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Color Stability and Surface Roughness of CAD/CAM Ceramill Composite and Cerasmart Endocrowns

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Abstract: *With the advent of adhesive and digital dentistry along with the introduction of new generations of ceramic materials, endocrowns have become more spread to restore endodontically treated teeth.[1] Endocrowns are adhesively placed restorations with total cuspal coverage.[2] The clinical impact of bleaching agents over the color stability of ceramics and composite CAD/CAM materials is of major concern regarding the shade and esthetics of the restoration.[3] Hydrogen Peroxide **(HP)** and Carbamide Peroxide **(CP)**, the 2 most popular bleaching products, can change the physical properties of dental restorations such as color, surface roughness, hardness and ion leakage [3]. Our study aims to evaluate the effect of two bleaching protocols on the color stability and surface roughness of endocrowns made with two CAD/CAM materials; Ceramill Composite **(CC)** (Amman Girrbach, Germany) and Cerasmart **(CS)** (GC, America) after thermocycling and mechanical aging. A total of 32 freshly extracted human mandibular first molar posterior teeth were included in this in-vitro study. Hence forth the above study showed that both CS and CC showed clinically perceivable color change values after bleaching with CP20% or HP 40% higher than the clinically acceptable threshold (ΔE 3.7). However, bleaching resulted in insignificant changes in surface texture of both tested restorations.*

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I. Introduction

Two classes of materials are used in the production of CAD/CAM restorations: Glass-ceramics/ceramics and Indirect composites **(IC)**. While glass-ceramics/ceramics have overall superior mechanical and esthetic properties, resin-composite materials may offer significant advantages related to their machinability and intra-oral repairability.[4] The composite class of CAD/CAM blocks should be divided into 2 subclasses, depending on their microstructure; (1) with dispersed fillers and (2) Polymer-infiltrated-ceramic-network **(PICN)** materials.[5] Cerasmart **(CS)** is a hybrid ceramic PICN consisting of flexible nano-ceramic matrix with an even distribution of nano-ceramic; composite resin material 71% silica and barium glass nano-particles by weight with a flexural strength of 238 MPa.[6,7] Ceramill Composite **(CC)** is a composite CAD/CAM block having compressive strength of 500 MPa and flexural strength of 191 MPa and consisting of strontium boroaluminosilicate glass 78% by weight and nanofillers, BODMA, Bis-GMA, UDMA.[8] Authors have found that hydrogen peroxide **(HP)** and carbamide peroxide **(CP)**, the 2 most popular bleaching products, can change the physical properties of dental restorations such as their color, surface roughness, hardness and ion leakage.[3] Also, numerous studies have found significant changes in color and surface roughness of nanohybrid and packable composite resins after bleaching[9–11]. This study was designed to evaluate the color stability before and after bleaching of endocrowns fabricated with CC and CS as well as the surface roughness.

II. Materials And Methods

This in vitro-study was carried out on freshly extracted human mandibular first molar teeth which were collected from periodontally affected patients.

Study Design: in-vitro study
Study Location: Fixed Prosthodontics Department, Faculty of Dentistry, Cairo University, Cairo, Egypt.
Study Duration: July 2016 to July 2017
Sample size: 32 CAD/CAM blocks (16 per group)
Sample size calculation: The sample size was calculated by the G power. A large effect size (f=0.5) was expected. A total sample size of 32 blocks (16 per group) is sufficient with power 80% and 5% significance level.

Statistical Methods: Data was analyzed using IBM SPSS advanced statistics (Statistical Package for Social Sciences), version 20 (SPSS Inc., Chicago, IL). Numerical data was described as mean and standard deviation or median and range. Data was explored for normality using Kolmogrov-Smirnov test and Shapiro-Wilk test. Comparisons between two different materials and two different bleaching methods were done by 2 way analysis of variance. A P-value less than or equal to 0.05 was considered statistically significant.

Subjects & selection method: A total number of 32 freshly extracted human mandibular first molars were collected from periodontally affected patients, remaining soft tissues were removed by ultrasonic scaler (Woodpecker UDS-K Ultrasonic Piezo Scaler) and the teeth were disinfected then stored in standardized saline solution. Average tooth dimensions were (17±2mm) in root length, (10±2mm) in bucco-lingual and (9±2 mm) in mesio-distal width. All measurements were taken at the cemento-enamel junction level using a digital caliper (Vernier Caliper, GB1, China)

Using simple randomization, the prepared samples were divided into 2 main groups (16 each), according to the type of endocrowns material used and 2 subgroups (8 each),according to the bleaching protocol; either at-home bleaching using Opalescence PF 20% Carbamide Peroxide or in-office bleaching using Opalescence Boost PF 40% Hydrogen Peroxide (table no.1).

Table no.1: shows number of samples and interaction of variables.

Variables	**Group CS** Cerasmart CAD/CAM (Hybrid Ceramic)	**Group CC:** Ceramill Comp CAD/CAM (Composite block)	**Total**
Subgroup CP: Opalescence PF 20% Active ingredient: 20% Carbamide Peroxide	N=8	N=8	N=16
Subgroup HP: Opalescence Boost PF 40% Active ingredient: 40% Hydrogen Peroxide	N=8	N=8	N=16
Total	N=16	N=16	N=32

Inclusion criteria:

1. Lower molar
2. Absence of carious lesions
3. No visible fracture lines in the root
4. Complete root formation

Exclusion criteria:

1. Previous endodontic treatment.
2. Cracked teeth,
3. Carious teeth,
4. Internal and external root resorption
5. Dilacerated roots

Procedure methodology

Teeth were mounted in epoxy resin blocks during endocrowns preparation and during testing procedures. A specially designed centralizing device was constructed to allow accurate placement of teeth in the epoxy resin blocks. Teeth were endodontically treated, prepared with butt joint design to receive the endocrowns restorations. Teeth were scanned with Cerec omnicam and Cerec software was used to design the restorations. CEREC MCXL machine was used to mill all the restorations.

Samples were then sub-divided according to their bleaching protocol either at-home or in-office and cemented using RelyX ultimate clicker resin cement using a standardized loading device.

All samples were subjected to thermo-mechanical aging to simulate one year using the chewing simulator to resemble the oral cavity conditions.

After Thermocycling and mechanical fatigue, All specimens (n=32) were measured to obtain baseline data in terms of:

A) Colour using X-Rite Spectrophotometer.

B) Surface Roughness using Environmental Scanning Electron Microscope (ESEM) and Optical Stereomicroscope.

Bleaching procedure was then applied to all samples, each according to its subgroup.

The outcomes were measured again after the bleaching procedure to determine and detect the effect of bleaching.
Then the data obtained were collected, tabulated and then subjected to statistical analysis.

The following results were obtained:

1- Regardless of the bleaching agent concentration, both CAD/CAM materials tested showed a significant increase in ΔE values above the clinically acceptable value (ΔE=3.7), color changes were perceivable by non-skilled persons and thus considered not clinically acceptable.

After bleaching with Carbamide peroxide, there was no statistically significant difference between the two CAD/CAM types.

After bleaching with Hydrogen peroxide, Ceramill showed statistically significantly lower mean (ΔE) than Cerasmart.

2- Concerning surface roughness, the results showed that CAD/CAM type, bleaching agent, time and the interaction between variables had no statistically significant effect on mean surface roughness (Ra). However, qualitative assessment using SEM micrographs revealed slight change in surface morphology.

Statistical analysis

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). Surface roughness (Ra) data showed parametric distribution while color change data showed non-parametric distribution. Data were presented as mean, median, standard deviation (SD), minimum, maximum and 95% Confidence Interval (95% CI) for the mean values.

For parametric data; repeated measures Analysis of Variance (ANOVA) was used to study the effect of CAD/CAM type, bleaching agent, time and their interaction on mean surface roughness. Bonferroni's post-hoc test will be used for pair-wise comparisons when ANOVA test is significant. For non-parametric data; Mann-Whitney U test was used to compare between the two CAD/CAM types and the two bleaching agents. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM®SPSS®Statistics Version 20 for Windows.

III. Result

A. Color Stability (ΔE) Results

Descriptive statistics

Descriptive statistics of ΔE values are presented in table no 2.

Table no 2: Descriptive statistics of ΔE values

CAD/CAM type	Bleaching agent	Mean	SD	Median	Minimum	Maximum	95% CI	
							Lower bound	Upper bound
Ceramill	Carbamide peroxide	7.09	3.73	7.99	1.65	12.25	3.18	11.01
	Hydrogen peroxide	4.62	2.34	4.59	1.42	7.71	2.17	7.07
Cerasmart	Carbamide peroxide	9.31	4.17	7.99	5.53	16.98	4.94	13.69
	Hydrogen peroxide	9.90	3.57	10.42	4.44	14.94	6.15	13.64

Comparison between CAD/CAM types

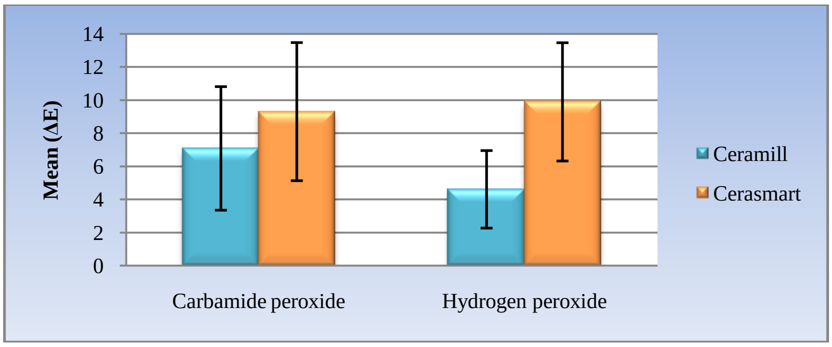
After bleaching with Carbamide peroxide , there was no statistically significant difference between the two CAD/CAM types.

After bleaching with Hydrogen peroxide, Ceramill showed statistically significantly lower mean color change values (ΔE) than Cerasmart.

Table no 3: The mean, standard deviation (SD) values and results of Mann-Whitney U test for comparison between ΔE of the two CAD/CAM types with different interactions

Bleaching agent	Ceramill CAD/CAM		Cerasmart		*P*-value
	Mean	SD	Mean	SD	
Carbamide peroxide	7.09	3.73	9.31	4.17	0.631
Hydrogen peroxide	4.62	2.34	9.90	3.57	0.037*

**: Significant at $P \leq 0.05$*



Bar chart representing mean (ΔE) of the two CAD/CAM types with different interactions

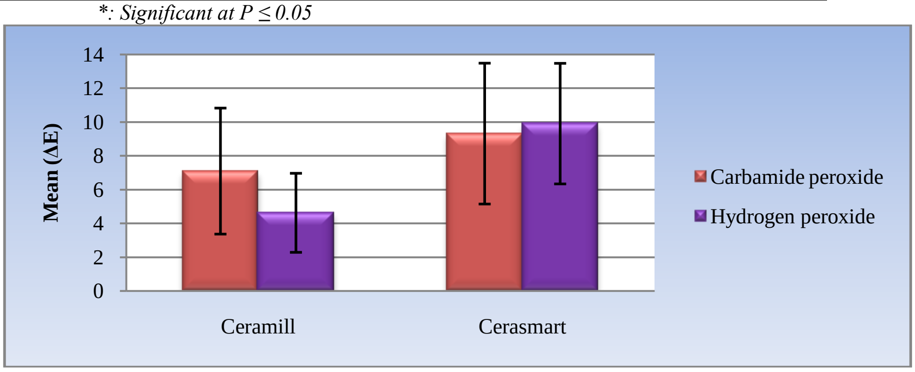
Comparison between bleaching agents

Either with Ceramill or Cerasmart, there was no statistically significant difference between the two agents.

Table no 4: The mean, standard deviation (SD) values and results of Mann-Whitney U test for comparison between ΔE of the two bleaching agents with different interactions

CAD/CAM type	Carbamide peroxide CAD/CAM		Hydrogen peroxide		*P*-value
	Mean	SD	Mean	SD	
Ceramill	7.09	3.73	4.62	2.34	0.150
Cerasmart	9.31	4.17	9.90	3.57	0.522

**: Significant at $P \leq 0.05$*



Bar chart representing mean (ΔE) of the two bleaching agents with different interactions

B. Surface Roughness (Ra) Results

1. Descriptive statistics

Descriptive statistics of Ra values (µm) are presented in table no 5.

Table no 5: Descriptive statistics of Ra values (µm)

CAD/CAM type	Bleaching agent	Time	Mean	SD	Median	Minimum	Maximum	95% CI	
								Lower bound	Upper bound
Ceramill	Carbamide peroxide	Before	0.2573	0.0015	0.2575	0.2552	0.2593	0.2557	0.2589
		After	0.2544	0.0019	0.2543	0.2513	0.2572	0.2524	0.2565
	Hydrogen peroxide	Before	0.2566	0.0018	0.2573	0.2542	0.2588	0.2548	0.2585
		After	0.2575	0.0014	0.2577	0.2549	0.2588	0.2560	0.2589
Cerasmart	Carbamide peroxide	Before	0.2573	0.0029	0.2579	0.2530	0.2601	0.2542	0.2603
		After	0.2560	0.0019	0.2560	0.2539	0.2584	0.2541	0.2580
	Hydrogen peroxide	Before	0.2571	0.0022	0.2566	0.2551	0.2607	0.2548	0.2595
		After	0.2553	0.0024	0.2552	0.2525	0.2593	0.2528	0.2578

2. Repeated measures ANOVA results

The results showed that CAD/CAM type, bleaching agent, time and the interaction between variables had no statistically significant effect on mean surface roughness (Ra). The interaction between the variables had no statistically significant effect on mean (Ra). Since the interaction between the variables is not statistically significant, so the variables are independent from each other.

Table no 6: Repeated measures ANOVA results for the effect of different variables on mean surface roughness (Ra)

Source of variation	Type III Sum of Squares	df	Mean Square	F-value	P-value
CAD/CAM type	0.00000001	1	0.00000001	0.003	0.960
Bleaching agent	0.000002	1	0.000002	0.451	0.509
Time	0.00002	1	0.00002	4.342	0.051
CAD/CAM type x Bleaching agent x Bleaching interaction	0.00001	1	0.00001	3.179	0.090

*df: degrees of freedom = (n-1), *: Significant at $P \leq 0.05$*

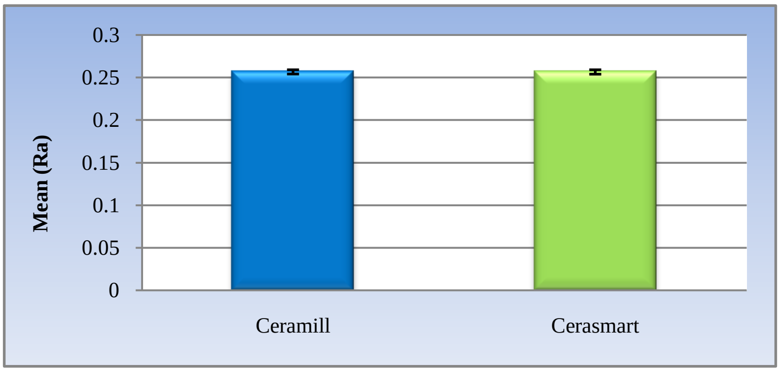
3. <u>Comparison between CAD/CAM types</u>

Regardless of bleaching agent and time, there was no statistically significant difference between the two types.

Table no 7: The mean, standard deviation (SD) values and results of repeated measures ANOVA test for comparison between Ra (µm) of the two CAD/CAM types regardless of other variables

Ceramill		Cerasmart		*P*-value
Mean	SD	Mean	SD	
0.2565	0.0025	0.2564	0.0026	0.960

**: Significant at $P \leq 0.05$*



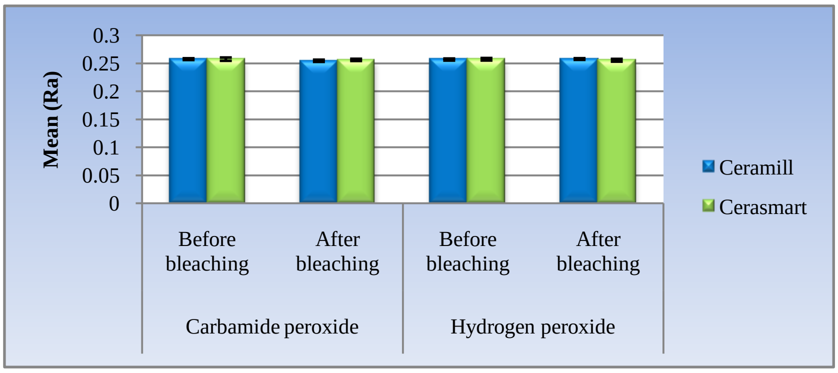
Bar chart representing mean surface roughness (Ra) of the two CAD/CAM types regardless of other variables

With each bleaching agent either before or after bleaching; there was no statistically significant difference between the two types:

Table no 8: The mean, standard deviation (SD) values and results of repeated measures ANOVA test for comparison between Ra (µm) of the two CAD/CAM types with different interactions

Bleaching agent	Time	Ceramill		Cerasmart		*P*-value
		Mean	SD	Mean	SD	
Carbamide peroxide	Before	0.2573	0.0015	0.2573	0.0029	0.975
	After	0.2544	0.0019	0.2560	0.0019	0.167
Hydrogen peroxide	Before	0.2566	0.0018	0.2571	0.0022	0.697
	After	0.2575	0.0014	0.2553	0.0024	0.066

**: Significant at $P \leq 0.05$*



Bar chart representing mean surface roughness (Ra) of the two CAD/CAM types with different interactions

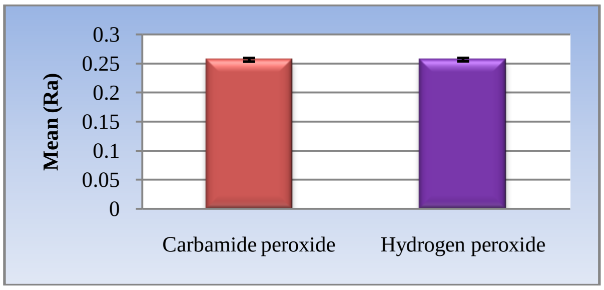
4. <u>Comparison between bleaching agents</u>

Regardless of CAD/CAM type and time, there was no statistically significant difference between the two bleaching agents:

Table no 9: The mean, standard deviation (SD) values and results of repeated measures ANOVA test for comparison between Ra (µm) of the two CAD/CAM types regardless of other variables

Carbamide peroxide CAD/CAM		Hydrogen peroxide		*P*-value
Mean	SD	Mean	SD	
0.2563	0.0031	0.2566	0.0029	0.509

**: Significant at $P \leq 0.05$*



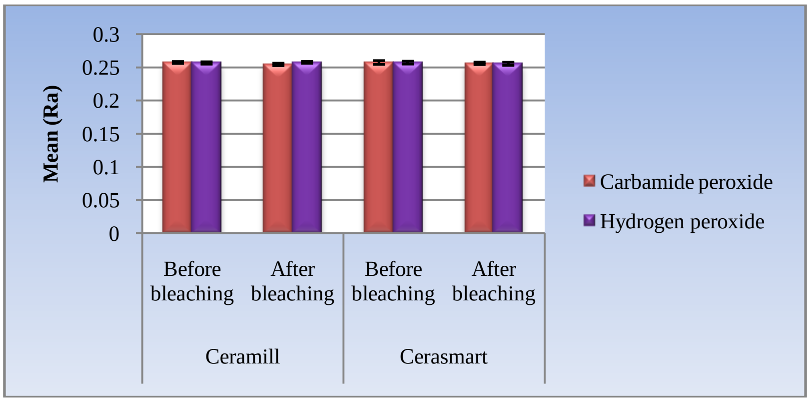
Bar chart representing mean surface roughness (Ra) of the two bleaching agents regardless of other variables

With each CAD/CAM type either before or after bleaching; there was no statistically significant difference between the two agents:

Table no 10: The mean, standard deviation (SD) values and results of repeated measures ANOVA test for comparison between Ra (µm) of the two bleaching agents with different interactions

CAD/CAM type	Time	Carbamide peroxide		Hydrogen peroxide		*P*-value
		Mean	SD	Mean	SD	
Ceramill	Before	0.2573	0.0015	0.2566	0.0018	0.606
	After	0.2544	0.0019	0.2575	0.0014	0.052
Cerasmart	Before	0.2573	0.0029	0.2571	0.0022	0.923
	After	0.2560	0.0019	0.2553	0.0024	0.532

**: Significant at $P \leq 0.05$*



Bar chart representing mean surface roughness (Ra) of the two bleaching agents with different interactions

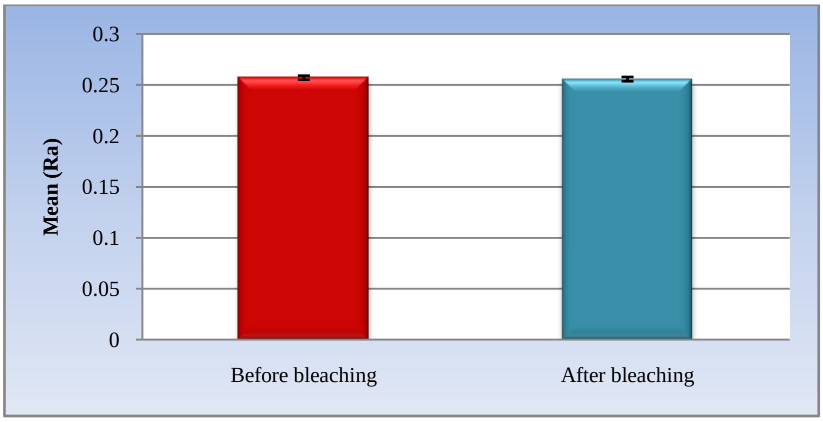
5. **<u>Effect of time (before and after bleaching)</u>**

Regardless of CAD/CAM type and bleaching agent, there was no statistically significant change in mean Ra after bleaching:

Table no 11: The mean, standard deviation (SD) values and results of repeated measures ANOVA test for comparison between Ra (µm) before and after bleaching regardless of other variables

Before bleaching		After bleaching		*P*-value
Mean	SD	Mean	SD	
0.2571	0.0020	0.2558	0.0021	0.051

**: Significant at $P \leq 0.05$*



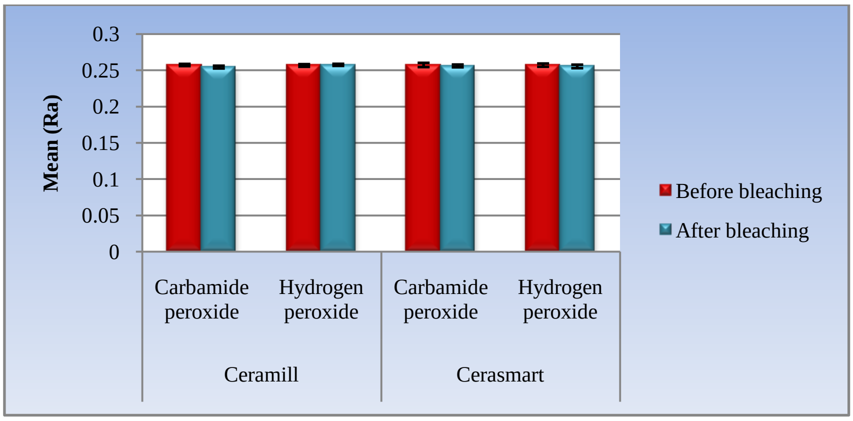
Bar chart representing mean surface roughness (Ra) before and after bleaching regardless of other variables

With each CAD/CAM type and each bleaching agent; there was no statistically significant change in mean Ra after bleaching:

Table no 12: The mean, standard deviation (SD) values and results of repeated measures ANOVA test for comparison between Ra (µm) before and after bleaching with different interactions

CAD/CAM type	Bleaching agent	Before bleaching		After bleaching		*P*-value
		Mean	SD	Mean	SD	
Ceramill	Carbamide peroxide	0.2573	0.0015	0.2544	0.0019	0.058
	Hydrogen peroxide	0.2566	0.0018	0.2575	0.0014	0.485
Cerasmart	Carbamide peroxide	0.2573	0.0029	0.2560	0.0019	0.3223
	Hydrogen peroxide	0.2571	0.0022	0.2553	0.0024	0.150

**: Significant at $P \leq 0.05$*



Bar chart representing mean surface roughness (Ra) before and after bleaching with different interactions

Interpretation of Scanning Electron Microscope (SEM) Microphotographs

In our study, the SEM images at baseline and after bleaching performed at magnification 1000X indicate that the surface of the samples showed a complex structure with a uniform distribution of polymer filler and ceramic network **Figures (1-8).**

Bleached samples analyzed with SEM showed changes in the morphology of the surface, compared to baseline SEM micrographs before bleaching. These changes were in the form of increased notches and surface porosity. After bleaching with the 2 bleaching gels (CP 20% and HP 40%) qualitative analysis of SEM images at magnification of 1000x shows a slight deterioration of the surfaces, suggesting that the roughness of CAD/CAM polymer-based blocks changed after exposure to bleaching agents.

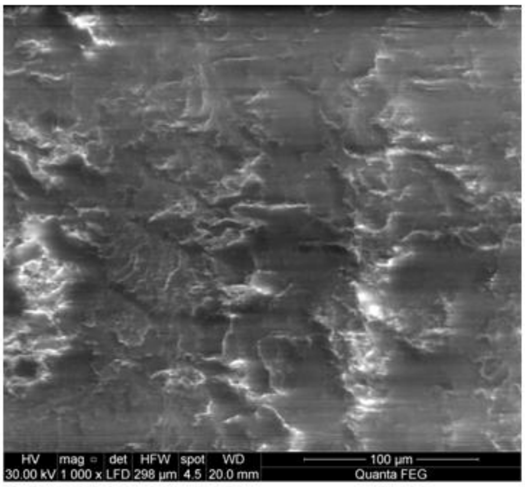


Figure 1: SEM Photomicrograph of a Ceramill comp specimen before

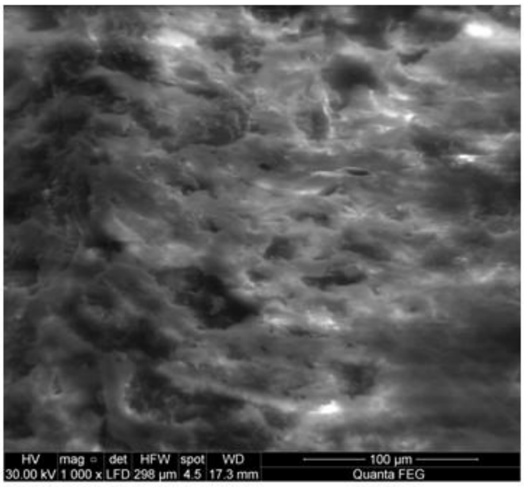


Figure 2: SEM Photomicrograph of a Ceramill comp specimen after bleaching with 20% CP.

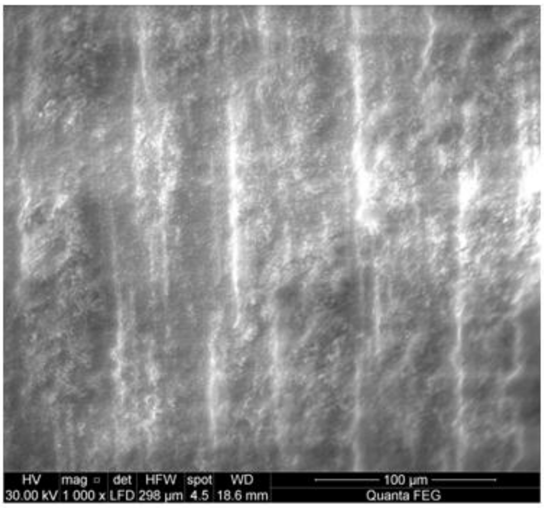


Figure 3: SEM Photomicrograph of Ceramill block before bleaching.

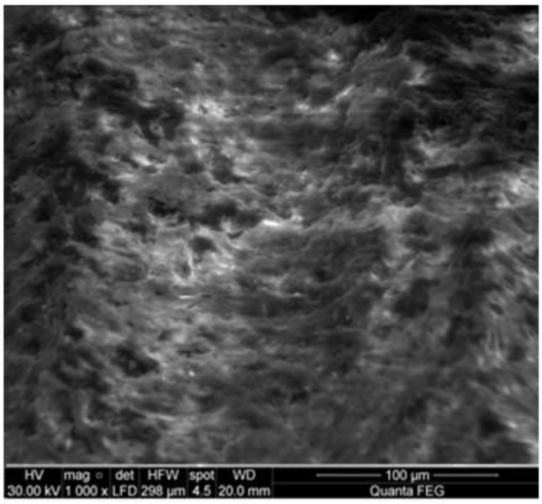


Figure 4: SEM Photomicrograph of Ceramill block after bleaching with 40% HP.

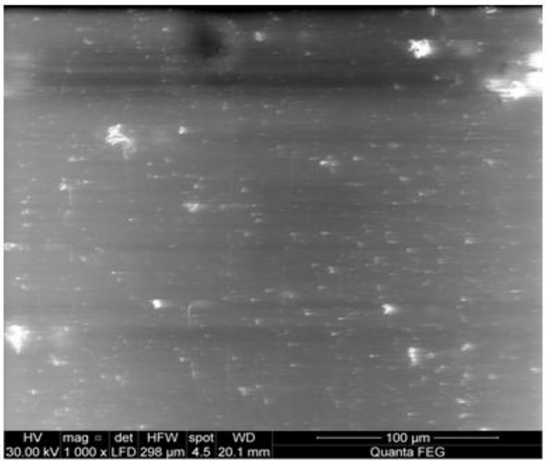


Figure 5: SEM Photomicrograph of Cerasmart block before bleaching.

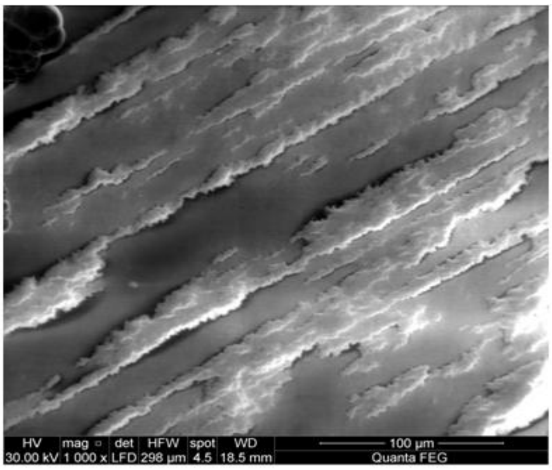


Figure 6: SEM Photomicrograph of Cerasmart block after bleaching with 20%

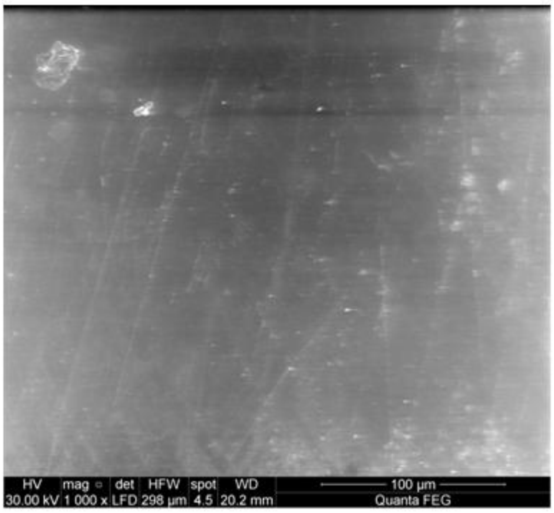


Figure 7: SEM Photomicrograph of Cerasmart block before bleaching.

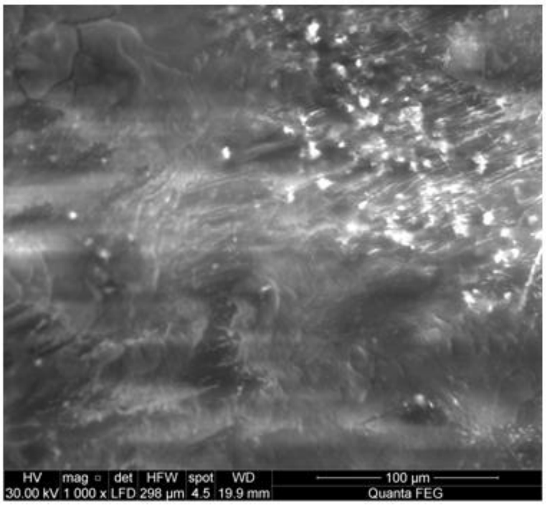


Figure 8: SEM Photomicrograph of Cerasmart block after bleaching with 40% HP.

IV. Discussion

The development of CAD/CAM systems and software offers several advantages in clinical practice.[12] Indirect composite CAD/CAM blocks as (Cerasmart, Ceramill Comp) were selected in the current study due to their benefits such as the ability to modify and repair the surface easily and their stress absorbing properties.

In vitro testing was used because it overcomes the limitations associated with clinical testing such as individual variation by creating a controlled environment. These tests provide a guideline and act as a baseline for the clinical studies. [13]

Posterior molar teeth were used based on previous studies that showed satisfactory performance of endocrowns in molar teeth in relation to esthetics, the action of occlusal forces and bond strength.[14–16]

Teeth were embedded in epoxy resin 2mm below the cement-enamel junction to mimic the position of the root in the bone. Epoxy resin was used as its modulus of elasticity (12GPa) close to that of the human bone (18GPa).[17] All teeth were decapitated perpendicular to long axis 2 mm coronal to the proximal CEJ in order to simulate the compromised condition of severely damaged endodontically treated molars.[18] Teeth were prepared according to clinically established preparation criteria for endocrowns[19] using a special milling machine to ensure standardization of the preparation. CEREC Omnicam was used to capture digital images in the present study which does not need reflective medium making capturing images easier and faster. CEREC 4.4 software was used to design the restorations. The same milling machine CEREC MCXL was used for all the restorations to ensure standardization of the restorations.

The endocrowns were cemented using Rely X Ultimate dual-cure adhesive resin cement. The adhesive resin cement was selected to be translucent shade for all study groups in order to minimize the influence of the color of the cementation mean and to allow a better evaluation of the optical properties of the specimens.[20]

Thermo-mechanical aging was performed for all the specimens to mimic the oral conditions that had proven to have an effect on the marginal fit and retention.

Bleaching is a common minimally invasive method to achieve esthetic outcomes. During bleaching, natural teeth as well as restorations are treated[21]; Therefore being familiar with the effects of bleaching on color and surface roughness is important.Considering the effect of bleaching on dental restorative materials; some authors have demonstrated that bleaching induces change in properties such as color, surface and subsurface microhardness, and surface roughness. In contrast, there are findings that reported that bleaching effect are clinically insignificant.[3,7]

Bleaching materials available are either hydrogen peroxide (HP) or carbamide peroxide (CP). On contact with tissues and saliva, CP immediately breaks down into about one-third HP and two-thirds urea. HP is highly reactive demonstrating a high capacity for oxidation and reduction to generate free radicals, it also demonstrates ability for diffusion.[22,23]

Color stability of teeth and dental restoration is one of the prerequisites for long-lasting esthetics of dental restorations. Dental materials can exhibit color shifting during fabrication or at placement, and after placement. The latter type of color shifting is associated with aging and staining.[24] Ceramic materials exhibit better color stability than composite resins. The stainability of the composite resin materials may be related to monomer hydrophobicity and water absorption properties. water absorption of composite resin is important, because this may be a sign of color change while absorbing colored fluids.[25]

Color measurement devices have been used for bleaching studies to document shade changes.[22] Spectrophotometers are today amongst the most accurate, useful and flexible instruments for color matching in dentistry.[26] So Color changes were recorded in this study using spectrophotometer; the data obtained from spectrophotometers are manipulated and translated into a form useful for dental professionals.[27] The advantages of spectrophotometric analysis with the CIE L*a*b* system are the detection of color changes that are not visible to the human eye and the ability to express color differences in units that may be related to visual perception and clinical significance.[28] There is some controversy in literature regarding the values of clinically noticeable color changes.[29] Vichi et al. used three different ranges for distinguishing color differences: ΔE values lower than 1.0 were considered undetectable by the human eye, values between 1.0 and 3.3 were considered visible by skilled operators, but clinically acceptable, and ΔE values greater than 3.3 were considered appreciable also by non-skilled persons and for that reason clinically not acceptable.[24] In our study, mean values of the color differences (ΔE) between the control group and each of the study groups were calculated and compared in this study to the reported clinical visible threshold ($\Delta E \geq 3.7$) found by Johnston and Kao.[30]

Regarding the effect of bleaching on color change values (ΔE), results revealed that both Ceramill Comp and Cerasmart showed ΔE values significantly greater than the threshold of 3.7 after bleaching regardless of the bleaching agent concentration and type which was considered perceivable by non-skilled operators and therefore clinically not acceptable **(table no 2).** Thus, the null hypothesis stating that no difference in the color stability of Cerasmart and Ceramill Comp after bleaching was rejected. This could be attributed to the fact that regardless of their chemical composition, dental resins tend to absorb liquids. Therefore, discoloration may occur over time when subjected to various media, such as coffee, tea, red wine, chlorhexidine or bleaching agents. The degree of color change of resins can be influenced by a number of factors such as incomplete polymerization, water sorption, chemical reactivity, diet, oral hygiene or surface roughness of the restoration.[31]

Regarding the comparison between the two types of CAD/CAM blocks, the Ceramill Comp specimens showed statistically significant lower mean ΔE than Cerasmart when bleached with 40% hydrogen peroxide at P=0.037. This might be attributed to the matrix composition of the two materials. The Cerasmart is based on UDMA resin matrix while the Ceramill comp CAD/CAM resin is based on both Bis-GMA and UDMA.The Cerasmart block differs from Ceramill Comp in the resin matrix. Cerasmart is composed of Bis-MEPP, UDMA, DMA while Ceramill Comp is composed of BisGMA, UDMA, BODMA. Also, the elastic modulus of Cerasmart is 8.7±0.3 GPa while that of Ceramill Comp is 13.8 GPa.[8,32–34°]On the other hand, after bleaching with 20% Carbamide Peroxide there was no statistically significant difference between the two CAD/CAM types.

These results are correspondent with the study of Stawarczyk et al in 2012 which evaluated the discoloration of 4 manually fabricated resins (Unifast III, Gradia and CronMix K) and 5 industrially fabricated CAD/CAM blocks (Ambarino High-Class Blanc, Zeno PMMA, artBloc Temp, artegral ImCrown, CAD-Temp) versus glass-ceramic (Empress CAD) as control. All tested groups showed color change (ΔE) at all time points, however the CAD/CAM resin composite Ambarino high-class blanc was the most affected regarding ΔE compared to all other groups.[33] Ambarino high-class blanc (Creamed – Creative Medical) is correspondent to the Ceramill Comp block used in the current study.[8]

Other studies reported that the resin matrix used in the composite-based materials have an important impact on discoloration. UDMA seems to be more color-resistant than Bis-GMA because of its low water absorption and solubility characteristics. Discoloration of Bis-GMA monomer is attributed to the -OH groups (hydroxyl group) in this monomer that yields to more water sorption. Water uptake in Bis-GMA-based resins was shown to increase from 3 to 6% as the proportion of TEGDMA increased from 0 to 1%. The presence of UDMA can contribute to a reduction in the amount of TEGDMA, which is the monomer responsible for higher rates of water sorption in resin-based materials due to its hydrophilic ether linkages. Therefore, materials that replace part of TEGDMA for UDMA may have less colour change.[33,35]

Regarding the effect of bleaching on surface roughness (Ra) values, results revealed that no statistically significant differences in Surface Roughness (Ra) values were observed before and after bleaching treatment between the two CAD/CAM block types (Cerasmart and Ceramill Comp), as well as between groups treated with 20% Carbamide peroxide and those treated with 40% hydrogen peroxide. So in the present study, neither the CAD/CAM block type nor the bleaching agent type had a significant effect on mean surface roughness (Ra) **(table no 12).** Thus, the null hypothesis stating that no change in surface roughness of tested materials will occur after bleaching was accepted.

° **BisMEPP:** 2,2-Bis(4-methyacryloxypolyethoxyphenyl)propane;
UDMA: urethane dimethacrylate
DMA: dodecyl dimethacrylate;
BisGMA: bisphenol A diglycidylether dimethacrylate

Upon analysis of specimens with scanning electron microscope (SEM) at baseline and after bleaching, bleaching resulted in slight changes in surface texture **(Figures 2, 4, 6 & 8**) when compared to the smooth texture obtained before bleaching **(Figures 1, 3, 5 & 7)**. This could be explained by the fact that, restoration surfaces could be damaged in contact with acidic fluoride gels or other solutions. In addition, the contact and possible diffusion of free radicals produced by bleaching agents can selectively extract the alkaline ions of ceramic network, causing damage[36,37]. The polymer network may also be affected by the erosion on the surface of the matrix and is dependent on resin matrix components and filler size.[10] In general, roughness change of the restorative materials depends on

the material, on the concentrations of bleaching gels, but also on the exposure times, all these factors can cause greater roughness.[38]

V. Conclusion

Within the limitations of this study, the following conclusions were drawn:

1. Both Cerasmart and Ceramill Comp showed clinically perceivable color change values after bleaching with carbamide peroxide 20% or hydrogen peroxide 40% higher than the clinically acceptable threshold (ΔE 3.7).
2. Bleaching has no effect in surface texture of both tested materials.

Clinical Implication: Indirect polymer-based composite resin blocks restorations should be protected before any bleaching procedure for fear of roughness and color change.

References

[1]. Erika Lander, D. & /Didier Dietschi. Endocrowns: A clinical report QUINTESSENCE. **28,** 877–884 (1993).

[2]. El-Damanhoury, H. M., Haj-Ali, R. N., Platt, J. A. & Hatem El-Damanhoury, R. H.-A. Fracture Resistance and Microleakage of Endocrowns Utilizing Three CAD-CAM Blocks. *Oper. Dent. j* **40,** 201–210 (2015).

[3]. El-Murr, J., Ruel, D. & St-Georges, A. J. Effects of external bleaching on restorative materials: a review. *J. Can. Dent. Assoc.* **77,** b59 (2011).

[4]. Ruse, N. D. & Sadoun, M. J. Resin-composite Blocks for Dental CAD/CAM Applications. *J. Dent. Res.* **93,** 1232–1234 (2014).

[5]. Nguyen, J. F., Migonney, V., Ruse, N. D. & Sadoun, M. Properties of experimental urethane dimethacrylate-based dental resin composite blocks obtained via thermo-polymerization under high pressure. *Dent. Mater.* **29,** 535–541 (2013).

[6]. Kurbad A, K. S. A new, hybrid material for minimally invasive restorations in clinical use. *Int J Comput Dent* **16,** 69–79. (2013).

[7]. Ghanem, L. Influence of bleaching on colour and surface roughness, and microshear bond streangth of repair, for novel hybrid ceramic. **63,** 1–14 (2017).

[8]. Ceramill M-center. Ceramill COMP units Ceramill COMP units. 2–4

[9]. Li, Q., Yu, H. & Wang, Y. Colour and surface analysis of carbamide peroxide bleaching effects on the dental restorative materials in situ. **37,** 348–356 (2009).

[10]. Wattanapayungkul, P. *et al.* The effect of home bleaching agents on the surface roughness of tooth-colored restoratives with time. *Oper Dent* **29,** 398–403 (2004).

[11]. Yu, H., Pan, X., Lin, Y., Hussain, M. & Wang, Y. Effects of Carbamide Peroxide on the Staining Susceptibility of Tooth-colored Restorative Materials. 72–82 (2009). doi:10.2341/08-42

[12]. Carlos, R. B. *et al.* Restoration of Endodontically Treated Molars Using All Ceramic Endocrowns. *Case Rep. Dent.* **2013,** 1–5 (2013).

[13]. Heydecke, G. & Peters, M. C. The restoration of endodontically treated, single-rooted teeth with cast or direct posts and cores: A systematic review. *J. Prosthet. Dent.* **87,** 380–386 (2002).

[14]. Dietschi, D., Duc, O., Krejci, I. & Sadan, A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature, Part II (Evaluation of fatigue behavior, interfaces, and in vivo studies). *Quintessence Int.* **39,** 117–129 (2008).

[15]. Evangelinaki, E. & Fragou, T. Effect of a Crown Ferrule on the Fracture Strength of Endodontically Treated Canines Restored with Fiber Posts and Metal-Ceramic or All-Ceramic Crowns. 384–388 (2013). doi:10.11607/ijp.3409

[16]. Dietschi, D., Duc, O., Krejci, I. & Sadan, A. Biomechanical considerations for the restoration of endodontically treated teeth: A systematic review of the literature-Part 1. Composition and micro- And macrostructure alterations. *Quintessence Int.* **38,** 733–43 (2007).

[17]. Jiang, W., Bo, H., YongChun, G. & LongXing, N. Stress distribution in molars restored with inlays or onlays with or without endodontic treatment: A three-dimensional finite element analysis. *J. Prosthet. Dent.* **103,** 6–12 (2010).

[18]. Hannig, C., Westphal, C., Becker, K. & Attin, T. Fracture resistance of endodontically treated maxillary premolars restored with CAD/CAM ceramic inlays. *J. Prosthet. Dent.* **94,** 342–349 (2005).

[19]. Chalifoux, P. R. Restoration of endodontically treated teeth: review, classification, and post design. *Pract. Periodontics Aesthet. Dent.* **10,** 247–254 (1998).

[20]. Charisis D, Koutayas SO, Kamposiora P, D. A. Spectrophotometric Evaluation of the Influence of Different Backgrounds on the Color of Glass-Infiltrated Ceramic Veneers. *Eur J Esthet Dent.* **1,** 142–56 (2006).

[21]. Atali, P. Y. & Bülent, F. The effect of different bleaching methods on the surface roughness and hardness of resin composites. **3,** 10–17 (2011).

[22]. Joiner, A. The bleaching of teeth : A review of the literature. **34,** 412–419 (2006).

[23]. Wattanapayungkul, P. & Yap, A. U. J. Effects of in-office bleaching products on surface finish of tooth-colored restorations. *Oper. Dent.* **28,** 15–19 (2003).

[24]. Vichi, A., Louca, C., Corciolani, G. & Ferrari, M. Color related to ceramic and zirconia restorations : A review. *Dent. Mater.* **27,** 97–108 (2010).

[25]. Acar, O., Yilmaz, B. & Altintas, H. Color stainability of CAD / CAM and nanocomposite resin materials. *J prosthet Dent* **115,** 71–75 (2016).

[26]. Chu, S. J., Trushkowsky, R. D. & Paravina, R. D. Dental color matching instruments and systems . Review of clinical and research

aspects. 2–16 (2010). doi:10.1016/j.jdent.2010.07.001
[27]. Johnston, W. M. Color measurement in dentistry. 2–6 (2009). doi:10.1016/j.jdent.2009.03.011
[28]. O'Brien, W. J., Hemmendinger, H., Boenke, K. M., Linger, J. B. & Groh, C. L. Color distribution of three regions of extracted human teeth. *Dent Mater* **13,** 179–185 (1997).
[29]. Ghinea, R., Perez, M., Herrera, L. J., Yebra, A. & Paravina, R. D. Color difference thresholds in dental ceramics. 57–64 (2010). doi:10.1016/j.jdent.2010.07.008
[30]. Johnston, W. M. & Kao, E. C. Assessment of Appearance Match by Visual Observation and Clinical Colorimetry. 819–822 (1989).
[31]. Nasim I, Neelakantan P, Sujeer R, S. C. Color stability of microfilled, microhybrid and nanocomposite resins—an in vitro study. .. *J Dent* **38,** e137–e142 (2010).
[32]. Lauvahutanon, S. *et al.* In vitro evaluation of the wear resistance of composite resin blocks for CAD/CAM. *dent Mater* **l,** 495–502 (2015).
[33]. Stawarczyk, B. *et al.* Discoloration of manually fabricated resins and industrially fabricated CAD / CAM blocks versus glass-ceramic : Effect of storage media , duration , and subsequent polishing. **31,** 377–383 (2012).
[34]. Horvath, S. D. key Parameters of Hybrid Materials for CAD/CAM-Based Restorative Dentistry. *Compend. Contin. Educ. Dent.* **37,** (2016).
[35]. Panka, R., Freire, A. & Vieira, S. Colour stability and opacity of resin cements and flowable composites for ceramic veneer luting after accelerated ageing. **9,** 2–8 (2011).
[36]. Augusto, S. & Ourique, M. Effects of different concentrations of carbamide peroxide and bleaching periods on the roughness of dental ceramics. **25,** 453–459 (2011).
[37]. Anusavice, K. J. Degradability of Dental Ceramics. *Adv. Dent. Res.* **6,** 82–89 (1992).
[38]. Zaki, A. A. & Fahmy, N. Z. The Effect of a Bleaching System on Properties Related to Different Ceramic Surface Textures. **18,** 223–229 (2009).

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