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Color stability and surface roughness of different recent provisional restorative materials” An In vitro study

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Abstract

Objectives: To evaluate the effects of staining solutions on the color stability and roughness of different provisional resin materials.

Materials and methods: The 105 specimens were divided into 5 groups according to type of provisional restorations twenty one test specimens for each group (N=21). Each material group specimens subdivided into 3 sub-groups according to coloring solutions (n=7) one group immersed in artificial saliva, the second in coffee solution and the third in mouth wash. Baseline color measurements, using spectrophotometer then after 2 and 4 weeks to measure color change (ΔE) by means of the CIE L*a*b* system. Surface roughness also were measured using profilometer for all specimens before and after immersion in staining solutions.

Results: In Color change (ΔE) the results showed that provisional material, Immersion media, and Time had a statistically significant effect on mean ΔE . The interaction between the three variables had a statistically significant effect on mean ΔE indicating that the variables are dependent upon each other. Change in surface roughness (ΔRa), in Comparison between provisional materials: After immersion in the three solutions, there was a statistically significant difference between mean ΔRa of provisional materials. In Comparison between immersion media With Prottemp4, Tempron, Vita CAD temp as well as breCAM.multiCOM; there was no statistically significant difference between mean ΔRa of immersion media, but with Tuff temp; there was a statistically significant difference between mean ΔRa of immersion media.

Conclusions: Type of provisional restorative materials, staining solutions and immersion times are significant factors that can affect color stability of the five provisional restorative materials tested, type of provisional restorative materials was the only significant factor for surface roughness, so choosing type of material must be the interest regarding to smoothness.

Keywords: Provisional materials, immersion media, time of immersion, color change, roughness.

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Introduction:

The Provisional resin restorations provide interim protection, esthetics, mastication, and maintain the abutment position while the definitive restoration is being fabricated. The surface smoothness and color stability are two of the most important requirements of the ideal provisional resin restorations [1]. The purpose of this study was to investigate the difference in performance of provisional crown materials that were fabricated either by a traditional direct technique or with the more sophisticated indirect CAD/CAM approach. There are many reasons why the surface of a restoration should be made as smooth as possible. It serves to ensure long-term esthetic success including color stability, and it is also noteworthy that prosthetic material wear is partly determined by surface finishing (i.e., polishing and/ or glazing)[2].

Material and Methods:

A total of one hundred and five specimens (105) specimens fabricated from 5 provisional resin materials; 3conventional provisional restoration

materials and 2 CAD/CAM provisional restoration materials. The test samples in this study were fabricated in the form of disks measuring 10 mm in diameter and 2 mm in thickness; to standardize disks sizes. For the manually provional materials they were prepared using teflon mold [3, 4] . The mold has a disk space (dimensions 2 x 10 mm) in which the manually fabricated provisional restoration materials (Protemp4, Tempron and Tuff Temp) were poured to construct specimens with these dimensions. After pouring the specimen, to achieve uniform disk specimen thickness it was covered and pressed by glass slide from the top, after curing the screws was unwind and the two parts were separated then the specimen removed easily from the mold space. The 2 CAD/CAM provisional restoration material specimens will be fabricated by the same mentioned dimensions using Isomet saw [5].VITA CAD Temp blocks were milled under water-cooling obtaining a cylindrical shape (10 mm of diameter) and then they were sectioned using a diamond saw (Isomet saw,

Buehler, Lake Bluff, IL, USA)^[6]. A breCAM.multiCOM disk, was milled same as vita cad temp. The specimens were finished by using wetting sand paper then using Enhance finishing and polishing system used. Finally the specimens were ultrasonically cleaned ^[5, 7, 8].



Figure (1): show an examples of provisional materials before &after immersion

The 105 specimens were divided into 5 groups according to type of provisional restorations twenty one test specimens for each group (N=21). Each material group specimens subdivided into 3 sub-groups

according to coloring solutions (n=7), immersed in 20 mL from each solutions; one group immersed in artificial saliva, the second in coffee solution and the third in listerine, then each group coded by the name of provisional restorations, the coloring solutions, and the number of the specimen from 1 to 7^[9, 10] as in figure (1). After obtaining baseline color measurements, by Spectrophotometer to measure color change (ΔE) by means of the CIE L*a*b* system figure (2). The twenty one specimens of each provisional restorative materials were placed in a correspondingly labeled container containing one of the three immersion solutions, then incubated^[11] at 37°C and stored in the dark place to simulate body temperature, and after 2 and 4 weeks^[12]. A profilometer (TR200, Qualitest, USA) figure (2), was used for evaluation of surface roughness (R_a , μm) of the specimens before and after immersion procedures. A diamond stylus (tip radius, 5 μm) was moved across the surface under a constant load of 0.75 μN ^[13]. The optical methods tend to fulfill the need for quantitative characterization of surface

topography without contact ^[14]. 3D Surface Roughness measurement using a Light Sectioning Vision System.



Figure (2) spectrophotometer, Profilometer and 3D optical microscope.

Results:

Color change (ΔE): The interaction between the three variables had a statistically significant effect on mean ΔE indicating that the variables are dependent upon each other. **Regardless of immersion media and time;** there was a statistically significant difference between provisional materials revealed

that Tuff temp showed the statistically significantly highest mean ΔE , then Tempron. There was no statistically significant difference between Protemp4 and breCAM.multiCOM; both showed statistically significantly lower mean ΔE . Vita CAD temp showed the statistically significantly lowest mean ΔE .

Regardless of provisional material and time; there was a statistically significant difference between mean ΔE at different immersion media. Pair-wise comparisons between immersion media revealed that coffee showed the statistically significantly highest mean ΔE . There was no statistically significant difference between mouth wash and artificial saliva; both showed the statistically significantly lowest mean ΔE values.

Regardless of provisional material and immersion media; there was a statistically significant increase in mean ΔE at second measurement.

Change in surface roughness (ΔRa); **Comparison between provisional materials:** After immersion in **mouth wash;** there was a statistically significant

difference between mean ΔRa of provisional materials, revealed that Tempron showed the statistically significantly highest mean ΔRa . Followed by Tuff temp followed by Vita CAD temp then Protemp4. All the previous materials showed an increase in Ra while breCAM.multiCOM showed a decrease in Ra with statistically significant difference from all materials. **After immersion in artificial saliva;** there was a statistically significant difference between mean ΔRa of provisional materials, revealed that Tempron showed the statistically significantly highest mean ΔRa then Tuff temp followed by Vita CAD temp then Protemp4. All the previous materials showed an increase in Ra while breCAM.multiCOM showed a decrease in Ra with statistically significant difference from all materials. **After immersion in coffee;** Tempron showed the statistically significantly highest mean ΔRa . There was no statistically significant difference between Protemp4, Tuff temp and Vita CAD temp; all

showed statistically significantly lower mean ΔRa values.

Comparison between immersion media:

With Protemp4, Tempron, Vita CAD temp as well as breCAM.multiCOM; there was no statistically significant difference between mean ΔRa of immersion media. **While with Tuff temp;** there was a statistically significant difference between mean ΔRa of immersion media (P-value = 0.017, Effect size = 0.341). Pair-wise comparisons between media revealed that artificial saliva showed the statistically significantly highest mean ΔRa . Mouth wash showed statistically significantly lower mean value. Coffee showed the statistically significantly lowest mean ΔRa .

Discussion:

The five provisional resin restorative materials used divided into 2 groups according to the method of construction; manually fabricated group (Protemp4, Tuff Temp, Tempron) and CAD/CAM group (VITA CAD Temp ,Brecam

MultiCom). The introduction of provisional CAD/CAM restorations promises a certainly easier method of fabrication for the clinician, but also offers potentially stronger provisional restorations. However, there may be an impetuosity to use CAD/CAM provisional materials, these restorations comprise a more expensive alternative to conventional directly made provisional restorations. Many trials were applied to improve the physical and mechanical properties of provisional resin materials. Among ways for improvement is the modification of fabrication method as direct, indirect fabrication and milling from CAD/CAM resin blocks.

Results of color showed; effects of provisional materials: Tuff temp showed the highest color change in the present study, may be due to most bis-acryl polymers are more polar than PMMA. Additionally dual-cured composite materials color stability depends on the photoinitiator component, resin matrix composition, light-curing device, and irradiation time, so chemical discoloration has been attributed to an

oxidation of the polymer matrix or oxidation of unreacted double bonds^[16] and agreed with Sultan R. Binalrimal, Peter Yaman^[17]. On the other hand results revealed that **tempron** has color change more than **protem4** which was unlike tuff temp and the previous studies; may be due to manipulation technique (powder-liquid). It demonstrated air inclusions surface voids and porosity of this material which were evident after polishing which contribute to color change noted in this study more than **protem4**, which agreed with numerous studies^[9, 18, 19] however, these values disagree and differ from the studies of Rutkunas and et al^[24] Jalali^[25]. And **BreCAM.multiCOM** are polymerized under controlled and standardized industrial conditions with optimized pressure and temperature parameters. This leads to a higher color stability of CAD/CAM- fabricated temporary restorations from industrially fabricated resin blocks, compared to conventionally fabricated ones. Agreed with Koroğlu^[13] And with Rayan^[26, 27]. **Vita CAD temp showed the statistically significantly**

lowest mean ΔE ; due to in addition to advantages of CAD CAM fabrication technique, it consists of a fiber-free, homogeneous, high-molecular and cross-linked acrylate polymer with micro-particle filler. And because the more homogeneous a polymer is, the less water is absorbed and the less soluble characteristics it has, which agreed with [28,29]. Result revealed **that coffee showed the statistically significantly highest mean ΔE . There was no statistically significant difference between mouth wash and artificial saliva; may** be due to the smaller molecular size of coffee coupled with both water absorption and adsorption^[30] of polar colorants onto the surface of materials. characteristic of the tested materials, creating a stronger staining effect^[31]. **Listerine** has some physical-mechanical properties of resin composites, softening the aesthetic restorative materials and significantly increasing the biodegradation of the resin composites over time, which agree with Canan Akay ^[35]. Also **artificial saliva** resulted in visible color changes in the materials that may due to water

accumulation and photo-oxidation affected the internal colors of provisional restorative materials^[24, 36-38]. There was a statistically significant increase in mean ΔE **at second measurement**. As the duration of immersion increased, longer the material is exposed to various factors, the greater the chances for color alteration and increased roughness as with da Fonsêca Costa^[9] **Results of Roughness revealed that;** all the previous materials showed an increase in Ra while BreCAM.multiCOM showed a decrease in Ra with statistically significant difference from all materials. **Tempron** showed the statistically significantly highest mean ΔRa in the all immersion media **followed by Tuff temp**, this explained by small, but visible, surface voids and porosity of the material which were evident after polishing of the Tempron specimens. Tuff-Temp is urethane dimethacrylate (UDMA), which is a bis-acrylic material showed high surface roughness may be due to its polarity so has great affinity to water, similar to the study findings of Ayuso-Montero,^[19] and in contrast, several

studies [18, 39, 40] noted the smoother surfaces of methacrylate resins compared with those of bis-acryl composite resins. **Protemp4 showed lower mean ΔRa than Vita CAD temp; the addition of nanofillers was claimed to provide a smooth surface after the polishing process.** Which agree with Hamad et al [77]; the addition of nano-silica (nano-SiO₂) and (nano-Al₂O₃) particles has a noticeable effect on the all properties; but disagree with the study that showed; the surface of the CAD/CAM provisional crowns were smoother than the Bis-acryl provisional crowns. And Anja Liebermann^[29], showed that the highest solubility was observed for the conventional protem4. **BreCAM.multiCOM showed the lowest mean ΔRa ;** despite VITA CAD-Temp was CAD CAM fabricated, but the chemical structure of BreCAM.multiCOM that consist of polymethyl methacrylate and has been offset with >20% ceramic fillers and VITA CAD-Temp that consist of a high-molecular and cross-linked acrylate polymer with 14 % microparticle filler

(silica). But disagree with Sen et al. [22] who reported presence of filler particles may prevent the surface of the material from being smoothed [39], and said the fillers to cause protrusions to be formed over the surface of the material.

Effect of storage media, with all provisional materials; there was no statistically significant difference between mean ΔRa of immersion media.

Conclusion:

Under the limitation of this study, several conclusions as:-

- ❖ Type of provisional restorative materials, staining solutions and immersion times are significant factors that can affect color stability of the five provisional restorative materials tested.
- ❖ Type of provisional restorative materials was the only significant factor for surface roughness, so choosing type of material must be the interest regarding to smoothness.
- ❖ Under the conditions of this study, CAD CAM provisional materials were more color stable and less

change in surface roughness compared to manually conventional type in exception of protemp4 that showed values very close or similar to CAD CAM materials.

- ❖ Coffee had the most effect in color changes.

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