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EFFECT OF HUMAN ENAMEL ON WEAR OF THREE TYPES OF INTERIM RESTORATIVE MATERIALS (AN IN-VITRO STUDY)

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ABSTRACT

Objectives: The purpose of the present study was to determine wear behavior of two different composite resin; UDMA / Urethane Dimethacrylate and bis-GMA based, compared with a PMMA conventional resin interim restorative materials.

Materials and Methods: Thirty samples (10 of each material; Revotek LC, TempSpan, Jet tooth shade) were prepared in the form of discs (10 mm diameter and 2 mm thickness), then all samples were subjected to Two-body wear simulation test using a programmable logic controlled equipment. Human enamel was used in this study as specimen's antagonist. Two wear measurement protocols; 1- roughness change measurement using the optical profilometry and, 2- weight loss measurement by electronic analytical balance were performed before and after loading

Results: Roughness change comparison between the experimental material groups showed that the highest roughness change was recorded for Revotek-LC group mean value (-0.000539 ±0.003 μm) followed by Jet tooth shade group mean value (-0.000478 ±0.001 μm) while the lowest roughness change was recorded for TempSpan group mean value (-0.0002 ±0.001 μm). The difference between groups was statistically non-significant. On the other hand, weight change results showed that the highest weight change was recorded for Jet tooth shade group mean value (-0.006717 ±0.0006 gr) followed by Revotek-LC group mean value (-0.00345 ±0.0021 gr) while the lowest weight change was recorded for TempSpan group mean value (-0.001167 ±0.0004 gr), and the difference between groups was statistically significant as indicated by ANOVA test followed by Tukey's post-hoc test ($p=<0.0001<0.05$) as indicated by ANOVA test followed by Tukey's post-hoc test ($p=0.9823>0.05$).

Conclusions: 1. There was no significant change in roughness of each tested interim restorative material before and after 3 months wear simulation cycles. 2. TempSpan and Revotek LC showed the highest wear resistance based on weight change measurements. 3. Jet tooth shade interim restorative material exhibit the lowest roughness change of enamel antagonist.

KEYWORDS: Composite resin, Acrylic resin, Interim restorations wear, Hardness.

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INTRODUCTION

The interim fixed restorations play a major role in success of definitive fixed prosthodontic restorations through providing the same functions.[1] They should primarily protect the pulp, maintain positional stability and occlusal function even through correcting irregular occlusal planes.[2] They also can restore the vertical dimensions alter the gingival contours and provide strength and esthetics for the abutment teeth.[3,4]

In many cases, interim restorations are used for a long period to evaluate the findings of endodontic and periodontal therapies, during the osseo integration and prosthetic phase of implant procedures, full mouth rehabilitation, tissue augmentation, alveoloplasty and orthodontics.[5]

Interim restorations have been divided into four main categories according to processing perspective, based on how they are transformed from plastic to solid masses: (1) chemically activated acrylic resins, (2) heat activated acrylic resins, (3) light activated composite resins, and (4) dual (or light and chemically) activated composite resins. From chemical perspective, there are two main groups: (1) Methacrylate Resin (Methylmethacrylate, Ethylmetacrylate, Vinylmethacrylate, Butylmethacrylate) and (2) Composite Resin (bis-GMA, bis-acryl, UDMA / Urethane Dimethacrylate).[6]

In addition to complex environment of oral cavity, a interim restoration is subjected to masticatory forces, that's why clinicians should be able to select an ideal product which is strong, durable, adapt accurately to the margin, and offer optimum mechanical properties, such as flexural strength, hardness, and wear resistance.[7-10]

Mastication is the most important function of teeth. It has been widely accepted that wear of dental materials in the oral cavity occurred mainly during chewing cycles, where the teeth, together with any restorations, move in contact with each other, resulting in friction and wear with the lubrication of saliva or food slurry.[11]

Dental wear has been accepted as a clinical problem that proceeds in a steady progressive mode, especially in the molar teeth, providing an estimation method of the evolution, age and diet of ancients in archaeology.[12-15]

Long lasting wear of the interim restorations, may result in loss of occlusal contacts, with consequent over eruption of antagonist teeth. In these situations, correcting the preparation and construction of new definitive restoration is a demand in order to adjust the occlusion.[16]

High wear resistance, which is the function of microstructure, properties of the materials and the wear process parameters, contributes to the longevity of the dental restorative materials and consequently, providing durable function and aesthetics of the restored teeth.[17] Although there are several published researches regarding mechanical properties of interim restorations,[2, 18-20] little is known about their wear behavior. The purpose of this study was to determine erosive wear behavior of two different bis-acryl based resins, compared with a PMMA conventional resin interim restorative materials. The null hypothesis was that there is no difference between wear resistance of the interim restorative materials.

MATERIALS AND METHODS

Three different interim materials (Revotek LC—GC Corp, TempSpan (Pentron Clinical Technologies, Jet self-cure tooth shade powder).

Preparation of Samples

Thirty samples (10 of each material) were prepared in the form of discs (10 mm diameter and 2 mm thickness) using especially designed custom made split brass mold (fig. 1) with two mold cavities.

Fig. (1) Split circular brass mold used to create disc samples.

The product names, types of materials and manufacturers are listed in Table 1.

TABLE (1) Materials names, types and manufacturers used in the study.

Brand	Material type	Manufacturer	Lot #
Revotek LC	light-cure urethane dimethacrylate resin	GC Dental Products, Tokyo, Japan	510291
Temp Span	Dual-cure Bis-GMA composite resin system	Pentron Clinical Technologies, LLC, USA	006379
Jet tooth shade	Chemical cure acrylic resin powder and liquid	Lang Dental Manufacturer, USA	P;2023215 L;144215BW

Revotek LC (GC Corporation, Japan): Light-cured single component composite resin. Group 1 – ten samples made. The mold was filled with the material using the spatula provided. and covered by myler strip over which glass plate was pressed. A light emitting diode (LED) powered visible light-curing unit (Spectrum 800™ curing unit; Dentsply Caulk, USA) was used for 40s in fast-cure mode (440-480 nm)

TempSpan (Pentron Clinical Technologies, LLC): Dual-cure resin system. Group 2 - ten samples made. The material was mixed using the amount of each component that was delivered by three turns of the dispensing syringes. The material was dispensed into the mold and allowed to auto-polymerize. To complete curing, light cure for 20 seconds. To remove oxygen inhibited layer each disc was treated with 99.9 % ethanol.

Jet tooth shade (Lang Dental Manufacturer, USA): Chemically cured two component systems. Group 3- ten samples made. The materials were dispensed, manipulated, and polymerized according to the manufacturers' instructions. The chemically cured materials were mixed in a mixing cup according to the manufacturers' suggested ratio, using a glass spatula until a homogeneous mix was obtained according to the manufacturer's directions. The materials were then placed separately into the mold as mentioned before and allowed to auto-polymerize.

After completely setting, the excess interim materials were ground by hand lapping with a 1000-grit silicon paper for 10 seconds. The surfaces of the samples were polished by one operator for 15 seconds using pumice, which was followed by rinsing with distilled water to remove any debris before immersion. All the samples were kept dry at room temperature until the rest of samples were fabricated.

Wear simulation test

Two-body simulated wear testing was performed using a programmable logic controlled equipment; the newly developed four chambers multimodal Dual-axis ROBOTA chewing simulator* integrated with thermo-cyclic protocol operated on servo-motor (Model ACH-09075DC-T, AD-Tech Technology Co., Ltd., Germany) (Fig. 2). The device allows simulation of the vertical and horizontal movements simultaneously. Each of the chambers consists of an upper Jackob's chuck as tooth antagonist holder that can be tightened with a screw and a lower plastic sample holder in which the sample can be embedded (Fig. 2). Specimens were mechanically loaded in the simulator and subjected

to 37,500 cycles of 49 N each at a frequency of 1.6 Hz. A total of 250 thermal cycles of 5°C to 55°C were performed simultaneously (Table 2). This wear protocol was chosen to simulate three months clinically according to previous studies.[21]

TABLE (2) Wear test parameters.

Vertical movement1 : mm	Horizontal movement3 : mm
Rising speed90 : mm/s	Forward speed90 : mm/s
Descending speed40 : mm/s	Backward speed40 : mm/s
Cycle frequency 1.6 Hz	Weight per sample 5 :kg

Human enamel antagonist specimen's preparation

Human enamel used in this study for in vitro wear testing against the experimental materials was produced by sectioning the premolars (n=15) that were recently extracted for orthodontic demands. Teeth with worn-out cusps or too sharp or fractured teeth were excluded. Longitudinal sectioning was performed mesio-distally using a low-speed cutting machine (Low Speed Saw 11e1180; Isomet) into two equal buccal and lingual halves (n=30). The enamel antagonist specimens were firmly gripped by tightening the Jackob's chuck of the upper part of wear simulator.[22]

Wear measurement

Roughness change measurement

The optical profilometry tend to fulfill the need for quantitative characterization of surface topography without contact.[23] Quantitative analysis of two-body wear on specimens and their antagonists was carried out before and after loading in a 3D-surface analyzer system. Specimens were photographed using USB Digital microscope with a built-in camera (Scope Capture Digital Microscope, Guangdong, China) connected with an IBM compatible personal computer using a fixed magnification of 120X. The images were recorded with a resolution of 1280 × 1024 pixel per image. Digital microscope images were cropped to 350 x 400 pixels using Microsoft office picture manager to specify/standardize area of roughness measurement. This area was chosen on the basis of the dimension of the typical bacteria expected to adhere to composite surface in vivo.[24] The cropped images were analyzed using WSxM software (Ver 5 develop 4.1, Nanotec, Electronica, SL).[25] Within the WSxM software, all limits, sizes, frames and measured parameters are expressed in pixels. Therefore, system calibration was done to convert the pixels into absolute real-world units. Calibration was made by comparing an object of known size (a ruler in this study) with a scale

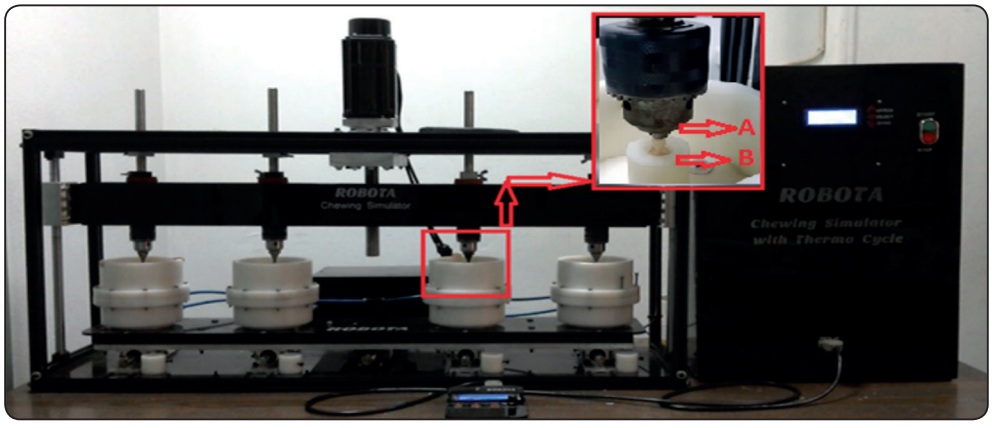

Fig. (2) Chewing simulator used for wear test (a) Enamel mounted and tightened into Jackob's chuck in the upper compartment as antagonist (b) Material disc in the lower compartment

generated by the software. WSxM software was used to calculate average of heights (Ra) expressed in μm , which can be assumed as a reliable indices of surface roughness.[26]

To achieve a better reflection on the surface of the samples and qualitative analysis of the wear areas, samples were examined and photographed using the same USB digital microscope at fixed magnification of X 25. Subsequently, a 3D image of the surface profile of the specimens was created using A digital image analysis system (Image J 1.43U, National Institute of Health, USA). The unworn surface served as a reference. With this method, a 3-dimensional geometry of the worn surface was generated.

Weight loss measurement

Weight loss was done by electronic analytical balance (Sartorius, Biopharmaceutical and Laboratories, Germany) with an accuracy of 0.0001 gr. to calculate the difference in weight before and after each wear cycles. As this electronic balance had a fully automated calibration technology and a micro weighing scale, values of all the mounted discs and antagonist samples were accurately measured. Each mounted sample was cleaned and dried with tissue paper before weighing. To ensure accuracy, the balance was kept on a free-standing table at all times - away from vibrations - and weighed the specimens with the glass doors of the balance closed to avoid the effect of air drafts

Statistical analysis

Data analysis was performed in several steps. Initially, descriptive statistics for each group results. One-way ANOVA followed by pair-wise Tukey's post-hoc tests were performed to detect significance between groups. Difference between weight before and after wear was found by paired t-test. Statistical analysis was performed using Graph-Pad Prism version 4.00 for Windows, Graph-Pad Software, San Diego California USA. P values ≤ 0.05 are considered to be statistically significant in all tests.

RESULTS

Roughness changes

The mean values and standard deviations (SD) for wear measured by roughness average (Ra measured in μm) recorded on all materials before and after 3 months wear simulation cycles summarized in table (3) and graphically represented in figure (3). The roughness change (μm) recorded for the antagonistic cusp is also shown.

In experimental material groups

For **Revotek- LC group;** it was found that the roughness mean value before wear was (0.255406±0.0048 μm) increased after wear simulation to mean value of (0.255944±0.0014 μm) with roughness change mean value (-0.000539 ±0.003 μm). The change in roughness was non-significant as demonstrated by paired t-test (p=0.7661>0.05)

For **TempSpan group;** it was found that the roughness mean value before wear was (0.254922±0.0019 μm) increased after wear simulation to mean value of (0.255122±0.002μm) with roughness change mean value (-0.0002 ±0.001 μm). The change in roughness was non-significant as demonstrated by paired t-test (p=0.8195>0.05)

For **Jet tooth shade group;** it was found that the roughness mean value before wear was (0.254756±0.0015μm) increased after wear simulation to mean value of (0.255233±0.0011 μm) with roughness change mean value (-0.000478 ±0.001μm). The change in roughness was non-significant as demonstrated by paired t-test (p=0.3396>0.05)

Comparison of roughness change between the experimental material groups; It was found that the highest roughness change was recorded for **Revotek-LC group** mean value (-0.000539 ±0.003 μm) followed by **Jet tooth shade group** mean value (-0.000478 ±0.001 μm) while the lowest roughness change was recorded for **TempSpan group** mean

value (-0.0002 ±0.001 μm). The difference between groups was statistically non-significant as indicated by ANOVA test followed by Tukey's post-hoc test (p=0.9823>0.05)

In enamel antagonist groups

For **Revotek LC group enamel antagonist;** it was found that the roughness mean value before wear was (0.261117 ±0.0027μm) decreased after wear simulation to mean value of (0.25705 ±0.0028 μm) with roughness change mean value (0.004067±0.001 μm). The change in roughness was significant as demonstrated by paired t-test (p=0.0271<0.05)

For **TempSpan group enamel antagonist;** it was found that the roughness mean value before wear was (0.261533 ±0.0023 μm) decreased after wear simulation to mean value of (0.25895 ±0.0026 μm) with roughness change mean value (0.002583±0.003 μm). The change in roughness was non-significant as demonstrated by paired t-test (p=0.1377>0.05)

For **Jet tooth shade group enamel antagonist;** it was found that the roughness mean value before wear was (0.261467 ±0.0052 μm) decreased after wear simulation to mean value of (0.26105±0.0036 μm) with roughness change mean value (0.000417±0.007 μm). The change in roughness was non-significant as demonstrated by paired t-test (p=0.8942>0.05)

Comparison of roughness change between the experimental material groups antagonist; It was found that the highest roughness change was recorded for **Revotek-LC group** mean value (0.004067±0.001 μm) followed by **TempSpan group** mean value (0.002583±0.003 μm) while the lowest roughness change was recorded for **Jet tooth shade group** mean value (0.000417±0.007 μm). The difference between groups was statistically non-significant as indicated by ANOVA test (p=0.5910>0.05).

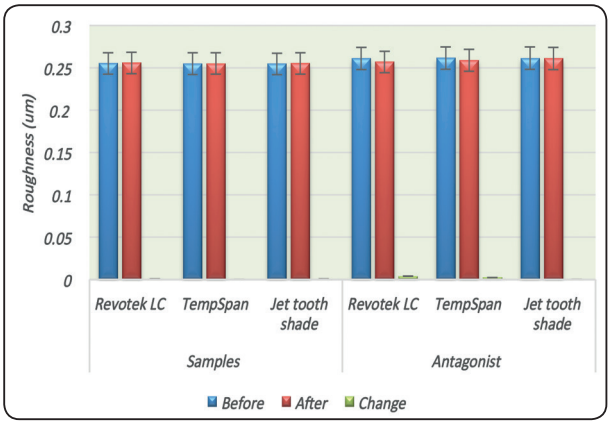

Fig. (3) Column chart showing wear by roughness change results mean values for experimental material groups and enamel antagonist before and after wear simulation.

Table (3) Wear results (Mean values ±SD) by roughness change for experimental material groups and antagonist before and after wear simulation

Variables		Samples roughness			Antagonist roughness		
		Before	After	Change	Before	After	Change
Material group vs. Enamel	Revotek LC	0.255406 ±0.0048	0.255944 ±0.0014	-0.000539 ±0.003	0.261117 ±0.0027	0.25705 ±0.0028	0.004067 ±0.001
	TempSpan	0.254922 ±0.0019	0.255122 ±0.002	-0.0002 ±0.001	0.261533 ±0.0023	0.25895 ±0.0026	0.002583 ±0.003
	Jet tooth shade	0.254756 ±0.0015	0.255233 ±0.0011	-0.000478 ±0.001	0.261467 ±0.0052	0.26105 ±0.0036	0.000417 ±0.007

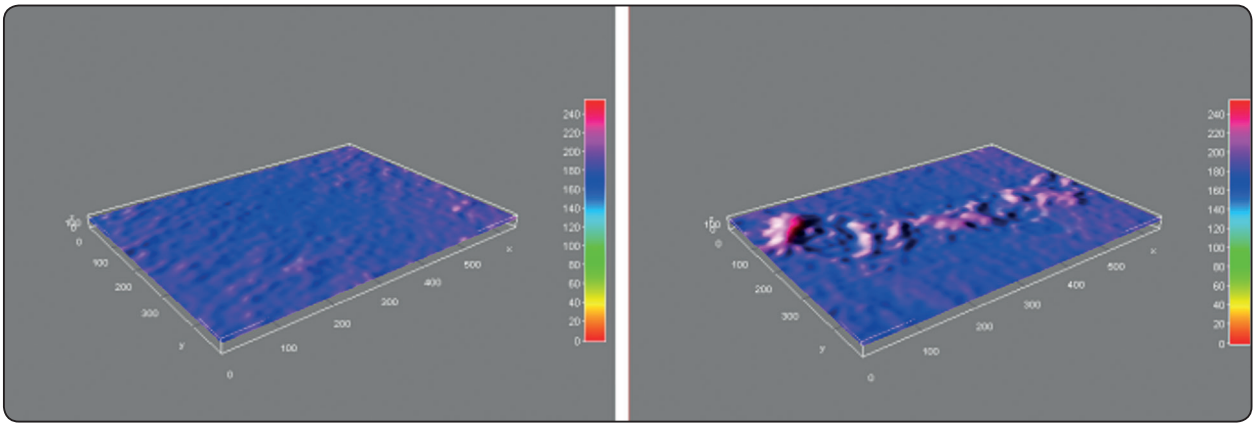

Fig. (4) Representative 3D image of experimental disc sample before and after wear simulation showing wear scar

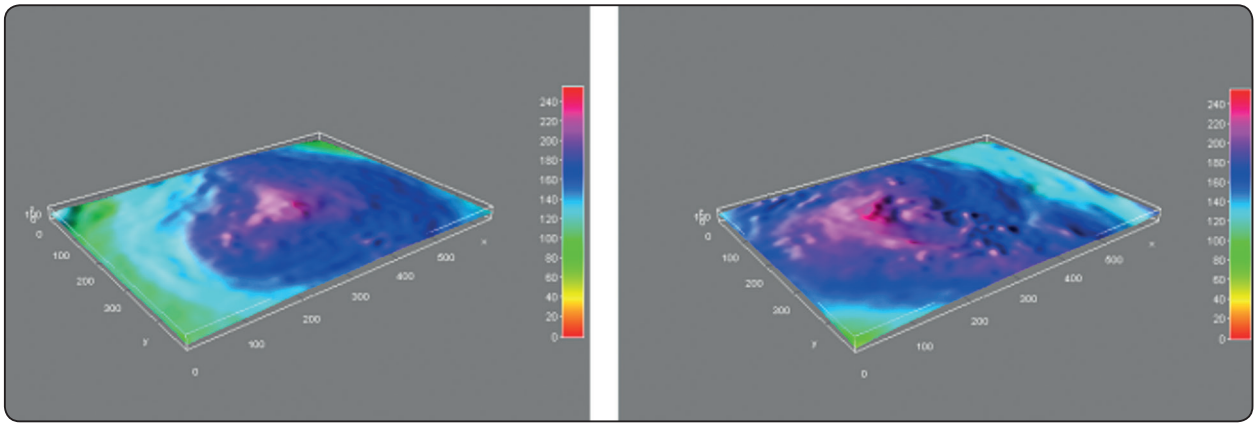

Fig. (5) Representative 3D image of enamel antagonist before and after wear simulation showing wear facet

Weight changes

The mean values and standard deviations (SD) for wear measured by weight loss (gram) recorded on all materials before and after 3 months wear simulation cycles summarized in table (4) and graphically represented in figure (6). The wear weight loss (gram) recorded for the antagonistic cusp is also shown.

In experimental material groups

For **Revotek-LC group;** it was found that the weight mean value before wear was (0.237117±0.0007 gr) decreased after wear simulation to mean value of (0.233667±0.0028 gr) with weight change mean value (-0.00345 ±0.0021 gr). The change in weight was significant as demonstrated by paired t-test (p=0.005<0.05)

For **TempSpan group;** it was found that the weight mean value before wear was (0.3229 ±0.0079gr) decreased after wear simulation to mean value of (0.321733±0.0081 gr) with weight change mean value (-0.001167 ±0.0004 gr). The change in weight was significant as demonstrated by paired t-test (p=0.0009<0.05)

For **Jet tooth shade group;** it was found that the weight mean value before wear was (0.180167±0.0055gr) decreased after wear simulation to mean value of (0.17345±0.0049 gr) with weight change mean value (-0.006717

±0.0006 gr). The change in weight was significant as demonstrated by paired t-test (p=<0.0001<0.05)

Comparison of weight change between the experimental material groups; It was found that the highest weight change was recorded for **Jet tooth shade group** mean value (-0.006717 ±0.0006 gr) followed by **Revotek-LC group** mean value (-0.00345 ±0.0021 gr) while the lowest weight change was recorded for **TempSpan group** mean value (-0.001167 ±0.0004 gr). The difference between groups was statistically significant as indicated by ANOVA test followed by Tukey's post-hoc test (p=<0.0001<0.05)

In enamel antagonist groups

For **Revotek LC group enamel antagonist;** it was found that the weight mean value before wear was (0.533133±0.1392 gr) decreased after wear simulation to mean value of (0.530983 ±0.1405 gr) with weight change mean value (-0.00215 ±0.0013 gr). The change in weight was significant as demonstrated by paired t-test (p=0.0053<0.05)

For **TempSpan group enamel antagonist;** it was found that the weight mean value before wear was (0.635517 ±0.0561 gr) decreased after wear simulation to mean value of (0.63165 ±0.0544 gr) with weight change mean value (-0.00387 ±0.0016 gr). The change in weight was significant as demonstrated by paired t-test (p=0.0011<0.05)

For **Jet tooth shade group enamel antagonist;** it was found that the weight mean value before wear was (0.728783 ±0.0081 gr) decreased after wear simulation to mean value of (0.724783±0.0078 gr) with weight change mean value (-0.00400 ±0.0007 gr). The change in weight was significant as proven by paired t-test (p=<0.0001<0.05)

Comparison of weight change between the experimental material groups antagonist; It was found that the highest weight change was recorded for **Jet tooth shade group** mean value (-0.00400 ±0.0007 gr) followed by **TempSpan group** mean value (-0.00387 ±0.0016 gr) while the lowest weight change was recorded for **Revotek-LC group** mean value (-0.00215 ±0.0013 gr). The difference between groups was statistically significant as indicated by ANOVA test (p=0.0374<0.05). Pair-wise Tukey's post-hoc test showed non-significant (p>0.05) difference between (**TempSpan** and **Jet tooth shade**) groups

TABLE (4) Wear results (Mean values ±SD) by weight change for experimental material groups and antagonist before and after wear simulation.

Variables		Samples weight			Antagonist weight		
Before		After	Change	Before	After	Change	
Material group vs. Enamel	Revotek LC	0.237117 ±0.0007	0.233667 ±0.0028	-0.00345^{B} ±0.0021	0.533133 ±0.1392	0.530983 ±0.1405	-0.00215^{B} ±0.0013
	TempSpan	0.3229 ±0.0079	0.321733 ±0.0081	-0.001167^{C} ±0.0004	0.635517 ±0.0561	0.63165 ±0.0544	-0.00387^{B} ±0.0016
	Jet tooth shade	0.180167 ±0.0055	0.17345 ±0.0049	-0.006717^{A} ±0.0006	0.728783 ±0.0081	0.724783 ±0.0078	-0.00400^{A} ±0.0007

Different superscript large letter in same column indicating significant between materials (Tukey's p<0.05)

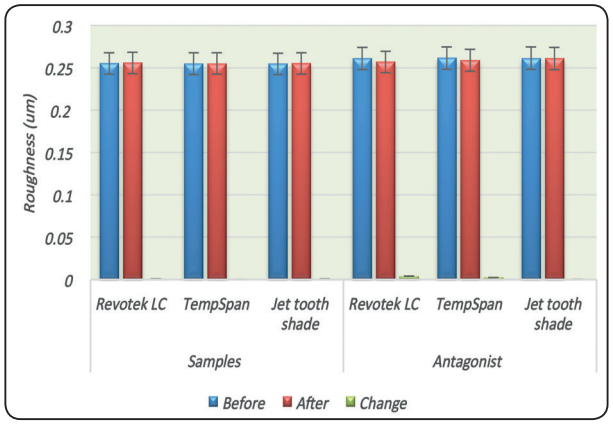

Fig. (6) Column chart showing wear by weight change results mean values for experimental material groups and enamel antagonist before and after wear simulation.

DISCUSSION

Interim restorations are required to fulfill numerous functions during their service time in the oral environment through providing several adjunct benefits to definitive prosthodontic treatment. They must reflect the variable treatment demands and requirements.[6]

Commonly used interim restoration materials are methacrylate resins and bis-acryl resin.[6] Methacrylate resins were the first available interim materials in dentistry that were introduced in the form of polymethyl methacrylate (PMMA) and polyethyl methacrylate (PEMA). PMMA first appeared around 1940, it is strong with a high coefficient of thermal expansion and high polish ability. However, it has a strong odor, low durability and high polymerization shrinkage. PEMA was introduced in the 1960s. Although less strong, durable, and abrasion-resistant than PMMA, it is a better alternative of direct interim prosthesis fabrication regarding biocompatibility and shrinkage.[6,27]

Bis-acrylic resin is similar to composite restorative materials because it is made of bis-acryl resin and inorganic fillers. Compared with methacrylate resins, it has superior strength, higher wear resistance, better marginal adaptation and lower shrinkage.[6,28.]

In addition to biocompatibility and good esthetic appearance, interim restorative materials should possess adequate strength, abrasion resistance and adequate wear resistance. The mechanical properties of interim materials may affect the integrity of interim restorations in situ when subjected to functional loads.[2,29,30]

Tooth surface loss caused by wear is a common clinical problem, where several epidemiologic researches suggesting up to 97% prevalence estimates, with about 7% of the population exhibiting pathological wear that requires treatment.[31] Wear of natural teeth and artificial materials can be classified into: physiologic, pathologic, prophylactic and finishing procedure wear.[32]

Physiologic wear, as a result of mastication function, is a progressive, very slow surface degradation that manifests as a flattening of cusp tips of molars and incisal edges of anterior teeth.[11,33-35] Compared with physiological wear, erosion, bruxism, xerostomia and some detrimental or occupational oral habits can cause excessive pathological wear of teeth and restorations according to many clinical reports.[32,33]

Hunter[36] descriped three modes of tooth wear in the mouth: attrition, abrasion and erosion, in one of the first textbooks of dentistry. Attrition and abrasion both are mechanical loss of tooth surface. While attrition is a result of two-body interactions, tooth-to-tooth, tooth-to-restoration or restoration-to-restoration, abrasion is caused by three-body interactions by introduction of exogenous agent such as food bolus, toothpaste, toothpick and dental floss.

Erosion is chemical or electrochemical surface loss of either teeth or restorations caused by action of acids of nonbacterial origin.[11] More recently, **Grippo**[37] coined a relatively new term 'abfraction'

to define non-carious, stress-induced dental hard tissue loss, which occurs most commonly at tooth cervix.

Most important sequelae of wear are Loss of occlusal anatomy and support, altering the vertical dimension of restored teeth, which may result in parafunction. In addition, wear progression and surface roughness not only suggest considerable patient discomfort and increased risk for periodontal disordres by the adhesion of biofilm on the temporary restoration,[38,39] It also provides foci for crack propagation induced by masticatory function. According to **Bollen et al**[40] surface roughness values higher than 0.2 μm facilitate microbial accumulation both in vitro and in vivo studies.

In order to simulate and investigate the tribological behaviour of dental materials systematically, three kinds of testing methods have been developed; in vivo, in vitro and in situ testing.[41]

Although in vivo methods provide a real oral environment and biomechanics,[33,42-44] they are subjective, sensitive time-consuming and expensive.[33,44] lack of control over important variables such as chewing force, dietary intake or environment factors could also significantly limits their contribution to wear mechanisms.[45] Therefore, in vitro simulation methods including: tooth brushing machines, two-body wear machines and three body wear machines have been introduced, incorporating several liquids such as water, alcohol, acids, olive-oil, olive-oil/CaF slurry, artificial saliva, with or without the inclusion of bacteria.[46]

As in vitro testing allows time saving, offers more controlled experimental variables and accurate measurements than in vivo testing[42] therefore, two-body simulated wear testing was performed in the present study. Surface hardness of the materials can be used as an indicator of density and wear resistance. Because it is a complex mechanical property which influences many other properties, such as strength, proportional limit, ductility, malleability and resistance to abrasion and cutting.[4]

According to the results of this study, it was noticed that although TempSpan group recorded the lowest roughness change mean value (-0.0002 ±0.001 μm), followed by Jet tooth shade group mean value (-0.000478 ±0.001 μm) and Revotek-LC group mean value (-0.000539 ±0.003 μm), difference between groups was statistically non-significant. These findings were agreed with **Oliveiraa et al**[47] who reported that there were no significant differences were observed among the acrylic resins evaluated and the composite resin which used as a parameter for comparison after water storage or thermocycling. In another study,[48] there were also no significant differences in the hardness and roughness values of the acrylic resins Dencor, Duralay and Vipi Cor. The study of **Şen et al**[49] showed that the methacrylate-based resin samples showed smoother surfaces than the bis-acrylic composite samples. This fact was related to the homogeneous composition of the acrylic in contrast of the heterogeneous composition of the composite, therefore wear could occur in more uniform pattern.

Based on weight change readings of this study, TempSpan group recorded the lowest weight change mean value (-0.001167 ±0.0004 gr) followed by Revotek-LC group mean value (-0.00345 ±0.0021 gr). While the highest weight change was recorded for Jet tooth shade group mean value (-0.006717 ±0.0006 gr). The difference between groups was statistically significant. Thus the null hypothesis was rejected

The lowest wear of bis acryl than MMA resin based interim restoration may be attributed to increased degree of conversion and a high concentration of cross-linking agents.[50]It has been also reported that surface hardness of composite resins is affected by both the organic matrix (monomers) and the inorganic fillers.[51,52] Regarding the organic matrix, it was found that the presence of aromatic groups in the monomers BisGMA and

BisEMA provides a polymeric structure with higher rigidity.[53]

These results were agreed with **Takamizawa et al**[54] who found that the wear rates of UniFast III (MMA) resin demonstrated significantly higher wear values than the three bis-acryl resins in wear mean depth and volume loss at 200,000 cycles.

TempSpan is a dual-cured bis-acryl resin that may increase the degree of polymerization, compared with Revotek LC and Jet materials.[8] The dual cure nature may have allowed more continual cross linking to take place. As a result, wear can be decreased significantly as the degree of cure, strength and toughness of the resin matrix increases.[55]

In contrast, the study conducted by **soderholm et al**[56] showed that Revotek, light polymerized composite resin material, which based on Urethane Dimethacrylate (UDEMA) resin matrix had better wear resistance than that of bis-GMA formulation.

For wear evaluation of dental materials, it is important that combined or total wear of both the material of interest and the opposing material to be considered, because materials may be worn by the antagonist or they may cause aggressive wear of the antagonist; especially if the opposing material is enamel.[44] Hardness is the resistance to permanent indentation, penetration or surface deformation therefore, can be used for prediction of the wear resistance and its abrasion ability to dental.[4]

Based on roughness change values of experimental enamel antagonist groups; Revotek-LC group recorded in this study the highest abrasion and roughness change mean value of opposing enamel ($0.004067\pm0.001\mu$m) followed by TempSpan group mean value ($0.002583\pm0.003\mu$m) while the lowest roughness change was recorded for Jet tooth shade group mean value ($0.000417\pm0.007\mu$m).

This is partially concurring with **Muley et al**,[57] where Bisacryl resin based Luxatemp Star showed significantly superior flexural strength and hardness as compared to the DPI Self Cure in dietary simulating solvents. It can be due to high capacity of bifunctional acrylates, incorporated in bis-acryl resin matrix, to cross-link with another monomer chain providing increased mechanical strength and hardness to the material.[2,18] More over differences in wear between composite resin based restorations used, might be interpreted by in-organic filler particles, their distribution, degree of conversion and the bond between the matrix and the fillers.[58,59]

CONCLUSIONS

Within the limited scope of the present study, the following conclusions can be drawn:

1. There was no significant change in roughness of each tested interim restorative material before and after 3 months wear simulation cycles.
2. TempSpan and Revotek LC showed the highest wear resistance based on weight change measurements.
3. Jet tooth shade interim restorative material exhibit the lowest roughness change of enamel antagonist.

CLINICAL RECOMMENDATIONS

The use of PMMA not suitable as long term interim restorative material due to its higher wear rates, compared with Urethane Dimethacrylate (UDEMA) and bis-GMA based resins.

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