Article

Alterations in Surface Gloss and Hardness of Direct Dental Resin Composites and Indirect CAD/CAM Composite Block after Single Application of Bifluorid 10 Varnish: An In Vitro Study

Tamer M. Hamdy [1,*], Ali Abdelnabi [1], Maha S. Othman [2] and Rania E. Bayoumi [3]

1   Restorative and Dental Materials Department, Oral and Dental Research Institute, National Research Centre (NRC), El Bohouth St., Dokki, Giza 12622, Egypt; ae.abdel-naby@nrc.sci.eg
2   Operative Dentistry Department, Faculty of Dentistry, Cairo University, Cairo 11553, Egypt; mahakarawan@yahoo.com
3   Biomaterials Department, Faculty of Dentistry (Girls), Azhar University, Cairo 11754, Egypt; raniaezzat.26@azhar.edu.eg
*   Correspondence: tm.hamdy@nrc.sci.eg

Abstract: The surface characteristics of the restorative material are essential to its longevity. Since resin composites are polymeric-based materials, they could be degraded when exposed to oral conditions and chemical treatment. Certain chemical solutions, such as fluoride varnish, have the potential to deteriorate the resin composite's surface properties such as gloss and hardness. The current study aimed to assess and compare the surface gloss and hardness of different types of dental resin composites (nanohybrid, ormocer, bulk-fill flowable direct composites, and indirect CAD/CAM resin composite blocks (BreCAM.HIPC)) after a single application of Bifluorid 10 varnish. A total of 80 disc-shaped resin composite specimens were evenly distributed in four groups of 20 specimens. These were divided into two equal subgroups of specimens with topical fluoride (TF) application (n = 10) and without TF application (n = 10). The specimens were examined for surface gloss and hardness. Independent sample t-test was used to investigate statistically the effect of TF on the gloss as well as the hardness of each material. One-way ANOVA and post hoc tests were used to assess the difference in gloss and hardness among the materials without and with TF application. The significance level was adjusted to $p \leq 0.05$. The results of gloss showed that the TF application led to a significant reduction in gloss values of all tested composites. The gloss among the various materials was significantly different. The TF had no significant effect on the hardness of nanohybrid, bulk-fill flowable, and BreCAM.HIPC composites (p = 0.8, 0.6, and 0.3, respectively). On the other hand, the hardness of ormocer was significantly reduced after TF application. Comparing the different resin composite materials, the hardness significantly differed. This study concluded that surface gloss and hardness seem to be impacted by the type and composition of the resin composites and vary depending on fluoride application.

Keywords: Bifluorid; dental composites; nanohybrid; ormocer; bulk fill; flowable; indirect composite; surface gloss; surface hardness

1. Introduction

In dental practice, dentinal hypersensitivity (DH) is a prevalent disease, especially in patients with abrasion, gingival recession, and tooth erosion [1]. It is a painful condition generated by the exposed cervical dentin, causing a severe, stabbing pain [2]. It affects around 20% of the population [3]. Dentin hypersensitivity can be managed in the dentist's office with specific topical agents or through self-applied therapy at home. Topical application of gels, solutions, varnishes, resin sealers, and dentin adhesives are examples of in-office desensitizing treatment methods for managing hypersensitivity [4]. Fluoride varnishes are one of the most widely used dental care techniques nowadays. Most fluoride

varnishes comprise 5% sodium fluoride; nevertheless, the manufacturer may have various fluoride concentrations and forms [5]. Sodium fluoride varnish is regarded as the gold standard desensitizing substance [6]. Bifluorid 10 (5% sodium fluoride and 5% calcium fluoride) adheres to the teeth and begins to provide instant protection from any damaging stimulus [7]. Moreover, it encourages the calcium fluoride to precipitate, sealing the open dentinal tubules [5]. The biocompatibility of dental restorations and the use of natural polymers and inert dental materials are of great concern in dentistry [8].

Direct and indirect dental resin composites are used in daily clinical practice due to their esthetics. The durability of the resin composites is significantly influenced by the properties of the surface. Chemical treatments or even preventive measures like fluoride varnish and other dental hygiene products can harm the surface of restorative materials [9,10]. They may have adverse effects on resin composites, like discoloration, surface erosion, reduced surface hardness, and the dissolving of inorganic fillers [11].

A more realistic appearance with improved esthetic and surface qualities has been attained by numerous advancements in dental composites. Surface gloss has a significant impact on whether composites look visually appealing [12]. The loss of gloss in resin composites has a detrimental effect on esthetics, since it determines whether the surrounding teeth are harmonious or not [13]. One of the most crucial elements in attaining superior clinical results and satisfactory esthetics is the restoration's surface quality [10]. The surface quality of the material directly affects its ability to reflect direct light. Surface gloss is frequently used to determine dental materials' surface characteristics [9]. The gloss is a result of the arrangement of light reflected on the surface and is closely correlated with surface roughness [9]. Increased surface gloss improves the esthetic appearance of the resin composites [14]. The clinical outcome of restoration depends on the surface hardness of the resin composites [15]. Changes in oral conditions may have the potential to damage the surface of the resins and change their surface hardness by influencing degradation of the organic part of the resin matrix [15,16].

Recent resin composites typically express surface and optical properties that closely mimic those of the natural dental structure and demonstrate attractive clinical endurance [17]. Resin-based composites are comprised of a matrix of organic substances, coupling agents and inorganic fillers, and other elements such as polymerization inhibitors, initiators, accelerators, photosensitizers, and photoinitiators. Advancements in filler technology (such as nanohybrid composites) and matrix formulations (e.g., ormocer and bulk-fill flowable composites) provide enhanced mechanical properties of the recent composite materials [12]. In addition, the introduction of indirect CAD/CAM resin composite blocks enhances their esthetic appearance and mechanical performance [18]. Composite CAD/CAM blocks were introduced as a material to enhance and adequately cure under elevated pressure and temperature, resulting in an increased conversion rate. The manufacturers claimed that it provides enhanced mechanical, chemical, and optical properties, which increase gloss retention, which is an important factor for a better esthetic appearance [19].

There is no information available comparing the gloss retention and hardness of newly introduced CAD/CAM composites and the other direct resin composites, when exposed to topical application of single-dose fluoride varnishes. This in vitro study was aimed to assess the surface gloss and hardness of different types of dental resin composites (nanohybrid, ormocer, bulk-fill flowable direct composites, and indirect CAD/CAM resin composite blocks) after a single application of Bifluorid 10 varnish. The null hypothesis was that there was no difference between the tested types of resin composites as regards their surface gloss and hardness. In addition, the single application of Bifluorid 10 varnish did not alter the surface gloss or hardness of the tested types of resin composites.

2. Materials and Methods

This study measured the change in the surface gloss and hardness of three direct dental resin composites and one indirect CAD/CAM composite block after a single application of Bifluorid 10 varnish. The three commercial direct resin-based composite materials

were nanohybrid composite, ormocer composite, and bulk-fill flowable composite, while the indirect CAD/CAM resin-based composite blocks were BreCAM.HIPC. Bifluorid 10 varnish was used in a single application. The commercial materials used in this study are listed in Table 1.

Table 1. The manufacturer's information of the materials used in the study.

Material	Manufacturer	Classification	Composition	Filler Content (wt%-vol%)	Filler Size
Luna nanohybrid composite	SDI limited, Bayswater, VIC, Australia	Nanohybrid	Resin: UDMA, Bis-EMA, TEGDMA; filler: SAS, AS	77/59	0.02–2 µm; 200–400 nm
Ceram.X® Mono	Dentsply Sirona GmbH, Konstanz, Germany	Ormocer	Resin: methacrylate resins and ethyl-4 (dimethylamino) benzoate; filler: methacrylate-modified polysiloxane (organically modified ceramic), barium–aluminum–borosilicate glass, and silicone dioxide nanofillers.	76/57	Glass filler mean size 1.1–1.5 µm; nanofillers 2.3–10 nm
SDR Plus	Dentsply Sirona, Konstanz, Germany	Bulk-fill flowable	Resin: modified UDMA, Bis-EMA, and TEGDMA; filler: Ba-Al-F-B-Si-glass and Sr-Al-F-Si-glass.	68/45	Mean 4.2 µm
breCAM. High-impact polymer composite (HIPC)	BreCAM.HIPC, Bredent, Eiterfeld, Germany	Indirect CAD/CAM blocks	Matrix: ultracompact thermoplastic amorphous cross-linked; PMMA Filler: ceramic microfiller (20%).	N/A	N/A
Bifluorid 10 varnish	VOCO GmbH, Cuxhaven, Germany	Bifluorid	5% sodium fluoride (equal to 22,600 ppm fluoride) and 5% calcium fluoride.	------	--------

2.1. Sample Size Calculation

The data for sample size calculation considered hardness and gloss, and based on these, the highest sample size was chosen. A standard sample size calculation was performed according to previous studies conducted by Gehlot et al. and MIKAMI et al. [15,20] in which the formula for analysis of variance was applied in G*Power statistical software (version 3.1.9.7). The average standard deviation (SD) was 0.150. Giving an alpha value of 0.05, a beta (β) level of 0.10 (10%), i.e., power = 90%, and an effect size (f) of 0.78. The minimum sample size needed with this effect size is n = 9 per group to test surface gloss and hardness. Thus, the obtained sample size of n = 10 per group is more than adequate to test the study hypothesis.

2.2. Study Design

A total of 80 disc-shaped resin composite specimens (8 mm diameter × 1 mm thickness) were made and standardized and evenly distributed in four groups of 20 disc-shaped specimens. These were divided into two equal subgroups of specimens with topical fluoride (TF) application (n = 10) and without TF application (n = 10) (Figure 1). The specimens were examined for surface gloss and hardness.
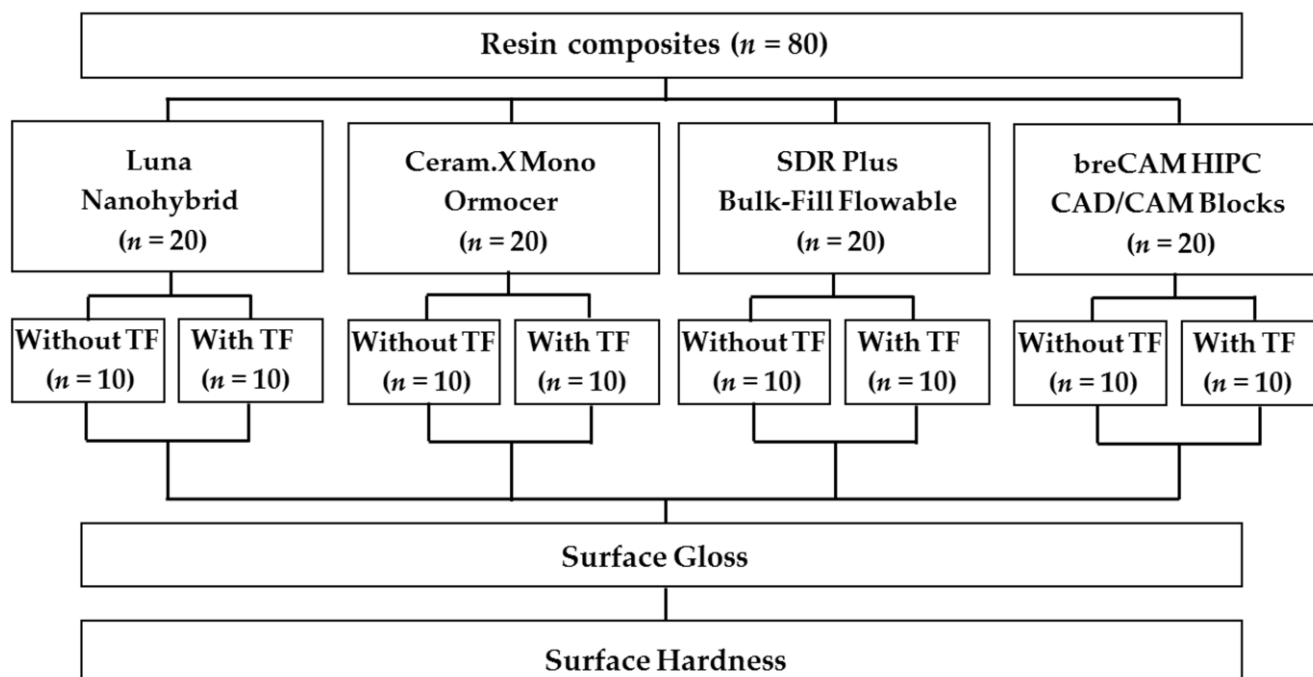
Figure 1. Distribution of groups according to resin composite type, topical fluoride application (TF), surface gloss, and hardness.

2.3. Specimen Preparation

Disc-shaped Teflon molds with a dimension of 8 mm diameter and 1.1 mm thickness were filled with each type of direct resin composite [21]. The composites were gently pressed against transparent polyester strips (Mylar strip; SS White Co. Philadelphia, PA, USA) and a glass slide. The resin composites were then light-cured for 20 s using a high-power light emitting diode (LED) curing unit (LED device Mini LED, Satelec, Acteon, Viry-Châtillon, France) placed in contact with the 1 mm glass slide for distance standardization, at an irradiance of 1200 mW/cm^2 and wavelength of 400–500 nm that was measured with an LED radiometer (Demetron, Kerr, Halluin, France). Afterward, all specimens were polished, from the measuring side for 30 **s** using a fine composite polishing kit (Shofu Composite Polishing Kit, Shofu Dental GmbH, Ratingen, Germany) with the purpose of achieving a final thickness of 1 mm. The indirect CAD/CAM resin composite blocks were reduced by standardizing the same dimensions using CAD/CAM Machine (group LU, Lava Ultimate A2 LT (3M USA, Saint Paul, MN, USA) to obtain a disc-shaped specimen. Each specimen was then manually reduced by the same polishing kit system mentioned above to obtain the 1 mm thickness. All specimens were stored in distilled water at 37 °C for 7 days in an incubator (CBM, S.r.l. Medical Equipment, 2431/V, Cremona, Italy). All specimens were then subjected to coating on one surface with a standardized thin coat of Bifluorid 10 (VOCO GmbH, Cuxhaven, Germany) using a brush for a single dose. After that, the coating was allowed to be absorbed for 20 s and then dried gently with air. Specimens were then stored in 20 mL artificial saliva for 24 h in an incubator at 37 °C. Prior to testing, the remnant of the coating was gently cleaned using a low-speed handpiece and a nylon bristle brush for 4 min. Then, the specimens were evaluated under a stereomicroscope (Olympus, Tokyo, Japan) to ensure complete removal of the coating.

2.4. Testing Procedures

2.4.1. Surface Gloss Test

The surface gloss of each specimen was measured using a glossmeter (ZGM 1130, Zehntner GmbH Testing Instruments, Sissach, Switzerland). Gloss was determined by directing a beam of light directed at an angle of 60° to the surface of each specimens [22];

following that, the light reflected at the same angle was measured. The equipment was calibrated against a black glass supplied by the manufacturer, which had a reference value of 93.7 gloss units (GU), before the gloss was measured. To prevent exposure to outside light, the specimens were placed on the glossmeter's top plate and covered with a black cover while the gloss was being measured. Every specimen had five measurements taken at its center, from which the mean value was calculated for each one. Measurements of gloss were recorded.

2.4.2. Surface Hardness Test

Surface microhardness for each specimen was determined using Digital Vickers hardness tester (NEXUS 400TM, INNOVATEST, model no. 4503, Maastricht, The Netherlands). The indentations were made within 15 s dwell time at a load of 100 g at 20× magnification [23]. The mean surface microhardness value for each specimen was calculated.

2.5. Statistical Analysis

Results are expressed as mean and standard deviation. The statistical analysis was performed using the Statistical Package for the Social Sciences (12.0, SPSS Inc., IBM, Chicago, IL, USA). According to the results of the normality test conducted with the Shapiro–Wilk and Kolmogorov–Smirnov tests, independent sample t-test was used to investigate statistically the effect of TF on the gloss as well as the hardness of each material. One-way ANOVA (analysis of variance) and post hoc tests were used to assess the difference in gloss and hardness among the various materials initially without TF application. Similarly, the difference between the used materials after using TF was assessed by using the previous analysis. The significance level was adjusted to $p \leq 0.05$.

3. Results

3.1. Surface Gloss Results

The mean surface gloss values of the various materials without and with TF application are displayed in Table 2.

Table 2. Mean surface gloss values of the various materials without and with TF application.

Surface Gloss	Without TF	With TF	*p* Value
Luna Nanohybrid	60.7 ± 0.1 [a III]	52.2 ± 0.4 [b III]	0.0001 *
Ceram.X® Mono Ormocer	57 ± 0.1 [a II]	50.3 ± 0.1 [b II]	0.0001 *
SDR Plus Bulk-fill flowable	65.7 ± 0.1 [a IV]	54.9 ± 0.3 [b IV]	0.0001 *
BreCAM.HIPC Indirect CAD/CAM blocks	53.6 ± 0.1 [a I]	48.4 ± 0.1 [b I]	0.0001 *
p value	*p* = 0.0001	*p* = 0.0001	

* Indicates a statistically significant difference (*p*-value < 0.05). Means with different small letters in the same row and means with different capital roman numbers in the same column both demonstrate a significant difference.

3.1.1. Effect of TF on Gloss of Each Material

TF application led to a significant reduction in gloss values of all tested resin composite materials (p = 0.0001 *).

3.1.2. Gloss of Various Materials (Initially without TF and after TF Application)

Without the application of TF, the gloss values were as follows in ascending order with significant differences between them (p = 0.0001): BreCAM.HIPC showed the lowest gloss value (53.6), followed by ormocer (57), then the Luna nanohybrid resin composite (60.7), and the bulk-fill flowable resin composite showed the highest gloss value (65.7).

Similarly, after TF application, the gloss values were as follows in the same ascending order with significant differences between them (p = 0.0001): BreCAM.HIPC showed the

lowest gloss value (48.4), followed by ormocer (50.3), then the Luna nanohybrid resin composite (52.2), and the bulk-fill flowable resin composite showed highest gloss value (54.9).

3.2. Surface Hardness Results

Table 3 displays the mean surface hardness (VHN) among the various materials without and with TF application.

Table 3. Mean surface hardness (VHN) of the various materials without and with TF application.

Surface Hardness (VHN)	Without TF	With TF	*p* Value
Luna Nanohybrid	46.9 ± 3.1 [III]	46.6 ± 0.4 [IV]	0.8
Ceram.X® Mono Ormocer	44.8 ± 1 [a III]	20.8 ± 1.7 [b I]	0.0001 *
SDR Plus Bulk-fill flowable	38.19 ± 1.9 [a II]	37.4 ± 1.8 [b III]	0.6
BreCAM.HIPC Indirect CAD/CAM blocks	26.9 ± 1.1 [I]	25.7 ± 1.7 [II]	0.3
p value	*p* = 0.0001	*p* = 0.0001	

* Indicates a statistically significant difference (*p*-value < 0.05). Means with different small letters in the same row and means with different capital roman numbers in the same column both demonstrate a significant difference.

3.2.1. Effect of TF on the Hardness of Each Material

TF had no significant effect on the hardness of the nanohybrid, bulk-fill flowable, and BreCAM.HIPC resin composites (*p* = 0.8, 0.6, and 0.3 respectively). On the other hand, the hardness of ormocer was significantly reduced after TF application (*p* = 0.0001 *).

3.2.2. Hardness of Various Materials (Initially without TF and after TF Application)

Without the application of TF, BreCAM.HIPC showed the least hardness (26.9 VHN), (*p* = 0.0001), while, the nanohybrid and ormocer displayed the highest hardness (*p* = 0.0001), with no significant difference between these two types (*p* = 0.9; 46.9 VHN and 44.8 VHN, respectively). Meanwhile, the bulk-fill resin composite showed intermediate results (38.19 VHN).

Whereas, after TF application, the hardness values were as follows in ascending order with significant differences between them (*p* = 0.0001): ormocer showed the lowest hardness value (20.8 VHN), followed by BreCAM.HIPC (25.7 VHN), then the bulk-fill flowable resin composite (37.4 VHN), and the Luna nanohybrid showed the highest hardness value (46.6 VHN).

4. Discussion

The aim of this in vitro study was to compare the surface gloss and hardness of three direct resin composites (nanohybrid composite, ormocer composite, and bulk-fill flowable composite), and one indirect CAD/CAM resin composite block (BreCAM.HIPC) after challenging their surfaces with a single application of Bifluorid 10 varnish.

Applying topical fluoride is a therapeutic and preventative dental therapy that can help improve tooth sensitivity, prevent tooth decay, arrest it, or slow it down, inhibit dental plaque, and promote tooth remineralization [24]. Professionally applied topical fluoride is a kind of topical fluoride application in which the dentist can deliver it to the patient in the dental clinic in gel or varnish form. Applying fluoride varnish is an easy, affordable, accessible, and practical way for practitioners to achieve superior results [25,26]. Bifluorid 10 comprises a mixture of sodium fluoride (NaF) and calcium fluoride (CaF). The high calcium content of saliva and dentinal fluid causes NaF to dissociate and release F ions, which diffuse through the tubules and precipitate when the dentin hypersensitivity is reduced by the calcium fluoride. The calcium fluoride (CaF) part of the varnish composition diffuses into the tubules and creates a semi-permanent barrier to occlude the tubules. By combining the calcium fluoride produced by the sodium fluoride reaction with the calcium in the dentin, the calcium fluoride is added to mechanically obstruct the dentin

tubules [27,28]. The primary benefits of Bifluorid 10 include rapid desensitization and the formation of a shielding barrier from thermal and mechanical provocations. Nevertheless, it can cause teeth staining [27]. However, the possible determinantal effect of recent direct and indirect resin composite restorations has not been documented.

Gloss is an optical property related to how light is distributed across an object's surface through reflection, scattering, and absorption [29]. A surface's gloss value, which measures the amount of light reflected at the same angle as the incident light, is a parameter employed to assess how smooth a surface is [30]. The inorganic filler type, load, and distribution, in addition to the refractive index and the thickness of the resin composites, have an impact on the surface gloss of the restorative materials [31].

The surface hardness of resin composite restorative materials indicates their resistance to scratching during service; however, the size and amount of filler content in the material may have an impact on this property [17,32,33]. Topical application of fluoride may lead to adverse effects on the resin composites, including surface erosion, gloss reduction, dissolving of inorganic fillers, and reduced surface hardness [34]. The main composition of the resin composites is an organic matrix and inorganic filler particles. It provides a heterogeneous nature to their microstructure, which is a challenging factor that could be reflected in surface features of the resin composites [10].

Nanotechnology has enabled the development of unique nanohybrid resin composites containing a mixture of different types and sizes of fillers particles (nanosized and conventional micron-sized) within the matrix. The decreased filler particle sizes and increased filler volume percentages enhance their physical and mechanical properties [35].

Bulk-fill flowable resin composites were recently introduced to permit the opportunity of applying materials of thickness as high as 4 to 6 mm. In order to enhance the depth of polymerization and boost the material's translucency, bulk-fill composite resins employ more reactive and different photoinitiators. Additionally, the amount of filler is decreased, while the size of the filler particles is raised (micron-sized) [36]. Moreover, they contain a higher proportion of diluent monomers in their composition to decrease the viscosity of the mixture [37].

Ormocer, which stands for organically modified ceramics, refers to the alterations performed on the resin matrix [38]. In contrast to conventional composites, ormocers have a matrix that contains both organic and inorganic materials. The ormocer matrix is based on using a saline precursor [38]. Ceram.X Mono combines both ormocer and nanotechnology. It combines traditional glass fillers with organically modified spherical ceramic nanoparticles and nanofillers [39]. The spherical pre-polymerized nanofillers and the organically modified resin matrix were claimed to produce enhanced mechanical and optical characteristics [40].

Recent advancements in resin composite technology, in conjunction with improvements in computer-aided design and computer-aided manufacturing (CAD/CAM), have provided an indirect resin composite block that is suitable to be used as a digital veneering material [41]. High-impact polymer composite (HIPC) technology delivers a composite characterized by a cross-linked, amorphous, heat-cured PMMA matrix, reinforced with ceramic microfiller. It is assumed to have superior physical and mechanical properties to conventional light-cured polymethyl methacrylate (PMMA), due to the absence of dental glasses and residual uncured monomers [42,43].

Bifluorid 10 was selected to be used in the current research as it showed clinically confirmed effectiveness for the treatment of dentin hypersensitivity [4]. The optimal standardization of the amount of fluoride varnish used was achieved by using the single-dose form. Regarding storage, the Bifluorid 10 was kept in a refrigerator at 4 °C as advised by the manufacturer. The four types of resin composites were selected in the current study according to the type of polymerization (direct and indirect composites) and based on the filler size, type, and content (nanohybrid, ormocer-based, and bulk-fill flowable composites). Moreover, the storage of the specimens was performed in an artificial saliva for 24 h in an incubator at 37 °C to simulate the oral conditions. Different storage media

could be used, such as distilled water, saline, ethanol, and artificial saliva. Artificial saliva was selected as it has the simplest physiological effect on the specimens to standardize the variables and simulate clinical situations [44,45].

The null hypothesis was rejected as the results of this study exposed a significant difference in surface gloss and hardness among all of the tested types of resin composites before TF application. Moreover, TF application led to a significant reduction in the gloss values of all tested resin composites. Although TF had no significant effect on the hardness of nanohybrid, bulk-fill flowable, or BreCAM composites, in HIPC resin composites, the hardness of ormocer was significantly reduced.

The results showed that TF application generally leads to a significant reduction in surface gloss of all tested resin composites. The alteration in the surface gloss may be due to deterioration of the organic matrix and composition of the resin composites as a result of the action of fluoride to a various degree [17]. The adverse effect of a single application of in-office Bifluorid 10 varnish on the surface hardness may be related to the feasible degradation of the resin matrix and the dislodgment of filler particles [17]. An adverse relationship has been observed between the filler content of the resin composite and the extent of surface deterioration. Lower filler loading materials typically exhibit more surface layer deterioration.

Moreover, the only affected resin composite after TF application as regards hardness was ormocer. This finding may be attributed to the lower degree of conversion of the matrix of ormocer in comparison to the dimethacrylate-based composites (nanohybrid and bulk-fill flowable composites) [46]. The resistance of nanohybrid and bulk-fill flowable resin composites to scratching after application of TF may be due to both of them being urethane dimethacrylate-based (UDMA) composites, which have more resistance to degradation effects [46]. In addition, UDMA-based composites have low viscosity and allow for a higher degree of conversion; they comprise hydrogen bonding, thereby improving conversion rates and enhancing mechanical characteristics [47,48]. Moreover, the BreCAM.HIPC groups, at the same time, exhibited a high resistance to the deterioration effect of the TF application, which might be explained by the low percentage of residual monomers and the formation of cross-linked composites, in addition to the presence of ceramic microfillers which may resist the harmful effect of fluoride [49]. Han et al. confirmed the previous finding as they showed a direct correlation between the resistance of resin composites to degradation and the distribution of fillers on their surface [49]. In addition, the heat-curing laboratory procedure may be producing a very low percentage of residual monomers with a predictable maximum curing quality compared to the conventional light-curing procedure performed in the direct resin composite clinical curing technique [19,50].

Generally, it was observed that both nanohybrid and bulk-fill flowable composites showed a higher degree of surface gloss and hardness after the application of TF compared to the other tested types of resin composites, which may be caused by the smaller size of the fillers in the matrix compared to those in the other tested types.

Nanohybrid resin composites include a nanosized filler particle that could be equally removed, along with the resin matrix, without noticeable adverse effects on hardness after exposure to TF [30]. Moreover, a smaller nanosized filler provides higher gloss values [51]. The increase in surface microhardness of the nanohybrid resin composite compared to the bulk flow resin composite may be due to the higher filler content which resists surface scratching [52]. Meanwhile, the initial increase in surface hardness of ormocer before TF application may be due to development of a smooth surface as a result of the higher percentage of microceramic filler along the matrix. The decrease in initial surface gloss of BreCAM.HIPC may be attributed to the absence of a glassy phase in the PMMA matrix [19]. The low surface hardness before the application of TF may be due to the lower filler content (20%) in comparison to the other tested types of direct resin composites. In a comparative study, artificial aging was performed to investigate the mechanical properties of dental LT Clear Resin after polishing [53]. It was found that artificial aging decreases the compression and tensile strength. Moreover, the study conducted by Paradowska-Stolarz et al. [54]

showed that BioMed Amber created using 3D printing is the most stable material regarding fractal dimension and texture analysis.

Gerhardt et al. found that the size and content of the fillers affected the surface gloss. They determined that a smaller filler size led to a higher gloss. [55]. Batista et al. concluded that nanohybrid composites displayed higher gloss values than ormocer-based resin composites [56]. Zovko et al. showed that ormocer-based nanohybrid resin composites exhibited stable gloss after exposure to an acidic beverage [9].

The limitations of this study include that the in vitro conditions do not exactly fit into the clinical situation as regards the washing effect of natural saliva movement, and mouth temperature may affect the results. In addition, a concern about the differences in the hydrophilic properties and permeability of each type of resin composite should be considered in the study. Additionally, examination of the specimens over a short period of time and the lack of surface imaging investigation represent such limitations. Not taking in consideration the use of different artificial ageing solutions and thermocycling is considered another limitation of this study.

Further investigations are recommended to evaluate the effect of topical fluoride application in several doses over longer periods rather than a single application. It is advised to perform further studies on other formulas of topical fluoride and other types of tooth-colored restoration materials. Moreover, it is suggested to examine other properties such as surface roughness, wear, and color stability. Furthermore, it is recommended to perform further investigation to study the effect of artificial ageing using different storage solutions under thermocycling, taking into consideration thermal changes.

5. Conclusions

Gloss retention and surface hardness appear to be influenced by the brand and type of resin composites. After a single application of Bifluorid 10, nanohybrid, bulk-fill flowable, and indirect CAD/CAM resin composites provide hardness stability. But all tested groups exhibit surface gloss alterations.

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