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EFFECT OF DIFFERENT BEACHING PROTOCOLS ON BIAXIAL FLEXURAL STRENGTH AND MICRO HARDNESS OF TWO CERAMIC MATERIALS

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ABSTRACT

Purpose: The aim of this study was to evaluate the effect of different bleaching protocols on biaxial flexural strength and micro hardness of two ceramic materials.

Material and Methods: A total of 112 discs, 56 discs of each material, were prepared from Celtra® Duo and VITA ENAMIC® with 10mm diameter and 1.2mm thickness. Each material was divided into 4 groups (n=14) according to the bleaching protocol done: **Group 1** Control group "no bleaching", **Group 2** home bleaching "Carbamide Peroxide 22%", Group **3** home bleaching "Hydrogen Peroxide 14%" and **Group 4** In-office bleaching using diode Laser. For each material, half the number of discs in each group (n=7) were subjected to Biaxial Flexural Test using Universal Testing Machine Instron-3345 together with Instron BlueHill® universal software, while the other half was subjected to Micro-Hardness Test using Tukon™ 1102 Wilson® Hardness Tester. Data was represented by mean and standard deviation (SD) values. Two-way ANOVA was used to study the effect of different tested variables and their interaction on biaxial flexural strength (Mpa) and micro-hardness, The significance level was set at $p \leq 0.05$ within all tests. Statistical analysis was performed with IBM® SPSS® Statistics Version 26 for Windows.

Results: For Biaxial Flexural Strength and Micro-hardness; Celtra duo samples had a significantly higher value than samples made with Vita Enamic for all bleaching groups. **Biaxial Flexural Strength:** There was a significant difference between samples subjected to different bleaching protocols ($p<0.001$). Pairwise comparisons showed value of the control samples to be significantly higher (Celtra Duo 494.15±6.51), (Vita Enamic 183.50±7.31) than samples treated with other protocols. **Micro-hardness:** There was a significant difference between samples subjected to different bleaching protocols ($p<0.001$). Pairwise comparisons showed value of the control samples to be significantly higher (Celtra Duo 710.84±9.36), (Vita Enamic 260.49±12.88) than samples treated with different protocols.

Conclusion: Bleaching resulted in a significant diminution for both biaxial flexural strength and surface micro-hardness of Celtra Duo and Vita Enamic.

KEY WORDS: bleaching techniques, laser bleaching Vita Enamic , Celtra Duo, flexural strength and Micro hardness

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INTRODUCTION

The number of people seeking optimum aesthetics is growing, and patients often seek solutions for aesthetic problems such as discolored teeth. Home and In-office Vital bleaching are widely used because of their conservative approaches and effectiveness in removing tooth discoloration. On the other hand, the availability of new types of dental ceramics have driven increased use of ceramic materials in a variety of restorative situations. Most patients who need tooth whitening might already have some kind of restorations in their mouth. On bleaching, the bleaching agents may lead to alterations in the surface morphology as well as in the chemical and mechanical properties of the existing dental restorative materials. Many studies are highlighting the effect of bleaching on the clinical success of different restorative materials that goes back to their different microstructures.

Israel et al in 2004 [1] found that bleaching techniques reduced the hardness of enamel and dentin and that the "in-office" bleaching reduced the hardness significantly more than the "home" bleaching technique. **A year later, Taher & Nadia Malek** [2] conducted a study the showed that At-home as well as in-office bleaching agents have a softening effect on some tooth coloured restorative material and the patient must be aware before using them. **In 2007, Polydorou et al**[3] conducted that at-home bleaching technique didn't have a statistically significant effect on the microhardness of any of the restorative materials tested. **Zaki and Fahmy in 2009** [4] found that ceramic restorations should be protected before any bleaching for fear of altering their roughness and whiteness. Patients should be advised that their existing porcelain restorations may not match their natural teeth after bleaching. **Ferreira HdA,et al in 2016**[5] concluded that dental ceramics' surface properties (roughness and microhardness) were not altered by the bleaching treatments applied. **Rodrigues et al in 2019** [6] found that bleaching agents associated with brushing cycles can alter surface properties and shade stability of glazed feldspathic ceramics, though such findings may not reflect the performance of unglazed feldspathic ceramics In the same year **Ozdogan, A et al** [7] showed that the bleaching agents increased the surface roughness and didn't affect the colour stability of the feldspathic porcelain. This came in consistent with **Karci, M. et al**[8] **in 2019** whom concluded that patients who have all-ceramic restorations in their mouths should be careful when using home bleaching agents, because whitening agents can affect the translucency of all-ceramic restorations such as e.max CAD and Empress CAD. **A year later, Demir Ne et al in 2020** [9] concluded that patients should be careful when using home bleaching agents because whitening agents can affect the mechanical properties of full ceramic restorations like e.max CAD and Empress CAD. Ceramic polishing may be required in clinical situations where ceramic restorations are accidentally exposed to bleaching gels. Therefore,the aim of this study was to asses the effect of different bleaching protocols on two different ceramic materials

The null hypotheses were that:

1. There will be no effect of the bleaching agents on the mechanical behavior of the two tested ceramics.
2. Different bleaching protocols effect on the two ceramic materials will not differ.

MATERIAL AND METHODS

A total of 112 discs, 56 discs of each material, were prepared from Celtra® Duo and VITA ENAMIC® with 10mm diameter and 1.2mm thickness. Samples from each material was divided into 4 groups (n=14) according to the bleaching protocol used: **Group 1** Control group "no bleaching", **Group 2** home bleaching "Carbamide Peroxide 22%", **Group 3** home bleaching "Hydrogen Peroxide 14%" and

Group 4 In-office bleaching using diode Laser and JW Power Bleaching NEXT (generation).

Celtra® Duo and VITA ENAMIC® were in the form of blocks. Insize® Digital Caliper was used for checking dimension standardization in every step. Blocks of each material were first ground into cylinders with 10 mm diameter using Universal tool grinder machine (C40 Sungkwang.) Cylinders were further sliced into discs with 1.2 mm thickness using IsoMet™ 4000 Linear Precession together with diamond disc IsoMet™ -Buehler. For Celtra Duo, glazing and firing cycle was performed according to the manufacture's firing recommendations in order to reach the maximum flexural strength of the material. While for Vita Enamic, polishing was performed using "VITA ENAMIC® Polishing Set Technical" according to the manufacturer's instructions.

These ceramic materials were subjected to the following bleaching protocols:

1. ***No bleaching*** acting as a control group.
2. ***Home Bleaching "Zoom NiteWhite" (Carbamide peroxide 22%)*** used according to the manufacturer's instructions 4hrs/day for 1 week. Carbamide peroxide breaks down into "Hydrogen peroxide and Urea", where Hydrogen peroxide further degrades into oxygen and water, while Urea degrades into ammonia and carbon dioxide. Urea plays an important role in making the mixture stable, increasing the duration of its effectiveness. That's why Carbamide peroxide releases half of its peroxide during the first two hours, while the other 50% is gradually expelled over the next few hours.
3. ***Home Bleaching "Zoom DayWhite" (Hydrogen peroxide 14%)*** used according to the manufacturer's instructions for 30min/day for 1 week. That's because Hydrogen peroxide decomposes much faster than Carbamide peroxide, as it releases most of its peroxide in the first 30-60 minutes.
4. ***In office "JW Power NEXT generation" (Hydrogen Peroxide 35 %) (Kaufering, Germany) subjected to Photon Plus Dental Diode Laser*** (Zolar-Canada) Wave Length: 810nm that was set according to the manufacturer's instructions on (Power: 7watt / Pulse: CW "Continuous Wave" / Direct Contact) for 30 sec + 10min without Laser. The photochemical reaction initiated by laser increases the formation of hydroxyl radicals from hydrogen peroxide, resulting in a faster whitening process[10] with less contact time and that's why high concentrations of hydrogen peroxide is recommended to be used. After then discs were washed under running water for 20 sec till the gel was washed out completely.

For each material, half the number of discs in each group (n=7) were subjected to Biaxial Flexural Test using Universal Testing Machine (Instron-3345, a division of Illinois Tool Works, USA) together with Instron BlueHill® universal software . In order to support the disc to be tested, three hardened steel balls with a diameter of 1.2 mm each, forming an equilateral triangle 60º, were positioned on a supporting circle with a diameter of 12mm. Each disc was positioned concentrically on the support "steel balls" with the treated surface downwards. The load was applied from above at the center of the disc through the piston with a diameter of 1.5mm at a cross-head speed of 1mm/min until fracture occurred. While for the other half; they were subjected to Micro-Hardness Test using Tukon™ 1102 Wilson® Hardness Tester (BUEHLER Germany). Each disc was placed underneath the indenter and a 500gm load was applied smoothly, without impact, forcing the indenter into the test specimen. The indenter was held in place for 15 seconds. After the load was removed, the indentation was focused with the magnifying eye piece of the testing machine(BUEHLER Germany) and the two impression diagonals were measured to the nearest 0.1-µm with a filar micrometer(INSIZE®-India), and averaged. Three indentations were made on each specimen, with 200μ distance between them and an average value was obtained from these three measurements Tester.

RESULTS

Numerical data were explored for normality by checking the data distribution, calculating the mean and median values and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data showed parametric distribution. It was represented by mean and standard deviation (SD) values. Two-way ANOVA was used to study the effect of different tested variables and their interaction on biaxial flexural strength (Mpa) and micro-hardness. Comparison of simple effects were done utilizing pairwise t-tests with Bonferroni correction. Statistical analysis was performed with IBM® SPSS® Statistics Version 26 for Windows.

Biaxial Flexural Strength

Effect of different variables and their interaction:

Effect of different variables and their interaction on biaxial flexural strength (Mpa) were presented in **Table 1**.

There was a significant interaction between type of ceramic material and bleaching protocol used (p<0.001).

Effect of ceramic material within each bleaching protocol:

Results are presented in table 2.

- **No bleaching:** Celtra duo samples (494.15±6.51) had a significantly higher value than samples made with Vita Enamic (183.50±7.31) (p<0.001).
- **Carbamide peroxide:** Celtra duo samples (434.20±14.06) had a significantly higher value than samples made with Vita Enamic (159.75±7.12) (p<0.001).
- **Hydrogen peroxide:** Celtra duo samples (377.83±16.66) had a significantly higher value than samples made with Vita Enamic (156.79±8.88) (p<0.001)
- **Laser:** Celtra duo samples (434.30±15.45) had a significantly higher value than samples made with Vita Enamic (153.13±5.82) (p<0.001).

Effect of bleaching protocol within each ceramic material:

- **Celtra duo:** There was a significant difference between samples subjected to different bleaching protocols (p<0.001). The highest value was found in control samples (494.15±6.51), followed by samples treated with laser

TABLE (1) Effect of different variables and their interactions on biaxial flexural strength (Mpa)

Source	Sum of Squares	df	Mean Square	f-value	p-value
Ceramic Material	1034459.58	1	1034459.58	8501.93	**<0.001***
Bleaching Protocol	36713.45	3	12237.82	100.58	**<0.001***
Ceramic material * bleaching protocol	14630.46	3	4876.82	40.08	**<0.001***

df=degree of freedom*; significant (p ≤ 0.05) ns; non-significant (p>0.05)

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(434.30±15.45), then carbamide peroxide treated samples (434.20±14.06), while the lowest value was found in samples treated with hydrogen peroxide (377.83±16.66). Pairwise comparisons showed value of the control samples to be significantly higher than samples treated with other protocols. In addition, they showed samples treated with hydrogen peroxide to have a significantly lower value than other samples (p<0.001)

- **Vita Enamic:** There was a significant difference between samples subjected to different bleaching protocols (p<0.001). The highest value was found in control samples (183.50±7.31), followed by samples treated with carbamide peroxide (159.75±7.12), then hydrogen peroxide treated samples (156.79±8.88), while the lowest value was found in samples treated with laser (153.13±5.82). Pairwise comparisons showed value of the control samples to be significantly higher than samples treated with other protocols.

B. Micro-Hardness

Effect of different variables and their interaction

Effect of different variables and their interaction on micro-hardness were presented in **Table 3**.

There was a significant interaction between type of ceramic material and bleaching protocol used (p<0.001).

TABLE (2) Mean, standard deviation (SD) and statistical analysis results of biaxial flexural strength (Mpa) for different ceramic materials and bleaching protocols

Bleaching protocol	(mean±SD)		p-value
	Celtra duo	Vita Enamic	
No bleaching	494.15±6.51^{A}	183.50±7.31^{A}	**<0.001***
Carbamide peroxide	434.20±14.06^{B}	159.75±7.12^{B}	**<0.001***
Hydrogen peroxide	377.83±16.66^{C}	156.79±8.88^{B}	**<0.001***
Laser	434.30±15.45^{B}	153.13±5.82^{B}	**<0.001***
p-value	**<0.001***	**<0.001***	

Different superscript letters indicate a statistically significant difference within the same vertical column*; significant (p ≤ 0.05) ns; non-significant (p>0.05)

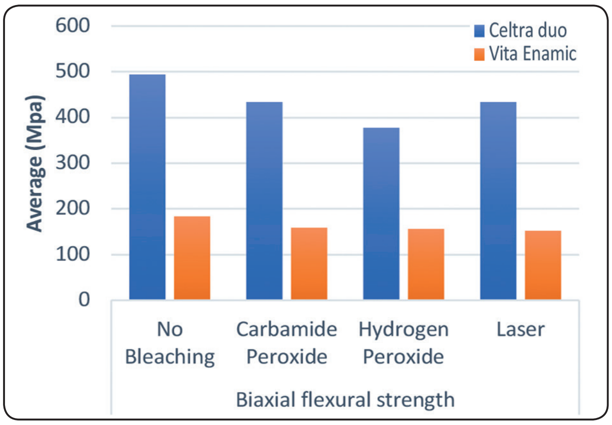

Fig. (1) Bar chart showing average biaxial flexural strength (Mpa) for different ceramic materials and bleaching protocols

TABLE (3) Effect of different variables and their interactions on micro-hardness

Source	Sum of Squares	df	Mean Square	f-value	p-value
Ceramic Material	2084994.46	1	2084994.46	8272.27	**<0.001***
Bleaching Protocol	65923.84	3	21974.61	87.18	**<0.001***
Ceramic material * bleaching protocol	39955.18	3	13318.39	52.84	**<0.001***

df = degree of freedom*; significant (p ≤ 0.05) ns; non-significant (p>0.05)

Effect of ceramic material within each bleaching protocol

Results are presented in table 4.

- **No bleaching:** Celtra duo samples (710.84±9.36) had a significantly higher value than samples made with Vita Enamic (260.49±12.88) ($p<0.001$).
- **Carbamide peroxide:** Celtra duo samples (625.75±14.68) had a significantly higher value than samples made with Vita Enamic (233.36±7.50) ($p<0.001$).
- **Hydrogen peroxide:** Celtra duo samples (543.51±23.97) had a significantly higher value than samples made with Vita Enamic (241.57±11.44) ($p<0.001$)
- **Laser:** Celtra duo samples (615.00±27.22) had a significantly higher value than samples made with Vita Enamic (216.04±6.68) ($p<0.001$).

Effect of bleaching protocol within each ceramic material:

- **Celtra duo:** There was a significant difference between samples subjected to different bleaching protocols ($p<0.001$). The highest value was found in control samples (710.84±9.36), followed by samples treated with carbamide peroxide (625.75± 14.68), then laser treated samples (615.00± 27.22), while the lowest value was found in samples treated with hydrogen peroxide (543.51±23.97). Pairwise comparisons showed value of the control samples to be significantly higher than samples treated with different protocols. In addition, they showed samples treated with hydrogen peroxide to have a significantly lower value than other samples ($p<0.001$).
- **Vita Enamic:** There was a significant difference between samples subjected to different bleaching protocols ($p<0.001$). The highest value was found in control samples (260.49±12.88), followed by samples treated with hydrogen peroxide (241.57±11.44), then carbamide peroxide treated samples (233.36±7.50), while the lowest value was found in samples treated with laser (216.04±6.68). Pairwise comparisons showed value of the control samples to be significantly higher than samples treated with different protocols except for Hydrogen peroxide ($p<0.001$). In addition, they showed samples treated with laser to have a significantly lower value than other samples except for those treated with carbamide peroxide ($p<0.001$).

TABLE (4) Mean, standard deviation (SD) and statistical analysis results of micro-hardness for different ceramic materials and bleaching protocols

Bleaching protocol	(mean±SD)		p-value
	Celtra duo	Vita Enamic	
No bleaching	710.84±9.36^{A}	260.49±12.88^{A}	**<0.001***
Carbamide peroxide	625.75±14.68^{B}	233.36±7.50^{BC}	**<0.001***
Hydrogen peroxide	543.51±23.97^{C}	241.57±11.44^{AB}	**<0.001***
Laser	615.00±27.22^{B}	216.04±6.68^{C}	**<0.001***
p-value	**<0.001***	**<0.001***	

Different superscript letters indicate a statistically significant difference within the same vertical column*; significant ($p \leq 0.05$) ns; non-significant ($p>0.05$)

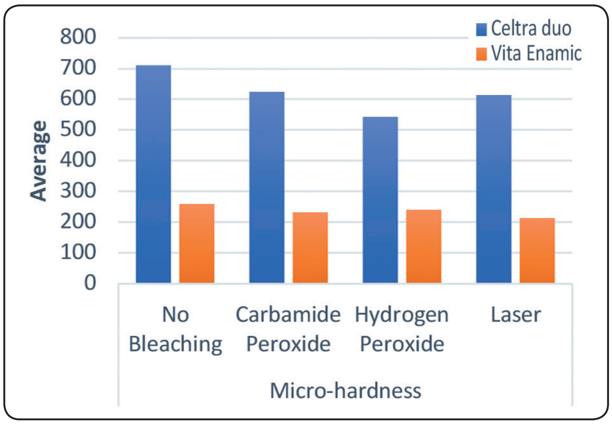

Fig. (2) Bar chart showing average micro-hardness for different ceramic materials and bleaching protocols

DISCUSSION

Many studies are highlighting the effect of bleaching on the clinical success of different restorative materials. The purpose of this study was to evaluate the effect of different bleaching protocols on mechanical properties of the material represented in the biaxial flexural strength and microhardness of two ceramic materials.

Two types of ceramic materials were selected in this study; Zirconia re-inforced lithium silicate "Celtra® Duo" and Polymer-infiltrated ceramic "VITA ENAMIC®"

In Zirconia re-inforced lithium silicate "Celtra® Duo", the inclusion of 10% zirconium oxide ensures particularly high strength. The crystallites formed are 4-8 times smaller than crystals of conventional lithium disilicates. The result is an ultra-fine microstructure that combines high average flexural strength with a high glass content. This has positive effects on the optical and mechanical properties of the material.[11]

Polymer-infiltrated ceramic "VITA ENAMIC®" is a "Dual Network" material, the dominant ceramic network is reinforced by a polymer network with each network penetrating the other to create a hybrid material that exhibits the positive characteristics of both a ceramic and a composite. The result is a material that mimics the strength and toughness of dentin and enamel.[12]

Biaxial Flexural test was chosen in this study as flexural strength indicates the maximum stress before fracture. It tells us how much stress is required to deform the material before the proportional limit is reached.[13]

Micro-hardness assessment was chosen to determine the effect of bleaching on the ceramic surface, since surface hardness is defined as the ability of the material to resist penetration.[14]

Concerning Biaxial Flexural Strength:

In this study, both null hypothesis were rejected the results of biaxial flexural strength showed that there was a significant interaction between type of ceramic material and bleaching protocol used ($p<0.001$).

Regardless of the bleaching protocol used, Celtra Duo samples had a significantly higher values than Vita Enamic samples. This goes back to the zirconia particles in the Celtra Duo's microstructure which are capable of resisting surface alteration from the bleaching agents. In case of Vita Enamic, the free radicals from the bleaching agent attack at the interface between the dual network (inorganic filler and the resin matrix) causing those fillers to disintegrate from the material surface.[15-17]

For Celtra Duo, there was a significant difference between samples subjected to different bleaching protocols ($p<0.001$). The highest value was found in control group, While the lowest value was found in Hydrogen peroxide group, this is can be explained by the release of the free radicals from the bleaching agents that were extremely reactive and prone to inducing an acidic environment during bleaching, causing structural changes in the restorative material.[4, 18], moreover the presence of the inorganic composition in lithium silicate that tend to be easily dissolved by the potent oxidizing and reducing effect of hydrogen peroxide.

However, Laser and Carbamide Peroxide groups were comparable in terms of biaxial flexural strength. This can be explained by the presence of Urea in Carbamide peroxide that buffers the acidity of Hydrogen Peroxide. On the other hand, the time factor played by the photochemical reaction initiated by Laser, resulted in a faster whitening process despite the high concentration of Hydrogen Peroxide used. These results were supported by **Tsubura S in 2010**[19] who evaluated the bleaching effect using Polanight 10% carbamide gel on teeth discolored by tetracycline with 3 months' active treatment, the participant satisfaction, the shade stability and the post-treatment side effects 2 years after the treatment. The whiteness-blackness difference (L*) became lighter within 3 months and the lightness remained until 2 years later. Tooth color changes were remarkable in both redness-greenness difference (a*) and yellowness-blueness difference (b*). No obvious shade changes or slight darkening was recognized 2 years post-treatment.

For Vita Enamic, there was a significant difference between samples subjected to different bleaching protocols ($p<0.001$). The highest value was found in control group, followed by carbamide peroxide, then hydrogen peroxide and finally Laser group (with no statistically significant difference among them). Bleaching agent caused destruction of the organic components in the polymer part (14 wt%) through the oxidizing ability of hydrogen peroxide as well as the biomimetic feature of Vita Enamic that came in consistent with the results of **Carvalho, A. O et al in 2015**[20] whom studied the effects of 10 % carbamide peroxide and 38% hydrogen peroxide on the biaxial flexural strength and flexural modulus of bovine dentin. Results showed that the group bleached with 38% hydrogen peroxide demonstrated significantly lower flexural strength than the unbleached control group.

Concerning Micro hardness

In this study the null hypothesis was rejected, and the results of micro-hardness showed that there was a significant interaction between type of ceramic material and bleaching protocol used ($p<0.001$).

Regardless of the bleaching protocol used, Celtra Duo samples had a significantly higher values than Vita Enamic samples. This goes back to the zirconia particles in the Celtra Duo's microstructure which are capable of resisting surface corrosion from the bleaching agent. In case of Vita Enamic, the free radicals from the bleaching agent attack at the interface between the dual network (inorganic filler and the resin matrix) causing those fillers to disintegrate from the material surface.[12-15]

For Celtra Duo, there was a significant difference between samples subjected to different bleaching protocols ($p<0.001$). Bleaching agents tend to release free radicals which are extremely reactive and prone to inducing an acidic environment during bleaching, causing structural changes in the restorative material,[4, 16] that explains why the control group showed highest value while the lowest value was found in Hydrogen peroxide group, the presence of the inorganic composition in lithium silicate tends to be easily dissolved by the potent oxidizing and reducing effect of hydrogen peroxide.

However, Laser and Carbamide Peroxide groups were comparable in terms of micro-hardness. This can be explained by the presence of Urea in Carbamide peroxide that buffers the acidity of Hydrogen Peroxide. On the other hand, the time factor played by the photochemical reaction initiated by Laser, resulted in a faster whitening process despite the high concentration of Hydrogen Peroxide used. These results were in contradiction with **Polydorou et al in 2007** [3] whom conducted an in vitro study to evaluate the effect of 15% carbamide peroxide home bleaching on the microhardness of six restorative materials (Four resin-based composite materials "a hybrid, flowable, micro-hybrid and nanohybrid", ormocer and Vitablocs Mark II) under different surface treatments. It was concluded that at-home bleaching technique didn't have a statistically significant effect on the microhardness of any of the restorative materials tested. This contradiction might go back to the usage of only one type of bleaching protocol, while this study used different bleaching protocols with different concentrations, which might be responsible in part for differences in the findings of both studies.

For Vita Enamic, there was a significant difference between samples subjected to different bleaching protocols ($p<0.001$). The highest value was found in Control group, while the lowest value was found in Laser group. It is clearly evidenced that hydrogen peroxide possesses extensive diffusion capability[21] by initiating the oxidation and reduction reaction through its free radicals.[16]

The hydrogen peroxides are able to segregate the polymer chain, especially at the site of double bonds, which are the most vulnerable parts of the restorative polymers.[22] Since the free radicals prefer to attack at the interface between the inorganic filler and the resin matrix, this can cause those fillers to disintegrate from the material surface.[15-17] Thus, a significant reduction in surface hardness after bleaching was observed in Vita Enamic® because it contains highly cross-linked polymer matrix and fine nano inorganic filler particles. The surface hardness of the polymer infiltrated ceramic is influenced by the amount and the type of inorganic fillers as well as percentage of bleaching agents. Thus, the cleavage effect that hydrogen peroxide has on the resin matrix of these resin polymers is responsible for the decrease in surface hardness. These results were in agreement with **Juntavee N et al in 2018** **[23]** whom conducted an in vitro study to evaluate the effect of light-emitting diode (LED) illumination bleaching technique (35% hydrogen peroxide) on the surface nano-hardness of various (CAD/CAM) ceramic materials (Lava™ Ultimate, Vita Enamic®, IPS e.max® CAD, inCoris® TZI, and Prettau® zirconia), with and without LED illumination. Results denoted that using 35% hydrogen peroxide bleaching agent with LED illumination exhibited more reduction in surface hardness of dental ceramic than what was observed without LED illumination. Also supported by **Karakaya et al in 2017** [24] whom evaluated colour stability, discoloration ability of different solutions, efficacy of 2 office bleaching agents: Perfect Bleach Office Plus (35% HP) and Opalescence Boost (40% HP), and surface roughness and topography of 3 restorative materials: Clearfil Majesty Esthetic (CME), Lava Ultimate (LU), and Vita Enamic (VE). They were immersed into 3 staining solutions for 2 weeks and then they were bleached. After staining, CME groups and control groups of LU and VE showed clinically acceptable colour changes (ΔE_{00} < 1.8). After bleaching, while a reverse effect on colour was observed, VE showed the furthest colour values to pure white. Most of the VE groups and a control group of LU showed surface roughness (R_a) values higher than critical value for biofilm accumulation (0.2 µm). Laser modifies the surface via ablation mechanism. The laser energy absorbed by the water causes vaporization, and micro explosions occur, resulting in irregularities at the surface. Laser uses not only existing water in the tissue but also exogenous water for ablation. The water present in the resin matrix helps explain the diminution in the hardness present with the material.[25] There is no enough data in literature about effect of laser bleaching on the different restorative materials, further researches in this aspect is needed.

A limitation of the present study was its in vitro design, whereas in clinical situations, restorations are constantly exposed to various factors with various responses.

Bleaching will remain a treatment option always demanded by patient so effect of type of bleaching method on properties of restorative material must be studied thoroughly in order to conclude which bleaching method is safe to use with each material

CONCLUSION

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

- Bleaching resulted in a diminution of both biaxial flexural strength and surface hardness of Celtra Duo and Vita Enamic.
- Regardless of the bleaching protocol used, Celtra Duo had a significantly higher values than Vita Enamic in both flexural strength and surface hardness.

- Bleaching protocols differ in their effect on ceramic materials so different bleaching protocols should be tested with each material to recommend the safest one with each material.

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