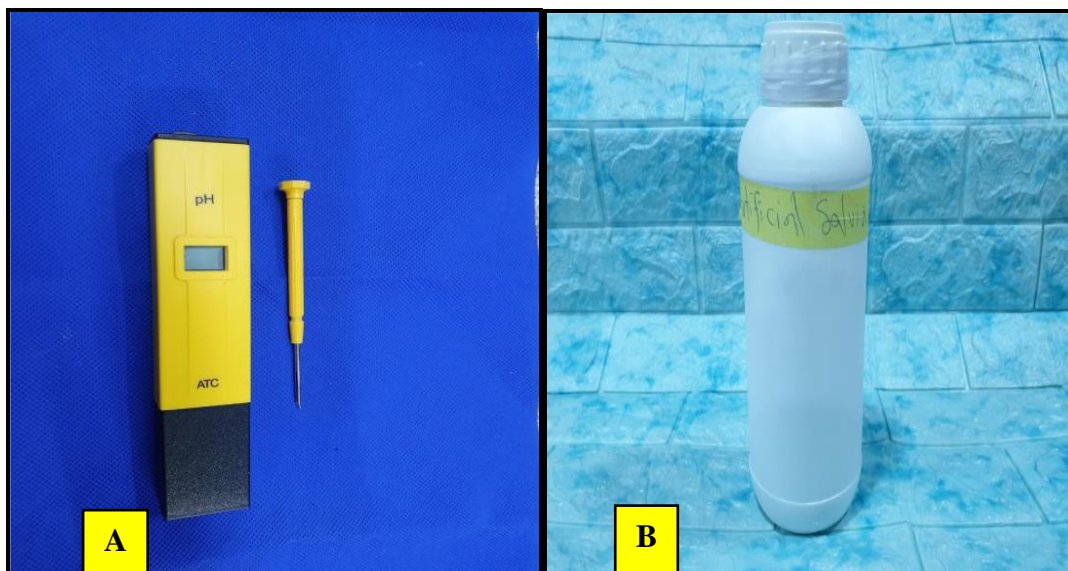

Fig.(2) (A) -normal artificial saliva (B) instrument measure pH of artificial saliva
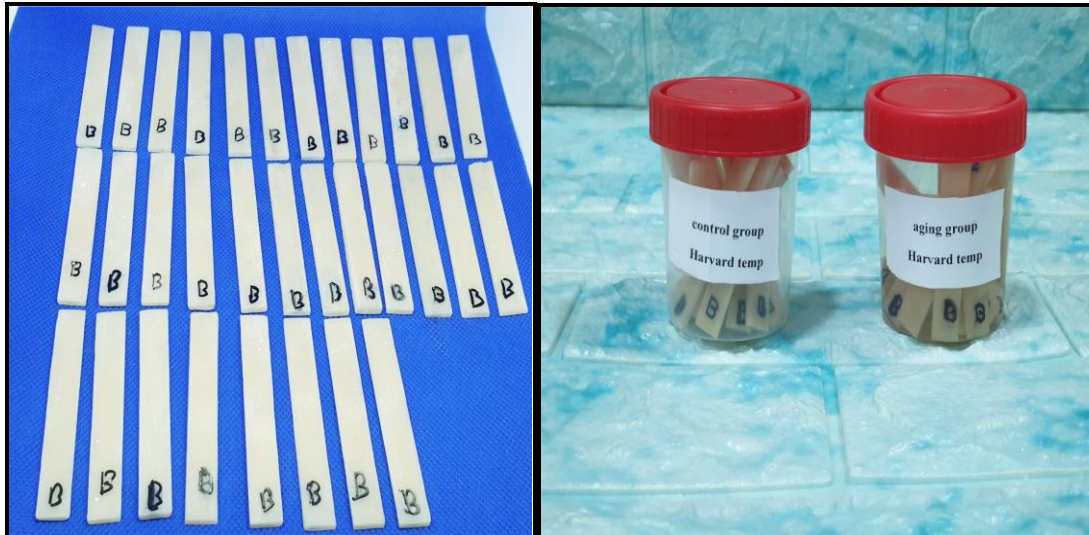
Fig .(3) Specimens of Harvard temp control and aging group

Fig .(4) Specimens of Charm temp control and aging group
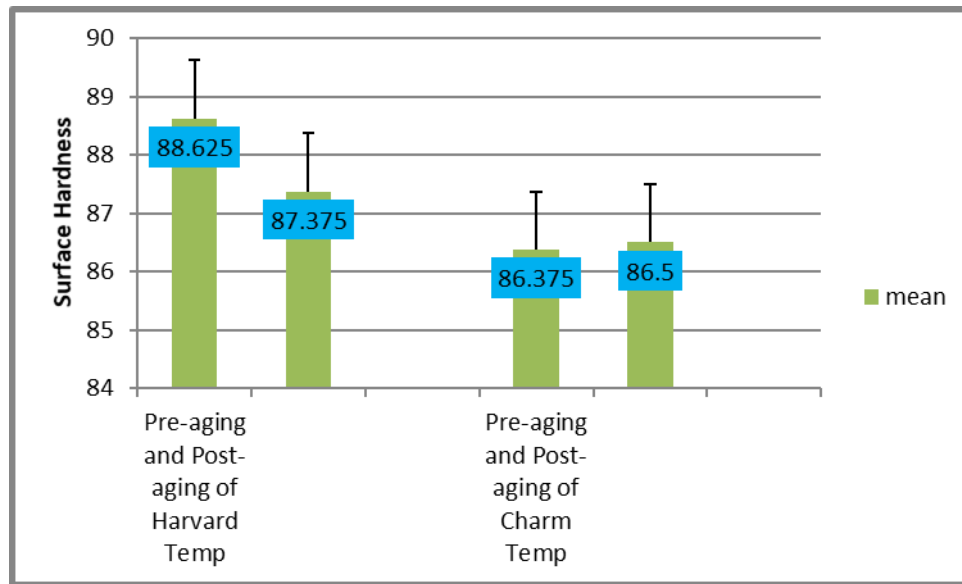

Fig. (5) hardness device (Shore-D)

Fig. (6) Bar chart showing means of the Surface Hardness shore (D) with standard deviation

Table (1): The study's products

Composites	Materials Industry	Composition
1. Harvard temp	Harvard Dental International GmbH Mar garetenstr 2-4 15366 Hoppe gar ten Germany	Unsaturated multifunctional meth acrylates multifunctional acrylates and malonyl urea
2. Charm temp	Dent Kist, Inc Korea	Barium Glass UDMA

Table (1) :Paired t-test between dry and aging in artificial saliva of Harand-temp and Charm-temp

Groups	t	P-value	Sig
Harvard-temp	3.416	.011	S
Charm- temp	0.552	.598	NS

Table (3): Paired t-test between Harvad-temp and Charm-temp of each experimental groups

Groups	Harvard temp Charm temp	t	P-value	Sig
Surface Hardness	dry	9.000	.000	HS
	storage	3.862	.006	S

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